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SMS BASED SYSTEM TO PROVIDE CATTLE HEALTH CARE INFORMATION IN MANDERA COUNTY

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Declaration

I Abdifatah Mohamed Abdullahi declare that this research project is my own original project and has not been presented anywhere for the purpose of an academic award.

Signature: _____

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P56/61392/2013

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Signature: _____

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List of Abbreviations

AHAs - Animal Health Assistants

ASALs - Arid and Semi-Arid Lands

CAHWs - Community Animal Health Workers

CCPP – Contagious Caprine Pleuropneumonia

DFD - Data Flow Diagram

EAFF - Eastern Africa Farmers Federation

FAO – Food and Agriculture Organization

G**DP -** Gross Domestic Product

GoK - Government of Kenya

GSM - Global System for Mobile communication

ICT – Information Communication Technology

ICT4Ag - Information Communication Technology for Agriculture

IMF - International Monetary Fund

KDGCBP - Kenya Dairy Goat and Capacity Building Project

KEVEVAPI - Kenya Veterinary Vaccines Production Institute

MAS - Mobile Authentication Service

PAHWs - Primary Animal Health Workers

PHP – Hypertext Pre-processor

PPR - Peste des Petits Ruminants

SAPS - Structural Adjustment Programmes

SMS - Short Message Service

SPSS – Statistical Package for Social Sciences

TMS - Traditional Medicine System

UNADA- Uganda National Agro-Input Dealers Association

WB - World Bank

Abstract

Background: The livestock sector in Mandera County provides livelihoods for majority of the residents who are mostly small-scale livestock producers. Not only is it a key source of food and nutritional refuge for consumers but also acts as "mobile bank" to provide security during droughts (Waithera 2011). This implies that fighting livestock disease is an inevitable task and a big headache to this marginalized community. However, veterinary services provided by the government rarely go beyond vaccination in these areas implying least accessibility (Leyland et al. 2014). The livestock producers are experienced in disease diagnosis and treatment using indigenous knowledge and ethno-veterinary medicines but are not knowledgeable in determining dosage rates, way of administration and quality of the available veterinary pharmaceuticals (Munyua, Farrah and Kahiu 1999). Despite this, mobile applications has been espoused to lower healthcare costs and improve its quality of healthcare as well as shift behavior to strengthen prevention, all of which can improve health outcomes over the long term (Anand and Srivatsa 2014, Qiang et al. 2011).

Objectives: to determine the system needs, to determine the potential of SMS in facilitating access to livestock health information as well as to develop and deploy a working prototype of SMS based livestock health Information system and a database with information livestock symptoms and treatment.

Methodology: The design of this system followed the Systems Development Life Cycle. The study sampled 17 livestock keepers at each Sub-county (system users) and 10 Ministry of Livestock staff and veterinary doctors (3 public and 2 private) who were the stakeholders at Mandera County while usability testing targeted 50 system users. Systems requirements, design considerations and usability were obtained from interviews and questionnaires with stakeholders and users respectively. Quantitative data was analyzed using SPSS version 20 while qualitative data was analyzed through content analysis. From pre-study findings, majority (90.7%) owned a mobile phone (93.2% basic phones) although 74.2% had no formal education. Animals kept by sometimes fell sick but 48.5% of them administered drugs from agro vets without consulting veterinary doctors because of their inaccessibility both in terms of unaffordability, geographical distance and unavailability. Although all were willing to use their phones to access animal health information especially in Somali language, none of them had used it before.

Results: The prototype developed being user initiated system was appropriate for the type of phones owned by the livestock keepers since it aided them to access animal health information. The system usability testing indicated that the users were elated by the system interaction, speed, language, clarity and accuracy.

Recommendation: As livestock keepers tend to administer drugs from agro vets directly without consulting veterinary doctors posing a great danger to their animals, there is need of scaling up of such prototypes to increase accessibility of expert animal health information to the livestock keepers.

CHAPTER ONE: INTRODUCTION

1.1 Background of The Study

1.1.1 Overview of Mandera County

Mandera County located in North Eastern Kenya borders Ethiopia towards North, Somalia on the East and Wajir County on the Southern side. The distance from Nairobi to Mandera town is about 1,100km by road. The approximate population of the county is about 1,025,756 persons and covers a total area of about 25,991.5 km^2. Administratively the county is segmented into six Sub-counties including Mandera West, Banisa, Lafey, Mandera South, Mandera North and Mandera East and additionally to 30 administrative wards.

Being an ASAL area, nomadic pastoralism involving rearing of camels, goats, sheep and cattle is main source of livelihoods in the County. The vast pasture land makes this source of livelihood economically viable. However, water for livestock and human beings consumption is a problem in this county with River Daua and a few shallow wells and major earth pans being the only source of water. Although in minimally practiced, small scale farming of onions, kales, bananas, papaws and mangoes are produced and supplied to the local market.

1.1.2 Background

The agricultural sector in combination with the livestock sector in 2014 accounted for 30.3% of total Kenya GDP with the livestock sector contributing about 12% of this total GDP; 40% of the agricultural GDP and 30% of farm-gate value of agricultural commodities (KEVEVAPI 2014; World Bank 2015). Pastoralists make-up 13.2% of Kenya's population, with livestock as their major source of livelihood and food security by supplying 70% of the livestock products in the Kenyan (Obando et al. 2010). In the pastoral livelihood (constituting 80% of main livelihood) about 60% of the population is semi nomadic; 15% fully nomadic (using 90% of the land) while 20% are occasional nomadic (Oyugi and Ngugi 2013; David et al. 2014). Livestock products have been proven to significantly deliver on the needed nutritional benefits milk, meat, and blood. Animal source foods are also the preeminent source of essential micro-nutrients, for

example vitamin B12 which is important in development of children in terms of physical and cognitive development (Eastern Africa Farmers Federation (EAFF) 2012).

Moreover, the situation analysis revealed that livestock situation in Mandera typical of agro-pastoral and pastoral systems in East Africa is inhibited by effects of the climate change resulting to regular droughts and floods which stress pasture and water resources as well as increases pests and diseases thus compromise livestock production (EAFF 2012). Furthermore, within these systems there is limited extension services compounded by inadequate access to financial services and livestock insurance in the event of an adversary thus drives poverty and vulnerability of this society (Mude et al. 2009). Moreover, in this area there has been no ICT systems designed for livestock support, such as, Mobile healthcare system which has been appraised with significant reduction in productions costs and livestock healthcare quality improvement as well as shift behavior in support disease prevention, which in altogether serves to improve health outcomes in the long-run (Anand and Srivatsa 2014; Qiang et al. 2011).
On the other hand, Mobile-health (M-health)—the use of mobile applications for livestock healthcare is a relatively still in infancy and vibrant area with the potential of improving animal welfare around the world. ICT-based agricultural extension services have the potential of empowering rural farming communities rendering the need of increasing number of extension staff invalid as well as improving information even among the illiterate farmers (Asenso-Okyere and Mekonnen 2012). The merger of health, technology, and finance through m-health is an intricate industry where it can be challenging to develop sustainable business models.

The livestock sector in Mandera County provides livelihoods for majority of the residents who are mostly small-scale livestock producers. Not only is it a key source of food and nutritional refuge for consumers but also serves as a mobile bank to provide livelihood-safeguard during droughts (Waithera 2011). This implies that fighting livestock disease is an inevitable task and a big headache to this marginalized community. However, veterinary services provided by the government rarely go beyond vaccination in these areas implying least accessibility as government has not employed sufficient number of veterinary officers (Leyland et al. 2014). The livestock producers in this area, although majorly illiterate, are knowledgeable in disease diagnosis and treatment via native knowledge and ethno-veterinary medicines but are not knowledgeable in determining dosage rates, way of administration and quality of the available

veterinary pharmaceuticals (Munyua, Farrah and Kahiu 1999). Ethno-veterinary medicine is a traditional method of treating livestock that endeavors to legitimize and authenticate its application (Köhler-Rollefson and Bräunig 1998; Mashanyare 2012; Mahmoud and Eftekhari 2013).

As defined, several studies discussed so far, more research was needed to have proper SMS based system to provide cattle health care information in Mandera County. With the use of the extensive mobile networks in Mandera County and the availability of mobile phones to majority residents, this project will therefore seek to provide Short Message Service (SMS) based expert system to store and disseminate ethno veterinary medicine information to the local community and for the future generations. This study assessed and appraised the present-day situation of Mandera livestock and how mobile healthcare application can be supported to the cattle live in Mandera County.

1.2 Problem Statement

Livestock sector in 2014 accounted about 12% of total Kenyan GDP; 40% of the agricultural GDP and 30% of farm-gate value of agricultural commodities (KEVEVAPI 2014; World Bank 2015). In Mandera County, pastoralism constitutes 80% of main livelihood (Oyugi and Ngugi 2013; David et al. 2014). Livestock situation in Mandera, typical pastoral system in East Africa is inhibited by effects of the climate change resulting to regular droughts and floods which stress pasture and water resources as well as increases pests and diseases thus compromise livestock production (EAFF 2012). People in Mandera are pastoralist and depend on cattle of which 80% of the cattle die due to lack of treatment. Pests (tsetse fly and ticks) and diseases (East Coast Fever, Trypanosomiasis, Rinder pest and Anthrax) are common in Mandera. This has contributed to the death of many herds of animals and enhanced poverty levels within the County. Areas in Mandera are inaccessible and veterinary services are scare making it difficult to treat or improve the animals given that the pastoralists are always on the move. Due to all these problems, there is a need to develop a system that will assist to reduce the cattle death and which is readily available regardless of one's locality at any particular time in Mandera County.

Farmers lose their livestock to treatable and manageable conditions because of lack of immediate healthcare attention since animal healthcare services are far away in the county headquarters and

the farmers keep moving from one place to another in search of pasture. This system hopefully helps farmers get information about what a sick animal could be suffering from and the necessary treatment. The farmer would then administer the medication while monitoring the cow/goat for improvement.

1.3 Objectives

The general objective of this project was to develop and deploy a working prototype of SMS based livestock health Information system and a database with information livestock symptoms and treatment. The system is user initiated SMS enquiry. A web portal for detailed diagram representation of the practical aspects is available both on computers and internet enabled mobile phones. The project specific objectives were:

1. To obtain the needs of the system users and other relevant stakeholders.
2. To assess the potential of SMS in facilitating access to livestock health information in pastoral Mandera County.
3. To design, deploy and test usability of a Multi-Lingual SMS based prototype system reachable to farmers in the in their native languages.

1.4 Scope

This project involved the development of SMS based system prototype for providing livestock healthcare information in Mandera County. A central database served as information repository reachable via an interface application that is responsible for receiving and processing user request before finally responding to the user with a reply. A web portal developed to aid system data manager to input information about symptoms, treatment as well as update the same, the portal development used hypertext pre-processor (PHP) language and MySQL database management system for back end. SMS was used to query animal health information from the database and the output received by the user will be textual.

1.5 Significance of The Study

The SMS based system to provide cattle health care information in Mandera County hopefully helps reduce large herds of cattle death and boost farmer's productivity and food security. Thus contributing to putting the region to the international levels in terms of cattle production.

1.6 Justification

Farmers loose thousands of livestock to manageable diseases because of lack of knowledge on how to treat manage the animal. Since accessibility to government livestock health services is impossible for the pastoralist community of Mandera County, this system addresses the gap of providing immediate response on treatment and management of an ailing domestic animal.

The system offers the following benefits to the users and other relevant stakeholders

1. The government is able to analyze the information provided by users to know which diseases are prevalent in the area and possibly take necessary administrative action.
2. Farmers are able train themselves on animal disease symptoms and therefore be able to apply relevant treatment to the cow / goat while at the same time sharing information to the farmers who are unable to access the system.
3. The system interacts with user in their own native local language and therefore clarity of information is guaranteed

CHAPTER TWO: LITERATURE REVIEW

2.1 Animal Disease Surveillance

According to Cameron (2012) each country in the world has an animal disease surveillance system. Surveillance and monitoring efforts are critical elements to effectively prevent and control disease (Wendt, Kreienbrock and Campe 2013). Surveillance helps to comprehend health status of a country's animals in order to identify problems and take necessary actions (Cameron 2012). However, surveillance needs and surveillance capabilities vary from country to country: for example, poor countries like in Sub-Saharan Africa have uncontrolled land borders implying it is nearly impossible to avoid regular disease outbreaks thus such countries will not maintain advanced disease surveillance but will primarily attempt to minimize the impact of these outbreaks. Disease surveillance is also important since human health and animal health is indivisibly linked, necessitating their monitoring to improve their prevention, prediction and control (Wendt, Kreienbrock and Campe 2013).

Current animal disease surveillance in Kenya are conducted by the Department of Veterinary Services but has limited reach in its monitoring efforts are thwarted since it relies on paper reports of notifiable diseases which means it will take longer time for these disease notification to reach central database (Walker, Ogola and Knobel 2011). This time delay can have overwhelming negative effects for example during the 1977 outbreak of the Rift Valley Fever, 400 people died before being reported at the national level and in later studies it was indicated that the deaths were preceded by high rates of abortion and death in the livestock owned by the affected community (Shears 2000). The livestock disease surveillance implementation in Kenya is hugely impeded by inadequate road network and electricity infrastructure given that most livestock keepers, especially pastoralists, live in far interior of the country (Walker 2013). Electronic transmissions over mobile networks results in a more timely transmission of surveillance data and trigger alerts of outbreaks of zoonotic diseases as well as allow early enough outbreak preventive measures to be taken (Institute of Medicine and National Research Council 2009). As a preventive measure, disease surveillance is designed to reduce animal health-related risks and mitigate on the major consequences of disease outbreaks on food production and livelihoods of farmers (Patil and Kulkarni 2012). Key factors for effective surveillance systems include proper system purpose definition, constantly redefining system

objectives and surveillance targets, an appropriate structure and flow of information, institutionalizing and formalizing the surveillance network, evaluating constantly system's effectiveness, characterization of specific targets, and acceptability by users and stakeholders (FAO 2011). By conducting disease surveillance it is possible to detect emerging diseases other than those that are currently notifiable however it is dependent on the quality of data collected in all echelon (FAO 2011; Patil and Kulkarni 2012).

Evidently, many zoonotic diseases are emerging in low-income and middle-income countries, animal health surveillance in these areas is needed to predict these human risk diseases and advise at-risk populations as well as implement public health measures to control it (Robertson et al. 2010; FAO 2011). Timely and quality information on disease events are necessary in understanding disease status, support decision-making, mitigate disease spread and quickly intervene in emergency situation (FAO 2011). Robertson et al. (2010) further argue that linking animal and human health data has been difficult because animal and human health surveillance systems data are gathered for different purposes and are measured at different scales. In a study in Sri Lanka, it was found out that mobile phone–based surveillance of animal diseases was acceptable and feasible in lower-resource settings (Robertson et al. 2010).

2.2 Livestock Health Information System

Animal health information systems exist in most developed countries practicing intensive livestock production systems since they strategically help enhancing production efficiency while in many developing countries public sector health information on disease incidence are often undeveloped (Perry et al. 2002). According to Perry, Randolph and McDermott (2001) with dramatic decline in public sector support in many developing countries, this situation has further deteriorated over the last decade. Furthermore, with such limited resources, data on disease occurrence mostly comes from commercial production systems and accessible regions and therefore the data on the diseases of those poor livestock keepers are very limited further hindering assessment of diseases status (Thornton 2010). Information management is fast becoming the key to effective action in animal health in the modern world, thus require effective systems to collect appropriate information from the field, properly analyzing to provide optimum

value, and presenting in an easy to use form to instigate appropriate actions to achieve effective disease control (Morris 1991).

According to Mugunieri, Omiti and Irungu (2004) in Kenya, the veterinary service privatization program has had varied impacts, for example, in high potential areas keeping good breeds of dairy and beef animals are kept, private veterinary practitioners or government agencies at a fee handle herd health while in ASALs accounting for about 70% of Kenya's livestock, herd health management is the hands of livestock owners. Livestock keepers in these ASALs, especially Northern Kenya, keep primarily indigenous breeds under either pastoral or agro-pastoral production systems characterized by inadequate infrastructure, harsh climate (erratic rainfall and frequent droughts), high poverty levels and low literacy levels (Rakotoarisoa et al. 2008). Because of cost implications and low demand of qualified veterinary personnel, setting up of private practice has not been achieved in these ASALs areas, however, community-based animal health delivery systems has been initiated to meet the needs of these farmers as well as fill in the gaps left by the government (Osofsky 2003). It has been observed that the putting up of private practice by professional veterinary personnel has not been realized in these areas because of the cost of establishment and the low demand for these services (Mugunieri, Omiti and Irungu 2004).

2.3 SMS Based Livestock Health Information Systems

'iCow', an SMS queried information and education platform was developed by Green Dreams Ltd (Green Dreams TECH LTD 2015). iCow by improving their access to crucial agricultural information aims at helping smallholder dairy farmers to raise their productivity. Available in English and Kiswahili it has three main modules, namely 'Mashauri', 'Kalenda' and 'Vetenari'. The 'Mashauri' gives education and advice by regularly sending tips to farmers on how to properly keep their animals; 'Kalenda' is a calendar which aids in the management of estrus cycles and gestation periods for individual cows, calves and heifers; and 'Vetenari' gives farmers access to registered veterinary personnel database as well as a database of registered support services (ICT4Ag 2015). These means that iCow acts as a virtual veterinary doctor, midwife and farm agri-business adviser (Banks and Brown 2014). iCow helps up to a million farmers who use it to counter losses occasioned by animal diseases by providing farmers with accurate

information at the time of need (Ngouambe 2013). Furthermore iCow is free, simple, and can be used with any type of mobile phone. In the event of a disease outbreak, the system allows farmers to alert the system immediately thus everyone in the system can react to it quickly (Kahumbu 2012).

mFarmer is a SMS service that gives Ugandan farmers weather reports and prevailing product market information. mFarmer makes use of Frontline SMS, an open source system, to administer, send and receive mobile phone messages. The system helps farmers authenticate selected agro-chemicals before buying by sending to a short code number a 12 digit number obtained on scratching the card attached to the product. On receipt of the code, the manufacturer of the product replies with an instant message advising the buyer on whether the agro-chemical is a counterfeit or not. The system can be easily adopted by all farmers even in remote areas on any mobile phone because it is similar to loading airtime and is familiar to everybody. By providing product prices, mFarmer helps to prevent them from being exploited by crooked middlemen. mFarmer's success in Nakaseke is partly due to the high mobile phone network penetration in the local area (Frontline SMS Cloud 2013; CIO East Africa - Business Technology Leadership 2013). By the end of 2013, it had reached 600 farmers in the Nakaseke district.

M-Farm is a transparency tool for Kenyan farmers where they just SMS the number 20255 (Safaricom Users) to get retail price information of their farm, purchase farm inputs from manufacturers directly at better prices, and locate their products buyers (M-Farm LTD 2015). Farmers send texts on their mobile phone about their produce on customized portal, and then the buyers directly link up with the farmers thereby cutting out the need for unscrupulous middlemen (Mwesigwa 2014). The M-farm also features an educational platform that educates farmers on new agricultural technologies and tips on how to meet market demand and through this platform also the farmers are able to seek solutions for the unique challenges they may be bothering them. As at 2015 April M-farm had over 100,000 farmers using the system from 100 in 2011 (Oooko 2015)

An SMS based reporting system introduced in 2007 by Orissa (India) Animal Husbandry and Veterinary Department to cost-effectively enable access to animal health care related information and breeding services to all the representatives of the department (South Asia Pro-Poor

Livestock Policy Programme 2013). Under this system mobile phones facilitate data collection and information dissemination while the well trained Management Information System staff provides back end support to compile, analyze and communicate information. This system has been argued to have had a marked impact in livestock production improvement among Orissa farmers due to better market demand and improved animal health as well as better quality livestock extension services within the State (Turner and Berkeley 2004).

The mKRISHI designed by Tata Consulting Services in India provides remote extension services that allow two-way interactions providing personalized advice to Indian farmers on low-end mobile phones who query the uses the system to access best practices and query agricultural experts mostly using SMS (Banerjee 2010). Using an automated database of FAQs, the system responds to farmers' queries but in more sophisticated questions is forwarded to 10 experts with internet access who interact with email-resembling system where they will be able to see photos and soil sensor information sent by the farmer, however, the response from the experts get to the farmers through SMS. This system aids farmers in disease or pest identifications as well as helps recommend on how best to handle the situations. Through the system advisory, it has helped individual farmers significantly reduce inputs-associated costs associated, increase yield and improve quality of produce (Sethu, Agaskar and Badaskar 2013). mKRISHI was first introduced to 500 farmers in two Indian states in 2010 but expansion plans for nationwide rollout are underway (Sen and Choudhar 2012). The sustainability of the mKRISHI platform is still debatable because of the platform problems emanating from numerous pieces (people, technologies and automatic sensors) that are interlinked making they the system difficult and expensive thus challenging on its sustainability (Sen and Choudhar 2012; Sethu, Agaskar and Badaskar 2013).

Huduma Kwa Wakulima, a Kenya Farmers Helpline was launched in 2009 by KenCall in collaborative support from the Rockefeller Foundation. With this system farmers call the Helpline directly and speak with an agricultural expert in English or Swahili (Sen and Choudhar 2012). The helpline operates through a content and customer management system which has farmer information, content and questions and answers stored (Kencall Outsourcing Ltd 2015). At twenty-five cent call on their mobile phone, farmers in Kenya can save by getting hands-on advice on their farming and livestock strategies providing massive return for the farmer (GSM

Association 2015). GSM Association (2015) estimates that around 43% of the calls to Kencall's Kenya Farmers Helpline are from women farmers, who rarely receive expert opinion and consultancies extension officers.

Dynamic frontline knowledge mobilization designed for primary animal health workers (PAHWs) based in the community was developed in Vientiane (Laos) as smartphone-based knowledge gathering technology for enhancing knowledge and expertise of the PAHWs in animal farming practices (Fèvre et al. 2014). In this case the PAHWs are the local farmers but the system also involved project facilitators. The system enabled sharing information and solidification of the PAHWs network in the field. Fèvre et al. (2014) on testing effectiveness of the system in enhancing capacity of PAHWs in animal farming practices; findings indicated that PAHWs positively appraised positively to the system as they saw its convenience, they also saw it as comparatively user-friendly for knowledge acquisition and reference since the PAHW reported applying it to answer queries raised by poultry farmers and further more they shared the system with fellow farmers.

Bhavsa and Arolkar (2012) proposed an architecture that tries to extend health care from traditional veterinary hospital setting to Wireless Sensor Network based remotely on health monitoring and diagnosis system for animal. By using this system (animal fitted with body sensors), we would get information and symptoms of the possible illness and disease of the animal on runtime as well as monitor environmental surroundings of the animal. In case of any adverse changes in bodily signs the system would then send the readings for analysis and diagnosis to the farmer or veterinary officer. Since monitoring is done at where the animal lives it does not necessitate travel to the treatment facilities, thus much safer and more opportune (Bhavsa and Arolkar 2012). The system will also allow farmers in remote place to consult doctors as well as allowing also rural based doctors to consult with specialists in urban area if need be similar to telemedicine.

While implementing a Kenya Dairy Goat and Capacity Building Project (KDGCBP) in Mwingi and Kitui Districts, a system incorporating a web-network of Animal Health Assistants (AHAs), Community Animal Health Workers (CAHWs) and Veterinary Surgeons was presented. The system linked farmers to trained CAHWs, who give elementary animal health care services in

the villages, and they in turn were linked to the AHAs (Kithuka, Mutemi and Mohamed 2007). The system not only allowed the animal health care service providers to be updated on animal health issues but also enabled them share information on availability of essential veterinary drugs and perfect the referral system thus resulting in reduced transaction costs and transport costs. By using SMS or the community phones to contact a CAHW, AHA or vet instead of having to walk very long distances to look for them the system made the lives of the farmers more easier as well as enabled the beneficiaries to get informed on surrounding issues of disease occurrences and developments in the livestock market.

According to Donovan (2012) to succeed, mobile services and applications also need to provide compelling value in terms of content and value for money especially for the poor where access to devices and networks is insufficient. Therefore agricultural programs using mobiles should be deliberately designed with cognizance to equity so as not to exacerbate inequalities in social structures (Donovan 2012). The above systems reviewed do not address issues to do with pastoralist community who are constantly on motion looking for water and pasture and therefore this project intends to develop a system that farmers themselves query for animal healthcare information.

2.4 Proposed Solution

The general objective of this project was to develop and deploy a working prototype of SMS based livestock health Information system and a database with information livestock symptoms and treatment. The system is user initiated SMS enquiry. A web portal for detailed diagram representation of the practical aspects is also available both on computers and internet enabled mobile phones. The system provides cattle health care information in Mandera County thus reducing large herds of cattle death and boost farmer’s productivity and food security

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Research Methodology

In the literature, the difference between quantitative, qualitative, or combining both approaches have been debated. Choosing an approach depends on the nature of the research, the different types of required information, the context of the study, and the availability of the resources (time, money, and human). Quantitative approach is suited for providing estimates of populations at large by using statistical comparison between estimated populations (Sukamolson 2012). On the other hand, the most prominent method in quantitative is survey method which is suitable in gathering data from a large population (Borrego, Douglas and Amelink 2009). In consistent with research problems, our study has been chosen to use quantitative approach to answer the research problems and to generalize and simplify the existing approaches and enable to capture objective and complex phenomenon through measurable variables.

In addition, the design of the research approach affects the data types that can be collected, the analyses that are possible, and thereby the results that can be obtained. The design of the research approach affects the type of data that can be collected, the analyses that are possible, and thereby the results that can be obtained. Figure 1 shows the overall present research method process with their associated report chapters.

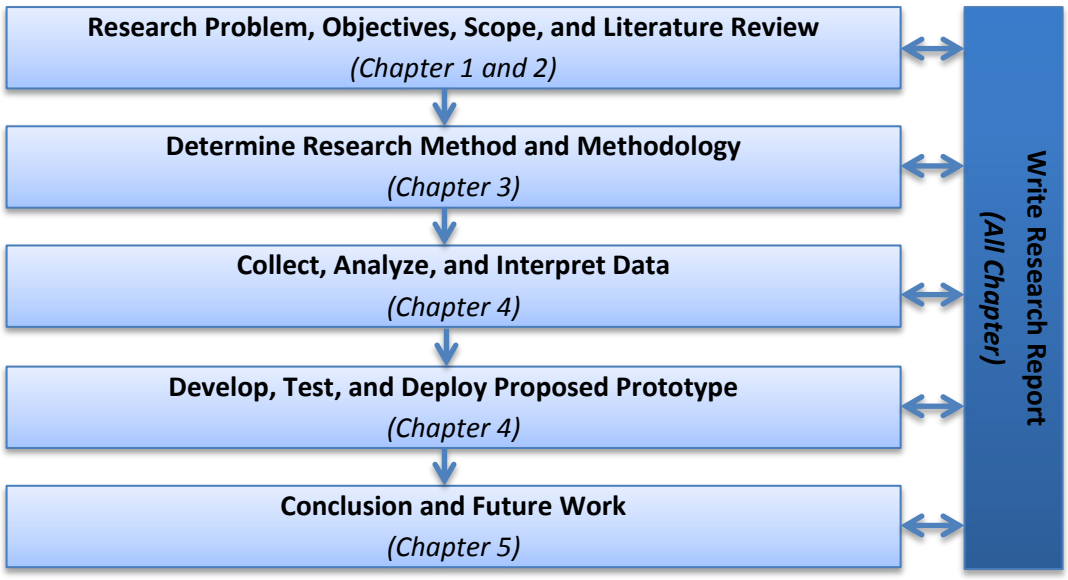

Figure 1: Present Research Method Process

In order to achieve these processes accurately, we developed research design phases that minimizes the risks of the study. Figure 2 describes the research phases of the research work.

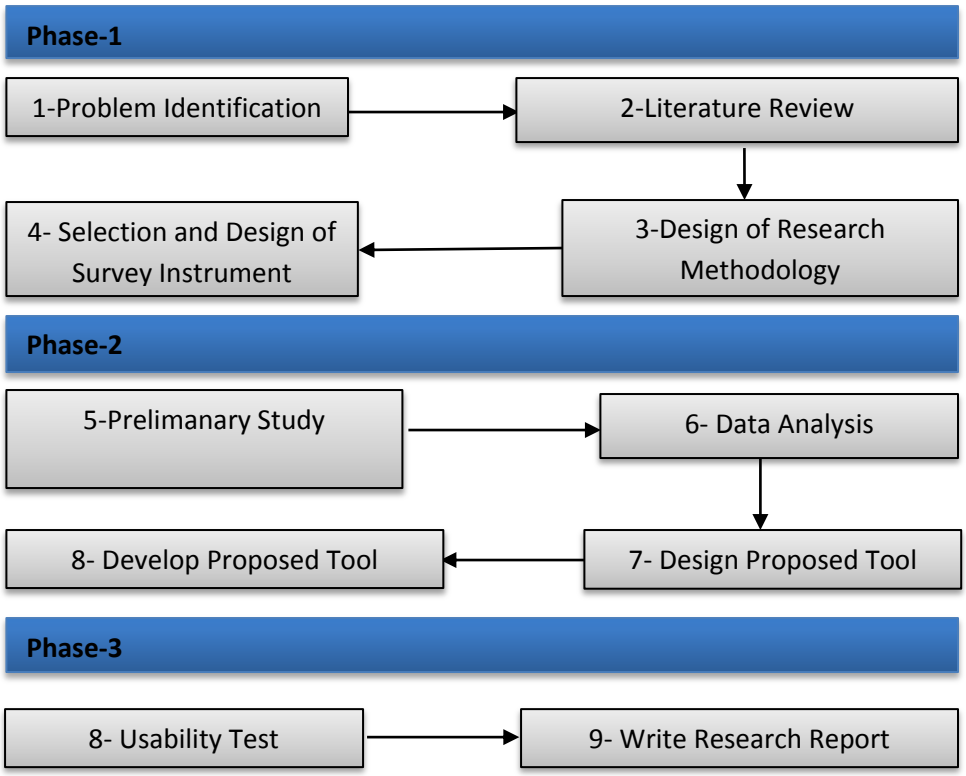

Figure 2: Research Phases

Phase 1: The research started by first indulging into the literature review. This was a long-standing process with the intention to understand the development and the state-of-the-art of cattle healthcare information system. During the literature review, the study has gathered the information of cattle healthcare information system to identify the meaningful of the research problem of the area. The next step was to identify existing tools to come up with appropriate approach. From the finding of this process, the methodology of the project and the selection of right methods are conducted in order to indent the most appropriate methods to conduct all research processes.

Phase 2: In this phase, the preliminary data collection was carried out to study and examine the identified problems in the healthcare information system for the targeted population. The result of this analysis, postulated the design and coding of the proposed prototype.

Phase 3: In the final phase, the usability test of the developed prototype was conducted. Finally the writing of the thesis was carried out to present all the information collected, analyzed, and conducted during this project.

3.2 System Design Methodology

The design of this system followed the systems development life cycle (SDLC), also referred to as the application development life-cycle. This included planning, creating, testing, and deploying an information system.

3.2.1 System Development Life Cycle Phases

The development phase will undergo the following stages

- **Project planning, feasibility study:** This established the high-level view of the intended project and determines its goals.
- **Systems analysis, requirements definition:** This phase refined the project goals into defined functions and operation of the intended application. End-user information needs were analyzed in this phase.
- **Systems design:** This described desired features and operations in detail, including screen layouts, business rules, process diagrams, pseudo code and other documentation.
- **Implementation:** The real code was written here.
- **Integration and testing:** This brought all the pieces together into a special testing environment and then check for errors, bugs and interoperability.
- **Acceptance, installation, deployment:** The final stage of initial development, where the software was put into production and run actual business.
- **Maintenance:** This takes care of what happens during the rest of the software's life: changes, correction, additions, moves to a different computing platform and more.

3.3 Choice and Challenges of Methodology

This methodology has been chosen because of the following strengths that it will bring into the project

1. Formal review is created at the end of each stage allowing maximum management control.
2. This approach creates considerable system documentation.
3. This documentation ensures that system requirements can be traced back to stated business requirements.
4. It produces many intermediate products that can be reviewed to see whether they meet the user's needs and conform to standards.

However, in spite of the strengths highlighted above the following challenges are expected with the Systems Development Life Cycle

5. What may be seen as a major problem for some, end-user does not see the solution until the system is almost complete.
6. Users get a system that meets the need as understood by the developers; this may not be what was really needed for them. There may be a loss in translation.
7. Documentation is expensive and time-consuming to create. It is also difficult to keep current. What may be current this month may not be the same this time next year!
8. Users cannot easily review intermediate products and evaluate whether a particular product (e.g., data flow diagram) meets their business requirements.
9. Another disadvantage of a program or software that follows the SDLC program is it encourages stiff implementation instead of creativity. There are requirements that must be met and that is all that developers complete.

Although both sides have been weighed up here, it is clear that the advantages are far greater than the disadvantages and hence this is the methodology that we shall follow.

3.4 Conceptual Design

The system was developed to be interactive to users as they query information about livestock health. The interaction is depicted by the Figure 3 below.

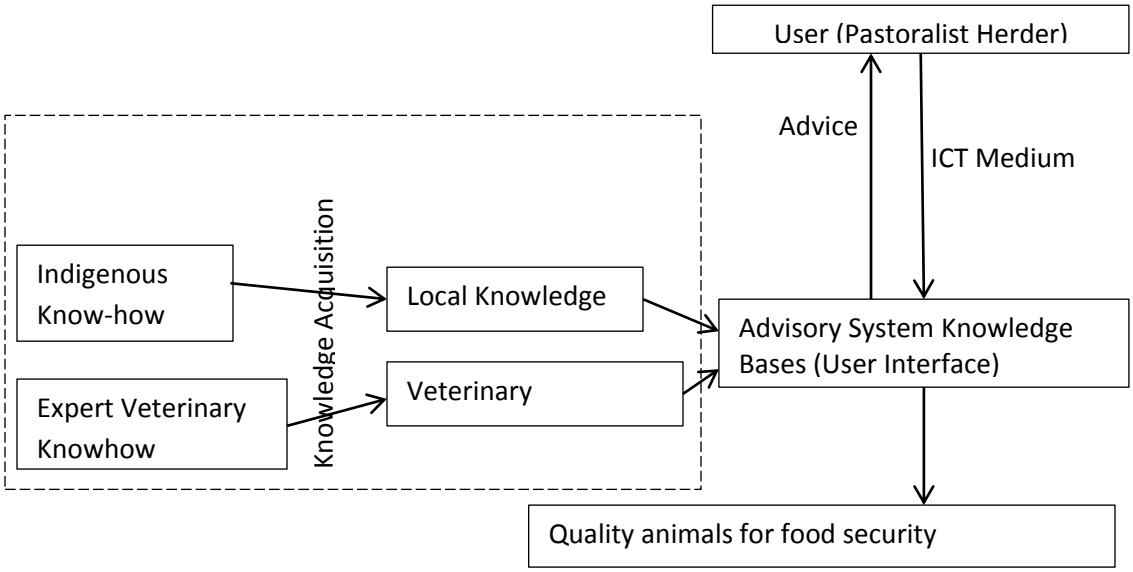

Figure 3: Conceptual Framework

The decisions made on animal health are made by the head of a household depending on existing advisory systems. The advisory systems entail both local and veterinary knowledge. Once the farmer consults the advisory system he will be equipped with sufficient knowledge on dealing with the existing problems thus resulting in quality animals hence enhancing food security within the locality.

3.5 Feasibility Analysis

The feasibility of this project has been outlined as follows

3.6.1 Economic Feasibility

Both hardware and software resources required for this project are readily available and affordable.

3.6.2 Technological Feasibility

Existing software technologies easily support both the development and implementation of this system to a live environment.

3.6.3 Operational Feasibility

The system's operation has been determined feasible since most users have mobile phones and are conversant with text messaging through Short Message Service (SMS).

3.6 System Testing Methodologies

Upon successful completion of the development phase the system was tested as follows:-

1. **Stub testing-** This test was performed on the individual modules in isolation to ensure an optimal performance per module.
2. **Program testing-** This test was performed after integrating the SMS module with the web admin to ensure that the events and modules that have been coded and stub tested for the program are tested as an integrated unit.
3. **Regression testing-** We carried out regression testing to extrapolate the impact of any changes on system performance (throughput and response time) by analyzing before-and-after performance against the test script.
4. **Acceptance testing-**This was carried out by helping participants to interact with the system so as to get their feedback. We used their feedback to improve the system.

3.7 System Research Design

The following is the system research design used for this report (See Table 1).

Table 1: Development platform

Database management System (Back-end)	MySQL
Programming Language	PHP
Scripting	JavaScript
User Interface	HTML

The interaction diagram depicts, (Figure 4) the flow of action between the user and the system.

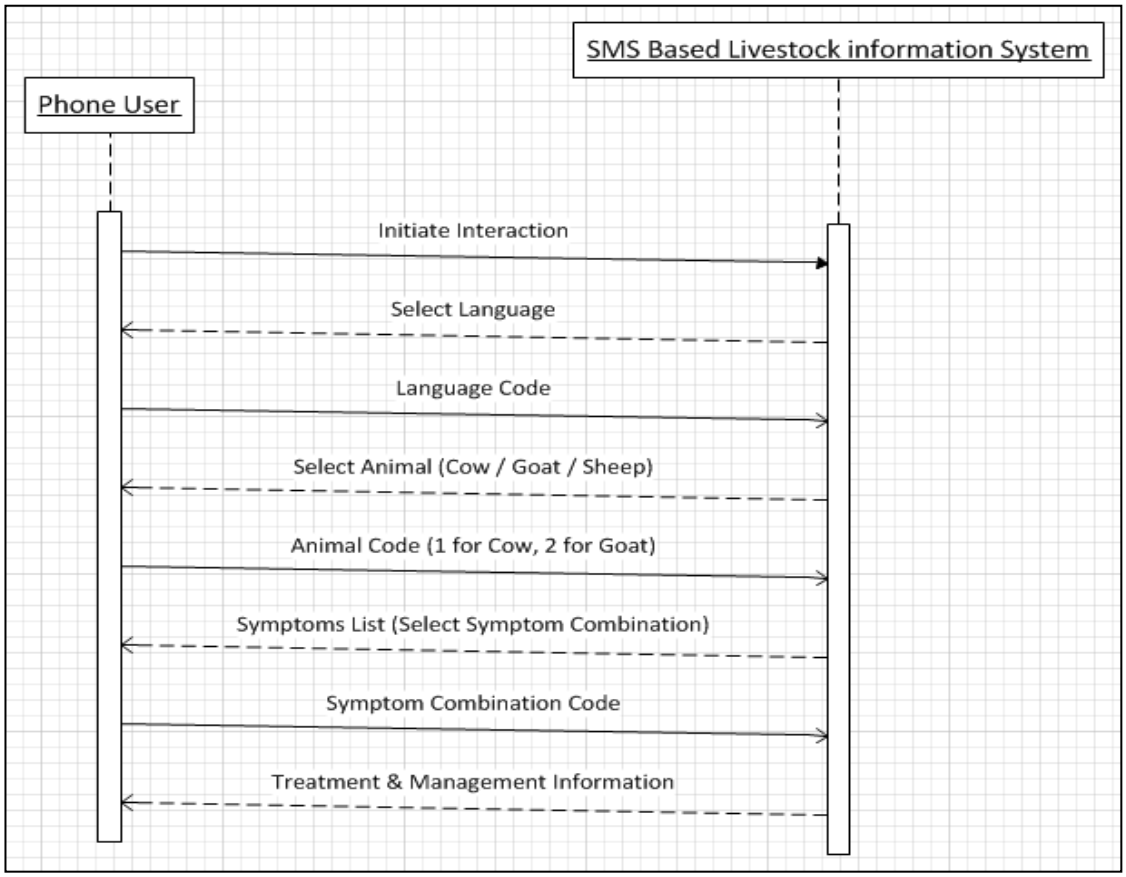

Figure 4: System Interaction diagram

3.8 Target Population and Sampling

3.9.1 Target Population

The study participants included livestock keepers who were the system users and Ministry of Livestock staff and veterinary doctors who were the stakeholders at Mandera County.

3.9.2 Sampling

To recruit the stakeholders, the researcher purposively sampled the stakeholders including 5 veterinary doctors (3 public and 2 private) and 10 other Ministry of Livestock staff at the County. The system users were sampled from the 6 Sub-Counties at Mandera which involved simple random sampling of 17 livestock keepers at each Sub-county.

3.9 Sources of Data and System Requirements

Systems requirements and design considerations were obtained from interviews and questionnaires with stakeholders and users. The study further made use of both primary and secondary data. Secondary data was obtained from approved Ministry of livestock vet section, e-journals, websites, conference papers, reports and books. Primary data was obtained from questionnaires and interviews administered to users and stakeholders.

3.10.1 Questionnaires

Questionnaires were administered to users of the system to identify the SMS based system potential, system needs as well as to test the system performance after implementation and during system changes. The questionnaires included both closed and open ended questions.

3.10.2 Key Informant Interviews

Key Informant interviews were conducted among stakeholders of the system among extension officers at the county to solicit their views on the needs of the system before designing the system.

3.10 Data Analysis

Quantitative data was analyzed using SPSS version 20 while qualitative data was analyzed through content analysis. Data collected on system needs was analyzed to identify the optimal system needs after will the system will be designed and piloted for system testing. Data collected during system testing was analyzed to determine the system usability will be analyzed.

3.11 Ethical Issues

The following ethical considerations were considered; respect for the respondents' freedom, the right to self-determination, privacy, volunteerism, confidentiality and avoidance of harm. The study was non-invasive and therefore the potential of doing harm was limited. The respondents were provided with information on the research and its intended purpose and informed consent was obtained from them. All the responses got from respondents were treated as confidential. The study was flexible to allow any respondent to withdraw if she/he feels uncomfortable to

continue with the study. The interviews were based on voluntary participation and only respondents who were willing to answer questions honestly were recruited. The respondents were not be paid or compensated for their participation.

3.12 Pre-study Findings

This section presents the pre-study inputs from the users relative to the study objectives. In a study to develop and deploy a working prototype of SMS based livestock health Information system and a database with information livestock symptoms and treatment, the researcher sampled 102 livestock keepers and 5 veterinary doctors from Mandera County. There was 95.1% response rate among livestock keepers and 60% response rate among veterinary doctors.

3.13.1 Socio-Demographic Characteristics

Majority of the livestock keeper respondents were aged between 30 and 39 years, male livestock keeper respondents composed of 72.2% while those with no formal education composed of 74.2% of the respondents (see Table 2).

Table 2: Demographic Characteristics

Characteristics	Categories	Count	Column N %
Age in years	30 – 39	36	37.1
	40 – 49	24	24.7
	20 – 29	23	23.7
	50 & above	11	11.3
	Less than 20	3	3.1
Gender	Male	70	72.2
	Female	27	27.8
Level of education	No formal education	72	74.2%
	Primary education	21	21.6%
	Secondary education	4	4.1%
	Tertiary education	0	0.0%

3.13.2 Potential of SMS in Facilitating Access to Livestock Health Information

Majority (90.7%) of the respondents owned a mobile phone while only 9.3% did not own a mobile phone (see Figure 5).

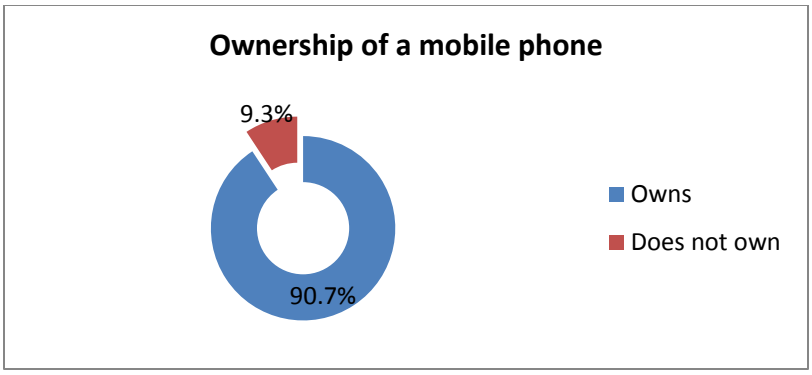

Figure 5: Ownership of a mobile phone

As shown in Table 3, majority of the respondents who owned phones owned a basic phone (93.2%) which they were using mostly (52.3%) on a daily basis. Most (78.4%) of these phones owned by the respondents were charged at the local centers.

Table 3: Type of phone, frequency of use and mode of charging

		Count	Column N %
Type of mobile phone owned	Basic phone	82	93.2%
	Feature phone	6	6.8%
	Smart phone	0	0.0%
Frequency of using mobile phone	Daily	46	52.3%
	Weekly	40	45.5%
	Monthly	2	2.3%
Mode of phone charging.	Electricity at home	8	9.1%
	Solar charging at home	11	12.5%
	Charging at the local centre	69	78.4%

Half of the respondents spent between 50 and 100 Kshs per month per week on airtime per week and on average all the respondents used 92.05 Kshs per week on airtime as shown in Figure 6.

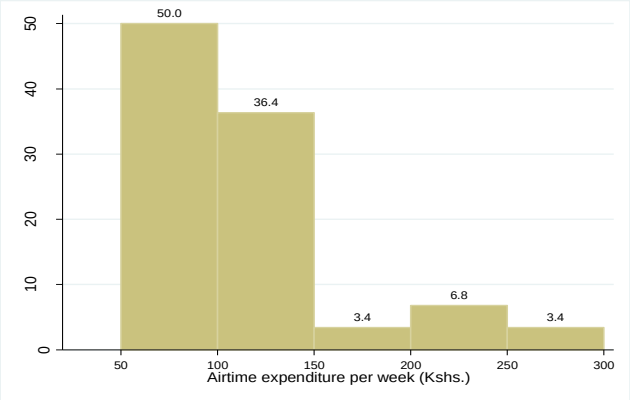

Figure 6: Airtime expenditure per week

None of the respondents had previously used a mobile phone to access animal health information while all the respondents reported to consider using a mobile phone based system providing animal health information. On a monthly basis the slightly more than half of the respondents proposed that the system providing animal health information system should cost between 50 and 250 Kshs as shown in Figure 7.

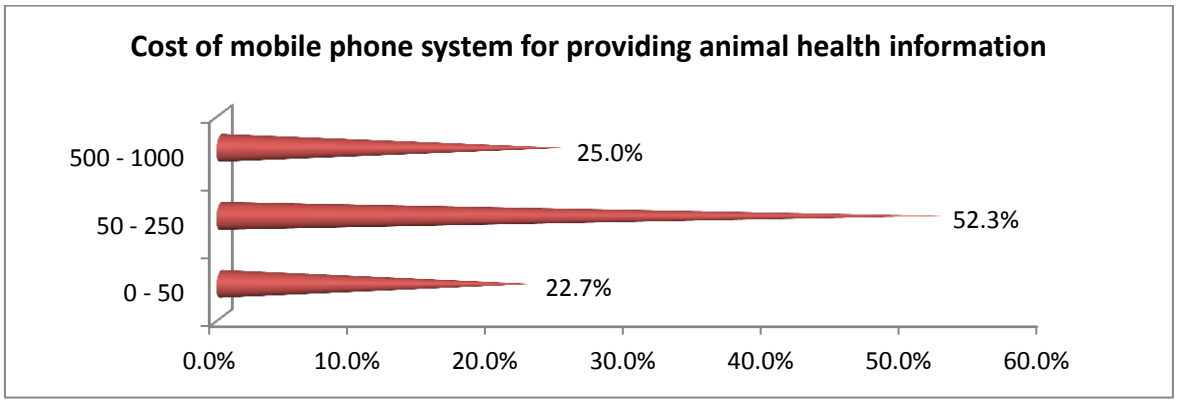

Figure 7: Proposed Cost of mobile phone system for providing animal health information

3.13.3 Needs of the System Users and other Relevant Stakeholders

Majority (74.2%) of the respondents kept goats while only 43.3% kept camels. According to majority of the respondents; cattle (65.2%), goats (59.7%) and sheep (57.4%) sometimes fell sick while came rarely (40.5%) fell sick as shown in Table 4. According to the Key Informants, diseases common affecting cattle, goats and sheep were babesiosis, CCPP, helminthiasis,

trypanosomiasis and PPR while diseases affecting camels were black quarter, anthrax and camel trypanosomiasis

Table 4: Frequency of animal sickness

Animal	Frequency of sickness				Total
	Never	Rarely	Sometimes	Always	
Cattle	5(7.6%)	14(21.2%)	43(65.2%)	4(6.1%)	66(68.0%)
Goat	0(0.0%)	17(23.6%)	43(59.7%)	12(16.7%)	72(74.2%)
Sheep	1(1.9%)	14(25.9%)	31(57.4%)	8(14.8%)	54(55.7%)
Camel	9(21.4%)	17(40.5%)	16(38.1%)	0(0.0%)	42(43.3%)

Nearly half (48.5%) of the respondents administered drugs from agrovets to their sick animals, 35.1% did nothing about their sick animals while an equal number (8.2%) administered local medication or sought veterinary advice from a doctor (see Figure 8).

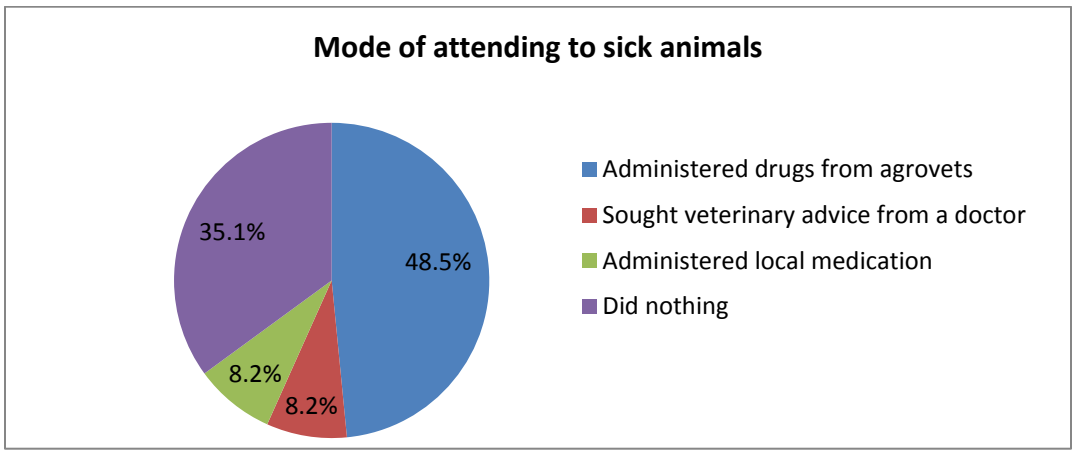

Figure 8 : Mode of attending to sick animals

Majority (76.3%) of the respondents had never sought veterinary advice from doctors for general heard health as shown in Figure 9. This was attributed to general inaccessibility of veterinary doctors both in terms of their unavailability, geographical distance and unaffordability of their services.

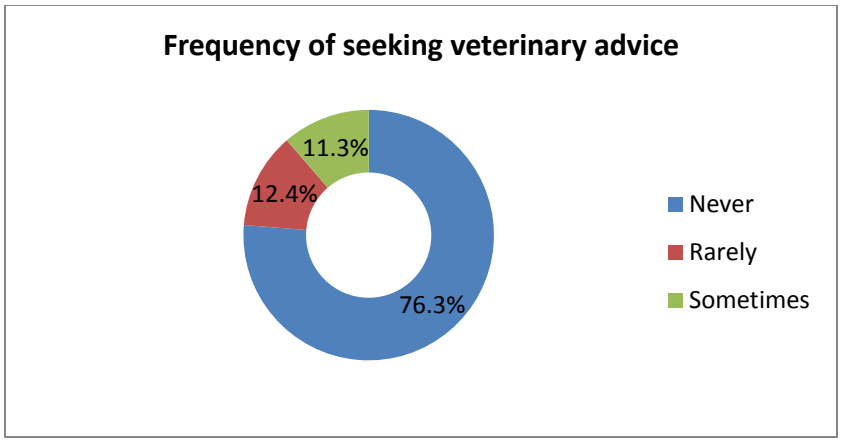

Figure 9: Frequency of seeking veterinary advice

According to majority (97.9%) of the respondents, they would prefer to use Somali language while accessing animal health information on mobile phones as shown in Figure 10.

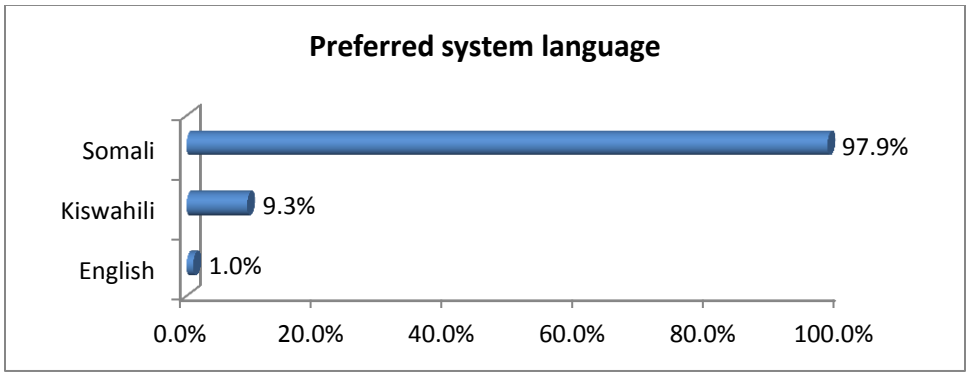

Figure 10: Preferred system language

CHAPTER FOUR: ANALYSIS AND DESIGN

4.1 Design and Deployment of a Multi-Lingual SMS Based System

4.1.1 Prototype Requirements Analysis

4.1.1.1 The Current System

From the analysis of the pre-questionnaires and the confirmation of user requirements by the public and stakeholders as shown above the following were discovered.

- There was no existing system in use
- This system would help a lot in educating farmers and helping them seek the first treatment of their cattle.

4.1.1.2 The Proposed System Prototype Requirements

Following the objectives of this system and the user requirements gathered from the participants who were interviewed or returned completed questionnaires, the proposed system envisaged the following functional requirements

i. The database should be able to receive and respond to cattle disease and treatment enquiries sent through SMS.

ii. The system should be able to compare the different search based on language and content of the disease symptoms and treatment searched.

iii. The system should provide Options to guide the users on the available cattle disease options.

iv. The SMS interaction should take the form of SMS chat but with specified options to guide the user.

4.1.1.3 Use Case Diagrams

This system is available on SMS. The user shall initiate the system by sending “110” to the Safaricom short-code 21446 as shown in Figure 11. Upon receiving the initiation code the system will respond by asking the user to choose the language they would like to interact with in the system. For the purpose of this project two languages were available that is English and

Somali. Upon selecting the language the user is then given a list of cattle disease symptom criteria based on established diseases. He will then be required to identify the criteria which best fit his cattle and then reply with the respective code. Upon reply at this stage the system will ask the user to choose an option for traditional medicine or Modern medicine. The system then tells the user the disease and treatment for the symptoms identified. Figure 12 shows the system flow chart of how information flows in the system.

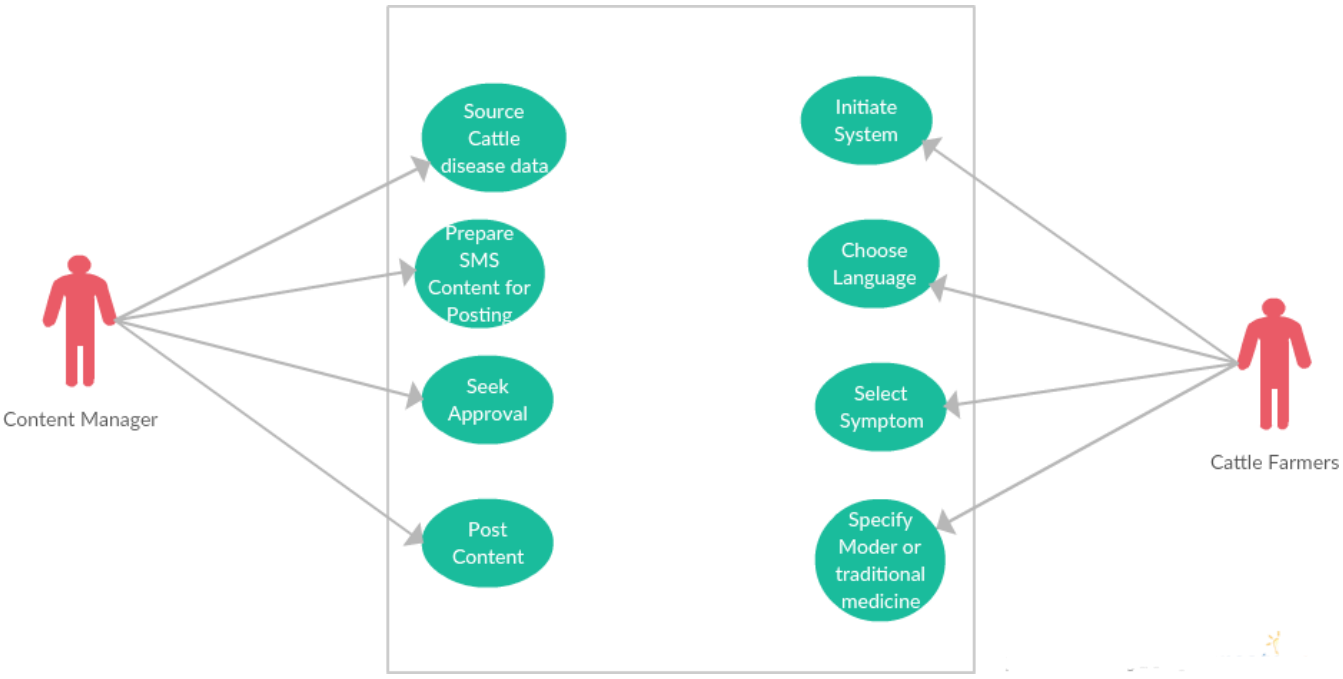

Figure 11: User Case Diagram for Functional Interactions on Mobile

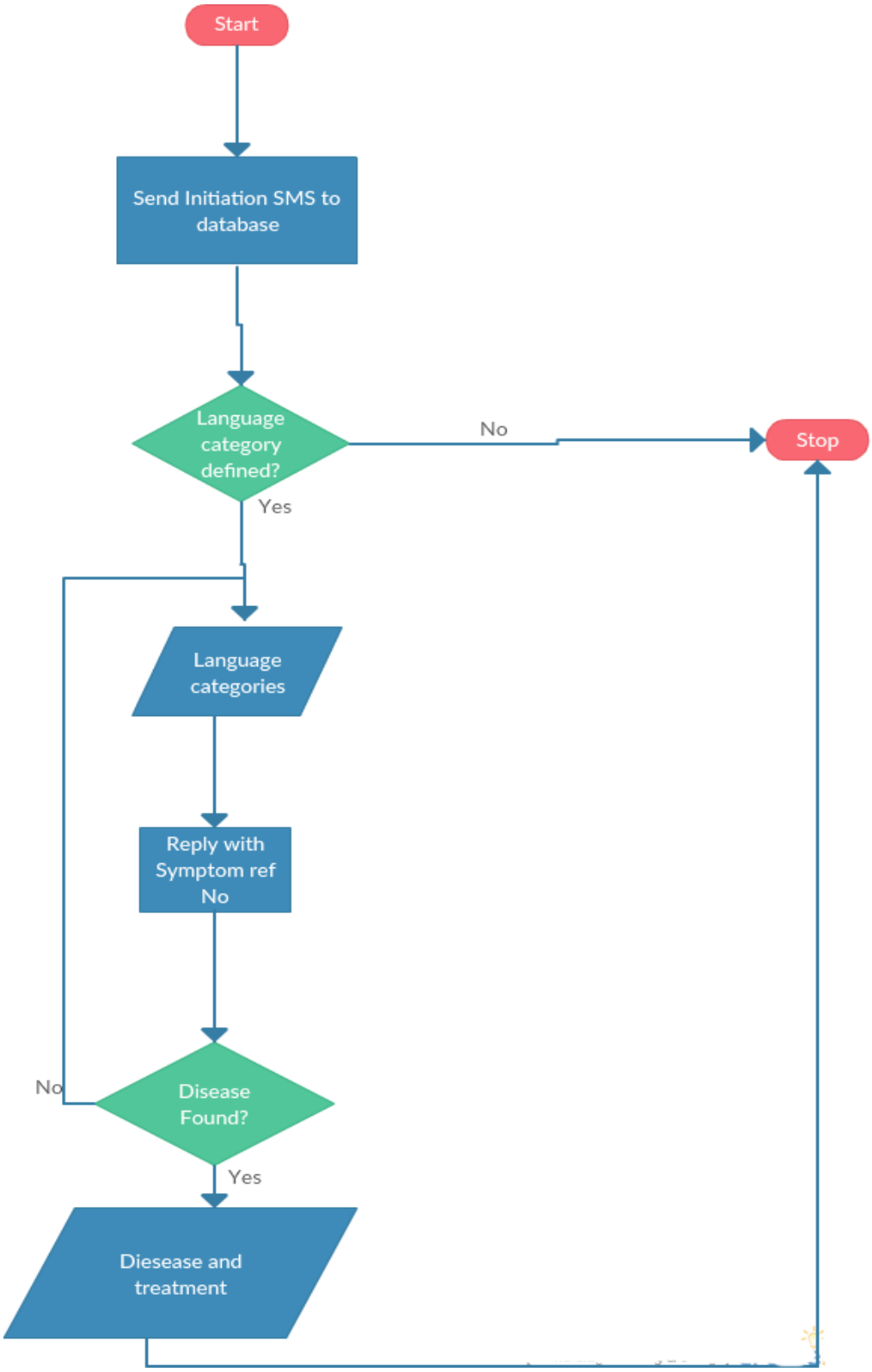

Figure 12: System Flow Chart for accessing first aid information via SMS

4.1.1.4 Non Functional Requirements

These types of requirements specify the constraints, goals or control mechanisms for the new system. The following major nonfunctional requirements were be implemented

a) **Reliability**-The system's ability to carry out key tasks for which it was developed.

b) **Integrity**- The database and data should be designed such that data stored is well organized to ensure integrity.

c) **Security**- The software should only allow authorized users to use the system

d) **Usability**-The user interface should be designed such that screens are similar therefore it will be easy to use and learn to work.

e) The user interface should be designed using Human Computer Interaction design principles i.e. aesthetically pleasing, clarity, consistency and efficient.

4.1.2 System Design

The Cattle Disease and treatment system comprised of different interrelated and interacting entities which required a model to help in its comprehension, while at the same time achieving various user requirements and supporting decision making. We designed with screen layout in mind and took care of all functional and non-functional requirements.

4.1.2.1 Conceptual Design

For the purposes of the objectives of this project modeling emphasis was based on the SMS interaction with the database as shown in Figure 13.

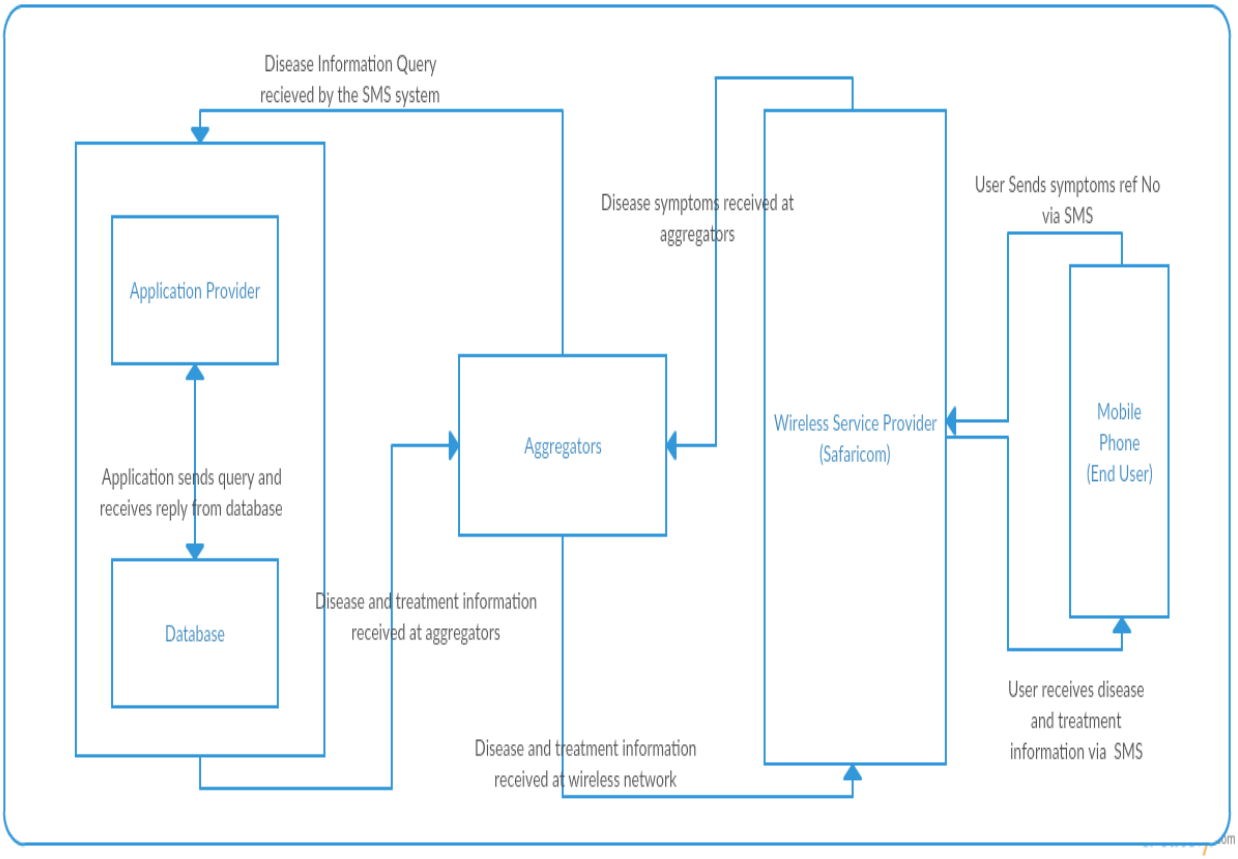

Figure 13: Conceptual Diagram

4.1.2.2 Data Movement within the System

This was illustrated using a Data Flow diagram (DFD) as shown in Figure 14. A DFD is a graphical representation of the "flow" of data through an information system, modeling its process aspects. A DFD creates an overview of the system which can be elaborated later. There are four major components used in the construction of a DFD.

i. External entities-An external entity can represent a human, system or subsystem. It is where certain data comes from or goes to. It is external to the system we study, in terms of the business process. For this reason, people used to draw external entities on the edge of a diagram. Data stores-A data store represents the storage of persistent data required and/or produced by the process. Here are some examples of data stores: membership forms, database table, etc.

ii. Processes- This is a business activity or function where the manipulation and transformation of data takes place. A process can be decomposed to finer level of details, for representing how data is being processed within the process.

iii. Data flow represents the movement of data from one component to the other. An arrow (→) identifies data flow, i.e. data in motion. Data flows are generally shown as one-way only.

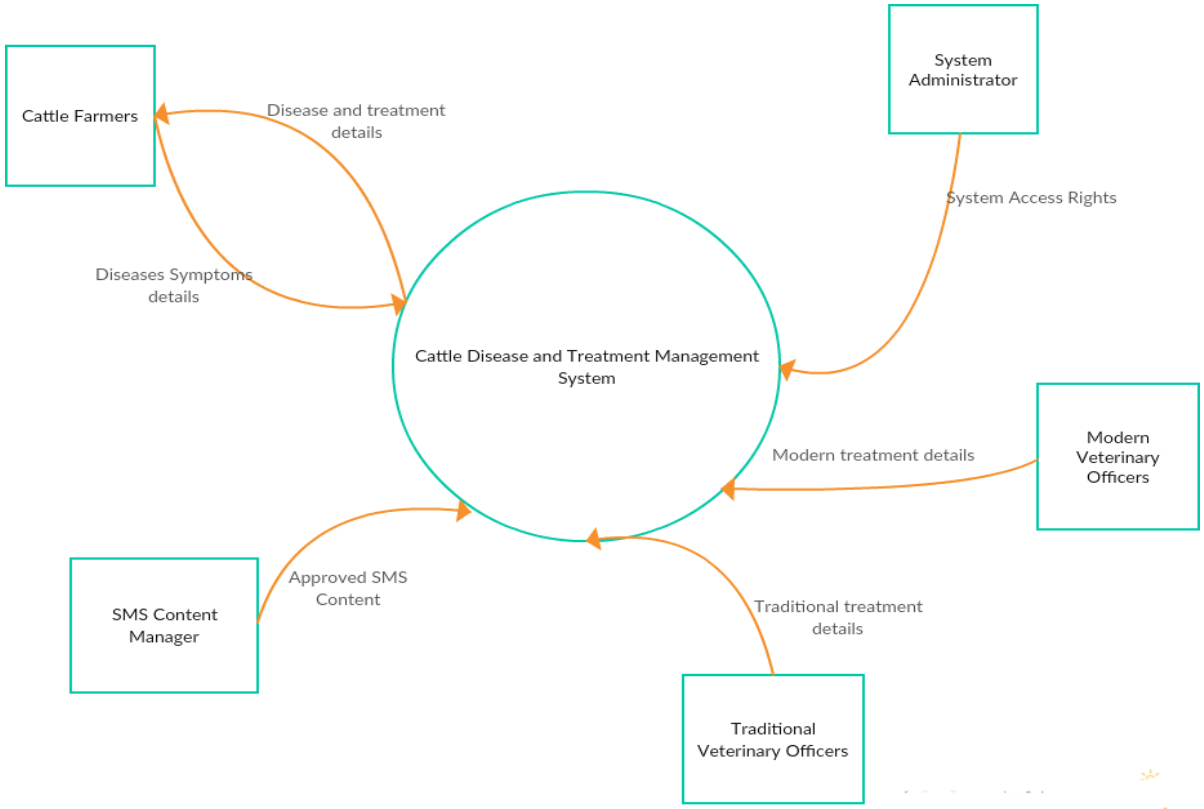

Figure 14: Context Diagram

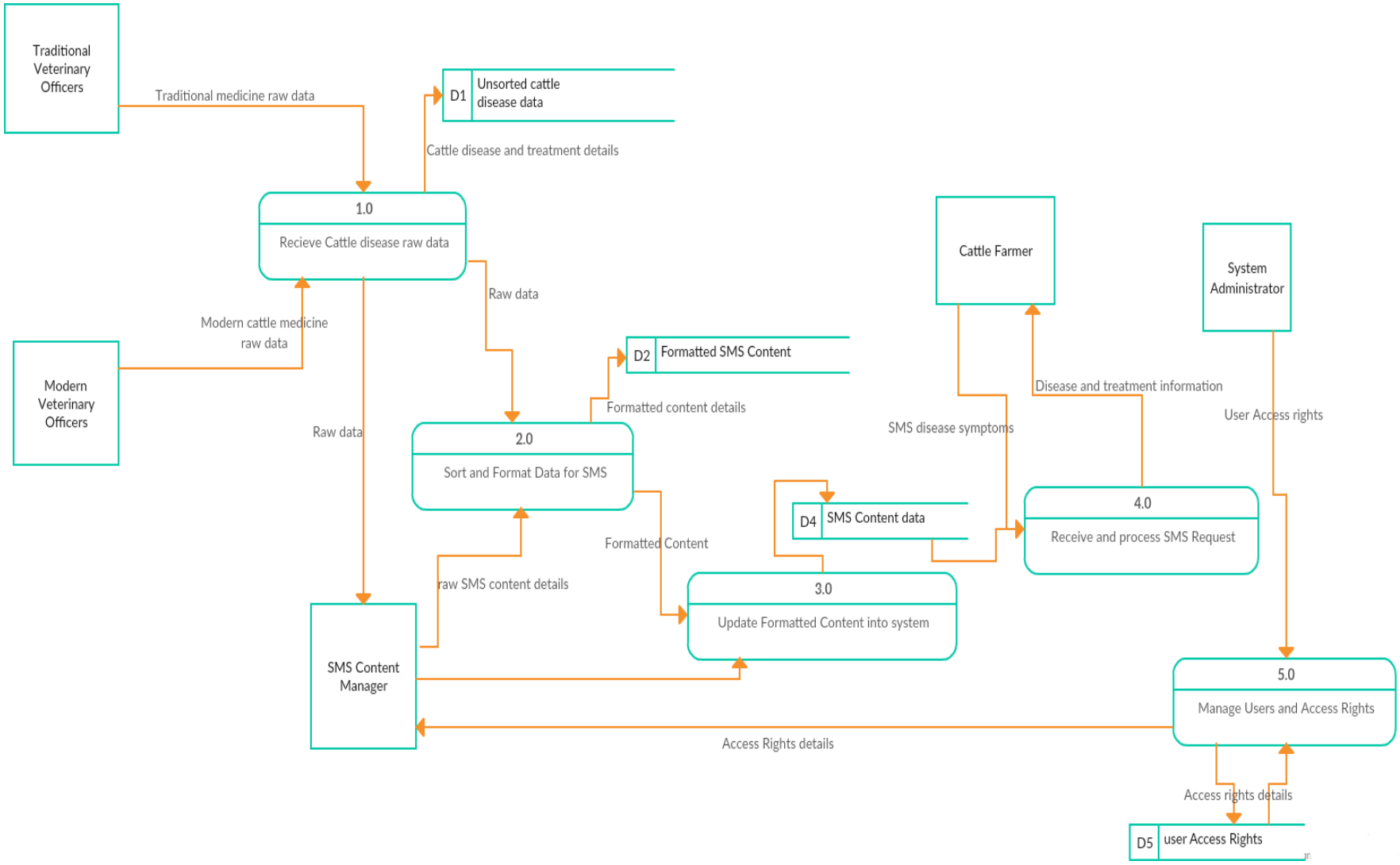

Figure 15: Level 0 Diagram showing the decomposition of the Context Diagram

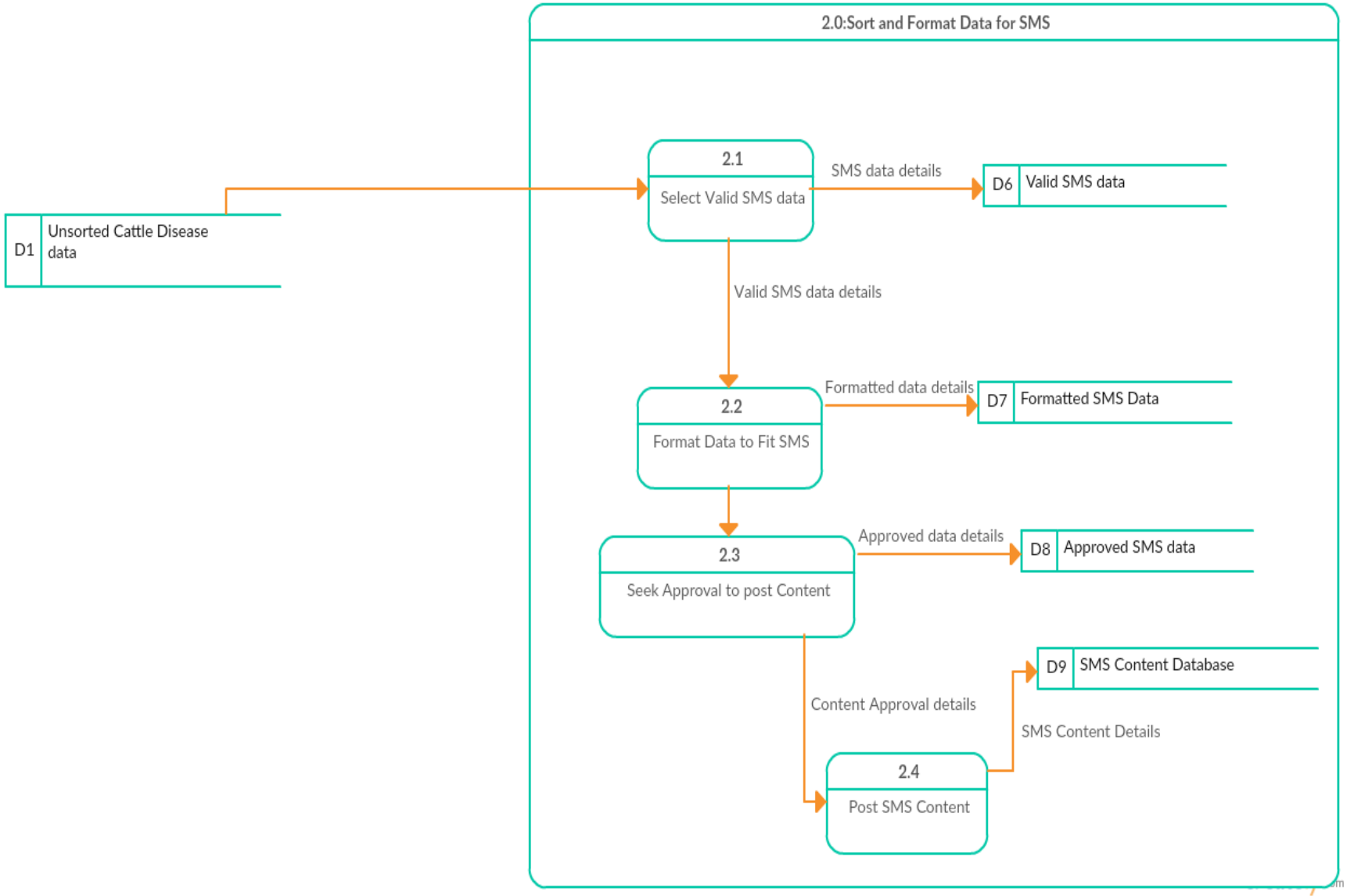

Figure 16: Level 1 Diagram showing the decomposition of process 1.0 of level 0 diagram

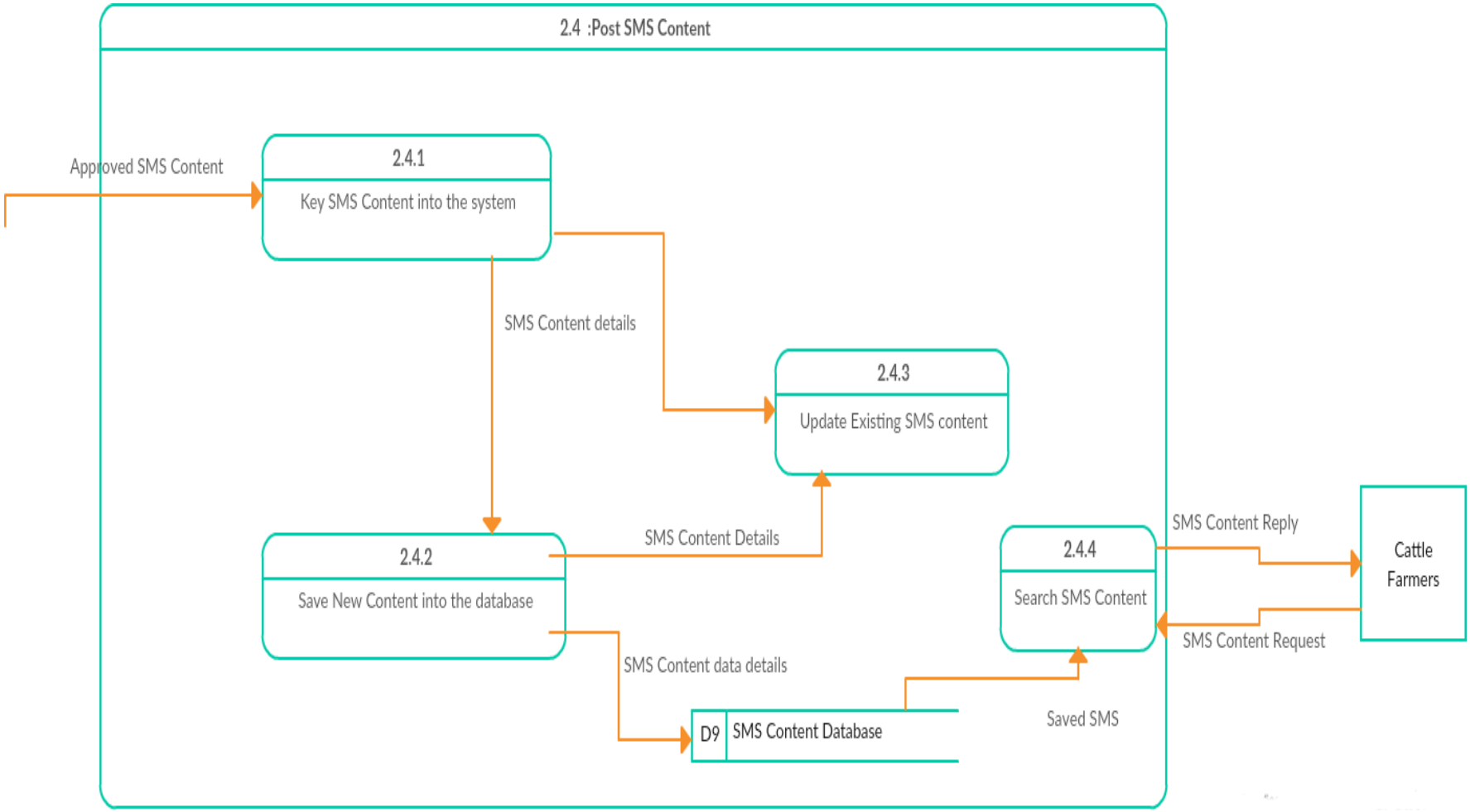

Figure 17: Level 2 Diagram showing the decomposition of process 1.7 of level 1 diagram

4.1.2.3 Data Model

This was represented using entity relationship diagrams. An entity relationship diagram shows the relationships of entity sets stored in a database. An entity in this context is a component of data. In other words, entity relationship diagrams illustrate the logical structure of databases.

i. Entity- this can be any object, place, person or class. It is represented using a rectangle.

ii. Attribute- A key attribute is the unique, distinguishing characteristic of the entity. For example, an employee's social security number might be the employee's key attribute. Attributes are represented by ovals.

iii. A Relationship describes relations between entities. They are represented by diamond shapes, show how two entities share information in the database.

4.1.2.4 Database design

The languages database stores the languages used to query the database, the diseases database stores symptoms and treatment data, language search logs stores the languages used by different users to query the system, disease search logs stores all search logs for user queries including the date and time as well as the user mobile number, and users database stores user usernames and passwords while user levels stores user access controls as shown in Figure 18.

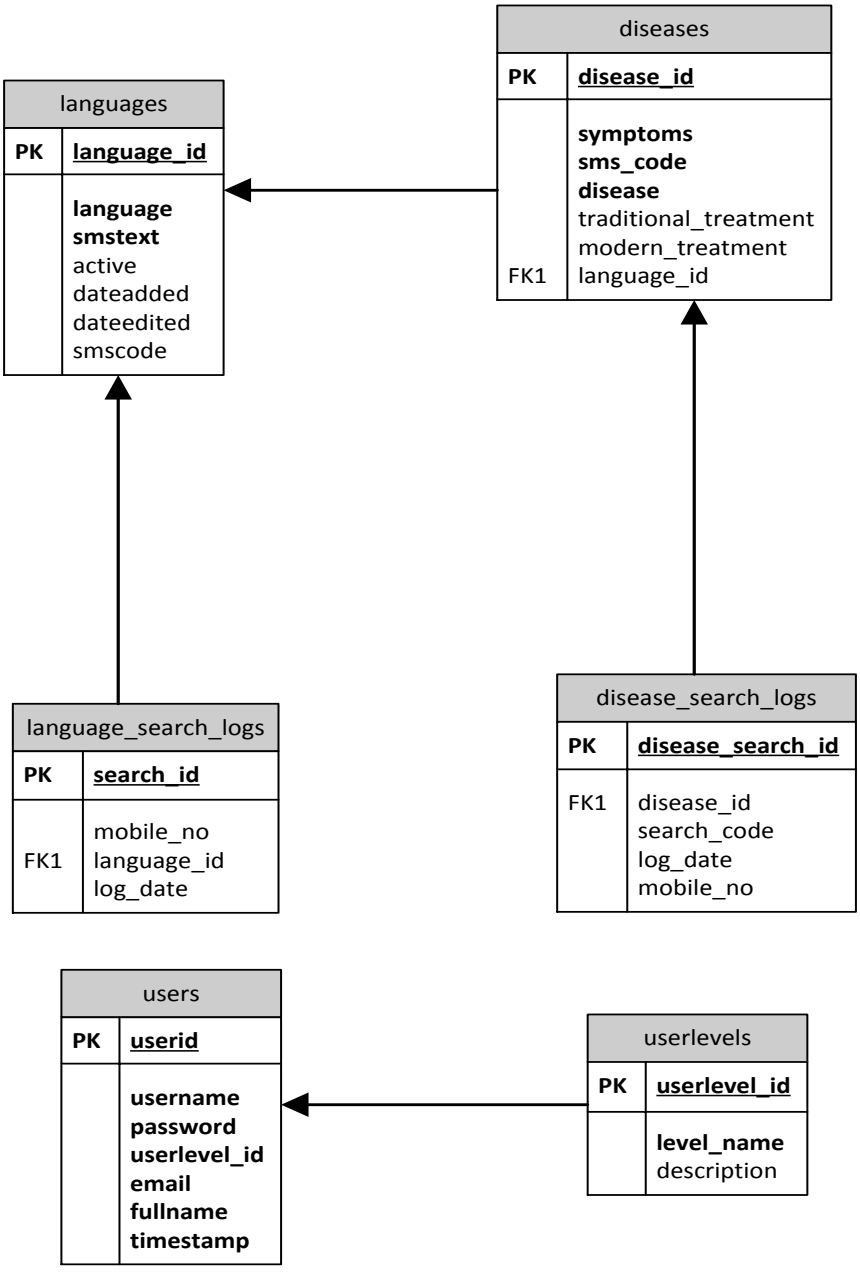

Figure 18: Database Design

4.1.3 Implementation

This section captures the activities carried out in the implementation stage. The end product at this stage was a fully working Cattle disease and treatment SMS system with operational short-code SMS functionality. The system used the following development tools and technologies:

4.1.3.1 Database Management System

We opted for a database that is easy to use and which ensures the security and integrity of data. The database should avoid data redundancies by implementing the use of primary keys and create relationships between entities through introduction of foreign keys. MySQL version 5.0 database management system was therefore the best tool and was used to design the database.

4.1.3.2 PHP5 (Preprocessor Hypertext)

PHP 5 was used as the front-end tool. It provided a link between the front end and the database. We opted for it because PHP5 provides an Integrated Development Environment that is easy to learn and use so long as one has the basic Hypertext Markup language knowledge.

4.1.3.3 Hypertext Mark Up Language

Hypertext Mark Up Language was be used for creation of tables, forms and form objects that were vital for saving records into the database, deleting, manipulating data items in the database as well as retrieving data from the database.

4.1.3.4 Adobe Fireworks

This was used as the basic graphics software for designing the template and manipulating images.

4.1.3.5 Cascading Style sheets

This was used for layout and presentation.

4.1.3.6 JavaScript

The JavaScript language is a Web-enhancing technology. When employed on the client computer, the language can help turn a static page of content into an engaging, interactive, and intelligent experience.

4.1.4 Project Deliverables

The following products were delivered at the end of the development period

a. Working system prototype (Working SMS Query and an administrative web interface)
b. Documentation-Project Report
c. Research paper

4.2 System Usability Testing

To test the system usability and reliability, 50 livestock keepers were targeted, however 46(92%) responded to the testing questionnaires.

4.2.1 Socio-Demographic Characteristics

Majority (30.4%) of the livestock keeper respondents were aged between 20 and 29 years, male livestock keeper respondents composed of 63.0% while those with no formal education composed of 32.6% of the respondents (see Table 5).

Table 5: Socio-demographics - Usability testing

Characteristics	Categories	Frequency	Percent (N = 46)
Age in years	<20	8	17.4
	20 - 29	14	30.4
	30 - 39	12	26.1
	40 - 49	8	17.4
	>=50	4	8.7
Gender	Female	17	37.0
	Male	29	63.0
Level of education	No formal education	15	32.6
	Primary	14	30.4
	Secondary	12	26.1
	Tertiary	5	10.9

4.2.2 System Reliability

Tabulation of system reliability was considered in terms of the number of successes in the runs during system design. The data was tabulated as shown in Table 6.

Table 6: System Reliability

Run number	Result	Successes	Reliability
1	Fail	0	0%
2	Fail	0	0%
3	Success	1	33%
4	Fail	1	25%
5	Success	2	40%
6	Success	3	50%
7	Success	4	57%
8	Success	5	63%
9	Success	6	67%
10	Success	7	70%

4.2.3 Diseases Inquired About

An equal number (73.9%) used the system to inquire about Helminthiasis and Babesiosis as shown in Figure 19.

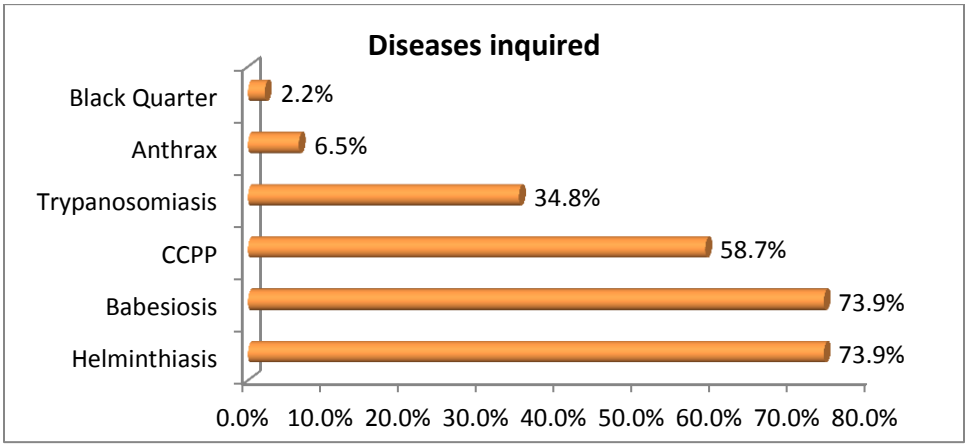

Figure 19: Diseases inquired

4.2.4 System Usability

To test the system usability, 5 point Likert (1 – strongly agree to 5 – strongly disagree) scale items relating to system interaction, speed, language, clarity and accuracy was used. As shown in Table 8, the respondents were elated by the system interaction, speed, language, clarity and accuracy (Detailed results in Appendix 7).

Table 7: System Interaction, Speed, Language, Clarity and Accuracy

Domain	Statement	Agree	Neutral	Disagree	Median
Interaction	Overall, I am satisfied with how easy it was to use this system	45(97.8)	1(2.2)	0(0.0)	A
	It was simple to use this simple	35(76.1)	11(23.9)	0(0.0)	A
Speed	I was able to get information I needed quickly using the system	38(82.6)	5(10.9)	3(6.5)	A
	I liked using the interface of this system	36(78.3)	7(15.2)	3(6.5)	A
Language	I felt comfortable using this system language	37(80.4)	7(15.2)	2(4.3)	A
	It was easy to learn to use this system	38(82.6)	6(13.0)	2(4.3)	A
Clarity	The information provided with this system was clear	36(78.3)	8(17.4)	2(4.3)	A
	The interface of this system was pleasant	32(69.6)	6(13.0)	8(17.4)	A
Accuracy	The information was effective in helping me get information I needed	35(76.1)	7(15.2)	4(8.7)	A
	This system has all the functions and capabilities I expect it to have	37(80.4)	6(13.0)	3(6.5)	A

CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

From the study objectives and findings, we conclude as follows:

1. **Deriving the needs of the system users and other relevant stakeholders:** the researcher concludes that animals kept by livestock keepers, i.e. cattle (65.2%), goats (59.7%) and sheep (57.4%), in Mandera County equally sometimes fell sick. As their animals became sick the keepers administered drugs from agrovets without consulting veterinary doctors (48.5%) because of their inaccessibility both in terms of unaffordability, geographical distance and unavailability.
2. **Assessing the potential of SMS in facilitating access to livestock health information:** the researcher concludes that most of livestock keepers in Mandera County owned basic mobile phones (93.2%), however none of them had used it to access animal health information but all were willing to use their phones to access this information especially in Somali language (97.9%) which they reported being comfortable with.
3. **Designing, deploying and testing usability of a Multi-Lingual SMS based prototype system reachable to farmers in the in their native languages:** the researcher concludes that the prototype developed being user initiated system was appropriate for the type of phones owned by the livestock keepers since it aided them to access animal health information instead of just administering drugs from agro vets without knowing the type of disease their animals were suffering from (73.9%). Also from the usability testing the system users were elated by the system interaction, speed, language, clarity and accuracy.

5.2 Challenges

Following the system design and testing, the researcher encountered the following challenges:

1. The system could only handle up to 160 characters.
2. Some people did not like text queries but preferred use of voice.
3. Short code SMS was expensive to the owner of the system if its design is to be free of charge.

5.3 Recommendation

From the study conclusions and objectives, we recommend as follows:

1. Since most livestock keepers in the study area owned basic mobile phone, it would be the most appropriate means of delivering of animal health information which were currently non-existent. This implied that system developers should target systems designed with basic phone features in mind.
2. As livestock keepers tend to administer drugs from agro vets directly without consulting veterinary doctors posing a great danger to their animals, there is need of scaling up of such prototypes of systems to increase accessibility of expert animal health information to the livestock keepers.
3. Lack of formal education renders system applicability relevant if only accessible in the Somali language, thus such systems can only designed with users own comfortable language.

5.4 Recommendations for Further Research

With the upsurge of application of mobile services in animal health, there has been little uptake of these systems especially among pastoralists communities and therefore it is imperative to further investigate reasons for the low uptake vis-à-vis exploration of possible ways of enhancing uptake of these services.

5.5 Future Work

The researcher further recommends for future work to be done as follows:

1. There is need to extend the system to other languages other than English and Somali as well as further expansion to cater for other livestock.
2. There is also need to evaluate this advisory system more vigorously.

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Appendices

Appendix 1: Consent Form

I am Abdullahi, a Masters Student in Information Systems at University of Nairobi. I am conducting a research SMS Based System to Provide Cattle Health Care Information in Mandera County. You have been randomly selected to assist in this research by responding to the questionnaire intended for this research. Note that you are not supposed to indicate your name anywhere and the information you provide will be treated with utmost confidentiality and will be used for the purpose of this research only.

It is anticipated that the research will take one hour of your time and the research questions includes those related potential of SMS in facilitating access to animal health based information and the needs of such a system. The questionnaire is divided into three sections which address the above factors and socio demographic characteristics.

Note that it is expected of you to complete all the questions to enhance validity and reliability of the findings however you may skip any questions you are not comfortable with. It is your right to stop your participation in the research at any time. There are no risks associated with participation and no financial benefits. Findings from the study will help in designing and testing an SMS based system providing cattle health care information thus improve productivity and food security.

Respondent Agreement

The research has been explained to me and I voluntarily consent to participate. I have had an opportunity for my questions to be answered.

_____ _____

Respondent signature Date

_____ _____

Interviewer signature Date

Appendix 2: Pre-study Structured Questionnaire

Section A: Respondents Characteristics

1. Age in years: Less than 20 { } 20 – 29 { } 30 – 39 { } 40 – 49 { }
   50 and above { }
2. Gender
   a. Female { }
   b. Male { }
3. What is your level of education
   a. No formal education { }
   b. Primary education { }
   c. Secondary education { }
   d. Tertiary education { }

Section B: SMS Based System Potential

4. Do you own a mobile phone?
   a. Yes { }
   b. No { } **If No, go to section C:**
5. If yes, what type of phone do you have?
   a. Basic phone { }
   b. Feature phone { }
   c. Smart phone { }
6. If yes, how frequent do you use your mobile phone?
   a. Daily { }
   b. Weekly { }
   c. Monthly { }
7. Approximately how much how much do you spend on your phone per week? { }
8. How do you charge your phone?
   a. Electricity at home { }
   b. Solar charging at home { }
   c. Charging at the local centre { }
9. Have you ever used your mobile phone to access animal health information?

a. Yes { }

b. No { }

10. If yes, how frequent have you used it in the previous year?

a. Daily { }

b. Weekly { }

c. Monthly { }

d. As need arise { }

11. If there was a system on your mobile phone providing animal health information would you consider using it?

a. Yes { }

b. No { }

12. If yes how much should such a system cost? { }

13. If no, would you propose the County government pay for such a system?

a. Yes { }

b. No { }

Section C: System Needs

14. Which livestock do you keep in your homestead?

a. Cattle { }

b. Goats { }

c. Sheep { }

d. Camels { }

15. In the last year, how frequent did your animals fall sick?

Animal	Frequency of sickness			
	Never	Rarely	Sometimes	Always
Cattle				
Goats				
Sheep				
Camels				

16. When your animal fell sick, how did you attend to it?

a. Administered drugs from agro vets { }

b. Sought veterinary advice from a doctor { }
c. Administered local medication { }
d. Did nothing. { }
e. Other (Specify)

17. In the last year, how frequent do you seek veterinary advice from doctors for general herd health?
    a. Never { }
    b. Rarely { }
    c. Sometimes { }
    d. Always { }
18. What are some of the challenges you experience while seeking veterinary advice from doctors?

    ……
    ……
    ……
19. While assessing animal health information on mobile phone which language would you is comfortable with?

    English { } Kiswahili { } Somali { }

Appendix 3: Key Informant Interview Guide

1. In the last year, **which disease frequently** affected the following animals, and **how are** these diseases treated?

Animal	Disease	Symptoms	Treatment
Cattle			
Goat			
Sheep			
Camel			

2. If Somali, can the diseases and symptoms of the diseases above be coded in the Somali language?
    a. Yes { }
    b. No { }
3. If yes, list some of the symptoms of the listed diseases above in Somali.

Animal	Disease	Symptoms	Treatment
Cattle			
Goat			
Sheep			
Camel			

4. When animal fell sick in your locality, how do farmers attend to them frequently?
    a. Administering drugs from agro vets { }
    b. Seeking veterinary advice from a doctor { }
    c. Administering local medication { }
    d. Doing nothing. { }
    e. Other (Specify)
5. What are some of the challenges farmers experience while seeking veterinary advice from doctors?

……

……

……

6. While assessing animal health information on mobile phone which language would farmers in your locality be comfortable with?
    a. English { }
    b. Kiswahili { }
    c. Somali { }
    d. Other (Specify)

Appendix 4: Usability Testing Structured Questionnaire

Section A: Respondents Characteristics

1. Age in years: Less than 20 { } 20 – 29 { } 30 – 39 { } 40 – 49 { }
   50 and above { }
2. Gender
   a. Female { }
   b. Male { }
3. What is your level of education
   a. No formal education { }
   b. Primary education { }
   c. Secondary education { }
   d. Tertiary education { }

Section B: System Usability Testing

4. Which disease and animal did you use the system to inquire about? Tick appropriately

Animal	Disease					
	Babesiosis	CCPP	Helminthiasis	Trypanosomiasis	Black quarter	Anthrax
Cattle						
Goats						
Sheep						
Camels						

5. How do you agree with the following information? SA – Strongly Agree; A – Agree; N – Neutral; D – Disagree; SD – Strongly Disagree

Domain	Statement	SA	A	N	D	SD
Interaction	Overall, I am satisfied with how easy it was to use this system					
	It was simple to use this simple					
Speed	I was able to get information I needed quickly using the system					
	I liked using the interface of this system					

Language	I felt comfortable using this system language					
	It was easy to learn to use this system					
Clarity	The information provided with this system was clear					
	The interface of this system was pleasant					
Accuracy	The information was effective in helping me get information I needed					
	This system has all the functions and capabilities I expect it to have					

Appendix 5: Sample Source Code

10. API code for managing SMS Logic

```
my $categories = "SELECT * FROM sdpm.categories ORDER BY code ASC";

my $results = $dbh->selectall_hashref($categories, 'code');

#my $messo = "";

foreach my $code (sort keys %$results){

my $cat_id = $results->{$code}->{id};#$results->{$id}->{dest_msisdn};

my $cat_code = $results->{$code}->{code};

my $cat_name = $results->{$code}->{categoryname};

my $messo = "$cat_code FOR $cat_name ";

print"captured is $messo.....\n";

print"capture.....\n";

#get all the required columns

my $textm = "SELECT * FROM sdpm.cat_message ORDER BY lid";
```

```
my $results = $dbh->selectall_hashref($textm, 'lid');

foreach my $lid (keys %$results){

my $messo2 = $results->{$lid}->{messagetxt};

print" In the table is $messo2...==============================..\n";

my $messo5 = "$messo2\n$messo";

print"$messo5.....\n";

#my $quote = 'Love is like quicksand, the deeper you fall in it, the harder it is to get out.';

my $sql1 = "update sdpm.cat_message set messagetxt = '$messo5'";

$dbh->do($sql1);

print"$sql1.....\n";

}
```

11. Code for connection to database

```
<?php
  include("include/functions.php");
  //include("include/pharmacyfunctions.php");


//function openConnection()
//{
   $dbcnx=@mysql_connect('localhost','root','');
  if (!$dbcnx)
     {
```

```
        echo ('<p>Unable to connect to the database server at this time.</p>' );
        exit();
      }

          if (!@mysql_select_db('vet_sms'))
           {
       exit('<p>Unable to locate the card system Services database at this time.</p>');
    }
//}
?>

<?
function closeConnection()
{
  mysql_close($dbcnx);
}
?>
```

12. Sample code for saving

```
?>
<?php

// Load key from QueryString
```

```
$bCopy = true;
$x_id = @$_GET["id"];
if (($x_id == "") || (is_null($x_id))) $bCopy = false;

// Get action
$sAction = @$_POST["a_add"];
if (($sAction == "") || ((is_null($sAction)))) {
	if ($bCopy) {
		$sAction = "C"; // Copy record
	} else {
		$sAction = "I"; // Display blank record
	}
} else {

	// Get fields from form
	$x_category_id = @$_POST["x_category_id"];
	$x_supplierid = @$_POST["x_supplierid"];
	$x_catBID = @$_POST["x_catBID"];
	$x_catCID = @$_POST["x_catCID"];

	//set codefield to service description dateedited


	$x_active = @$_POST["x_active"];
	$x_description = @$_POST["x_description"];
	$x_pPic = @$_POST["x_pPic"];

	$x_smstext = @$_POST["x_smstext"];
	$x_isbnno = @$_POST["x_isbnno"];
	$x_description = @$_POST["x_description"];
	$x_buyerid = @$_POST["x_buyerid"];
```

```
        $x_id = @$_POST["x_id"];

        $x_dateadded = @$_POST["x_dateadded"];
    $x_code = @$_POST["x_code"];

    $x_issueno = @$_POST["x_issueno"];
    $x_distributionnote = @$_POST["x_distributionnote"];
    $x_dateedited = @$_POST["x_dateedited"];
    $x_sID = @$_POST["x_sID"];
```

13. Sample code for Editing

```
// Load key from QueryString
$x_id = @$_GET["id"];

// Get action
$sAction = @$_POST["a_edit"];
if ($sAction == "") {
        $sAction = "I";          // Display record
} else {

        // Get fields from form
        // Get fields from form
        $x_id = @$_POST["x_id"];

        $x_category_id = @$_POST["x_category_id"];
        $x_catCID = @$_POST["x_catCID"];

        //set dateaddedfield to service description active
```

```
        $x_smstext = @$_POST["x_smstext"];
        $x_description = @$_POST["x_description"];
        $x_pPic = @$_POST["x_pPic"];

        $x_code = @$_POST["x_code"];
        $x_isbnno = @$_POST["x_isbnno"];
        $x_description = @$_POST["x_description"];
        $x_auID = @$_POST["x_auID"];
        $x_pbID = @$_POST["x_pbID"];

        $x_dateadded = @$_POST["x_dateadded"];
    $x_dateadded = @$_POST["x_dateadded"];

    $x_dateedited = @$_POST["x_dateedited"];
    $x_distributionnote = @$_POST["x_distributionnote"];
    $x_active = @$_POST["x_active"];
    $x_sID = @$_POST["x_sID"];
    $x_lID = @$_POST["x_lID"];
    $x_status = @$_POST["x_status"];
    $x_abstract = @$_POST["x_abstract"];
            $x_categoryname = @$_POST["x_categoryname"];

}
```

14. Sample Code deleting

```
<?php include ("ewconfig.php") ?>
<?php include ("db.php") ?>
<?php include ("productsinfo.php") ?>
<?php include ("advsecu.php") ?>
<?php include ("phpmkrfn.php") ?>
```

```
<?php include ("ewupload.php") ?>

<?php

// Initialize common variables
?>
<?php
$arRecKey = NULL;

// Load key parameters
$sKey = "";
$bSingleDelete = true;
$x_id = @$_GET["id"];
if (($x_id == "") || (is_null($x_id))) {
	$bSingleDelete = false;
} else {
	if ($sKey <> "") $sKey .= ",";
	$sKey .= $x_id;
	if (!is_numeric($x_id)) {
		ob_end_clean();
		header("Location: productslist.php");
		exit();
	}
}
if (!$bSingleDelete) $sKey = @$_POST["key_d"];
if (!is_array($sKey)) {
 if (strlen($sKey) > 0) $arRecKey = split(",", $sKey);
} else {
 $sKey = implode(",", $sKey);
 $arRecKey = split(",", $sKey);
}
```

```
if (count($arRecKey) <= 0) {
        ob_end_clean();
        header("Location: productslist.php");
        exit();
}
```

Appendix 6: System User manual

The system is accessed via sms but we have a web portal used to update data.

System Administration

Log in

To log in to the system you run the url 192…….

The following log in screen comes where you are required to enter the username and password assigned to you by the administrator.

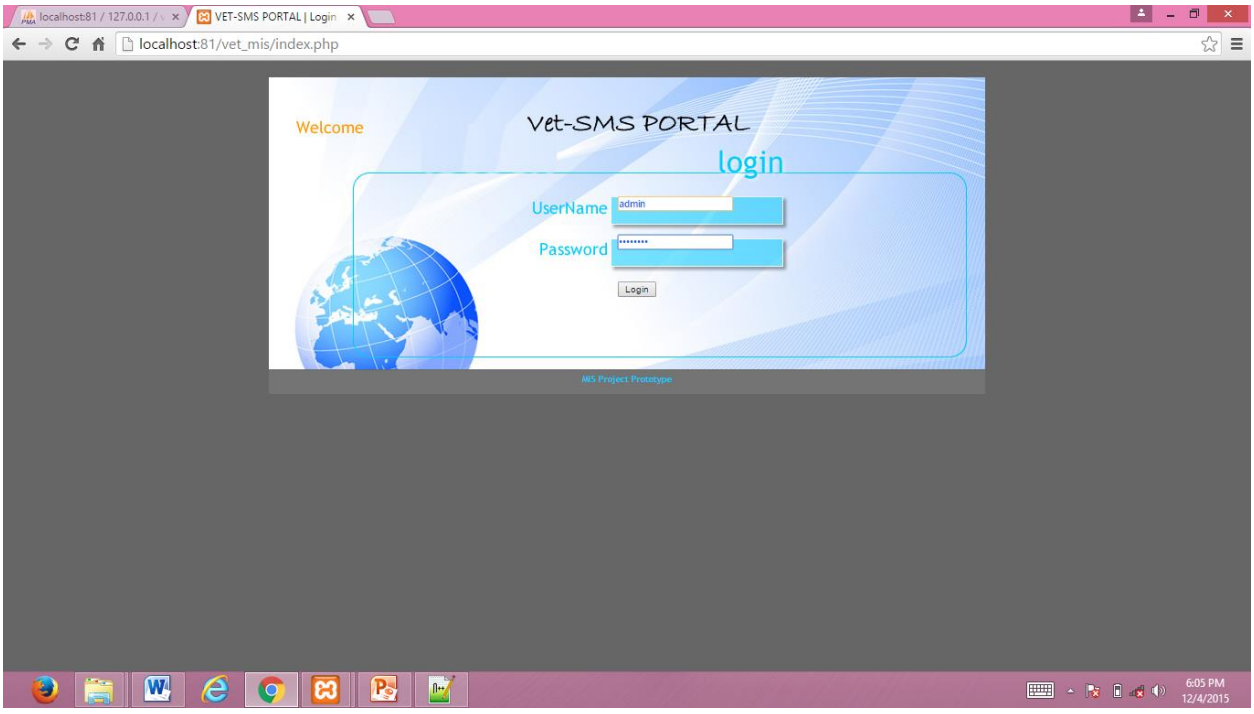


Figure 20:Log in Screen

Once logged in the below screen comes up with an arrow which you are supposed to click to enter the system menus

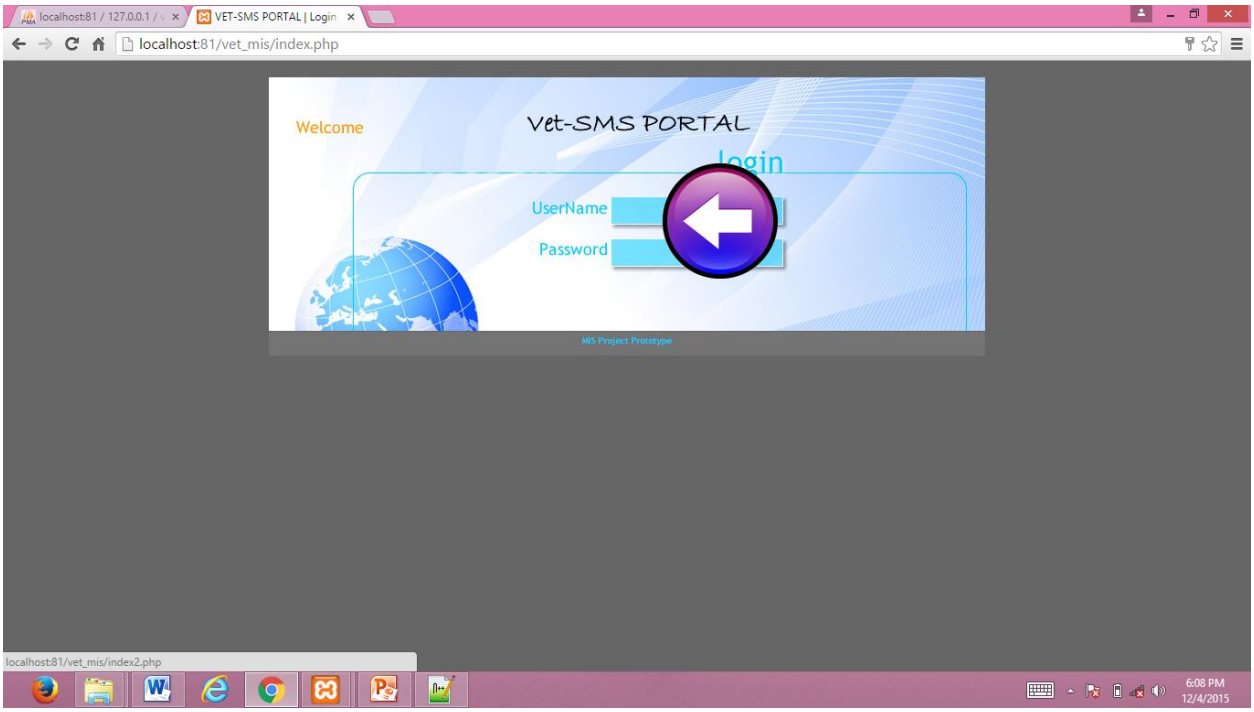


Figure 21:Landing Page

Adding a new language

To add a new language from the menu as shown in figure 22 below click on Language categories

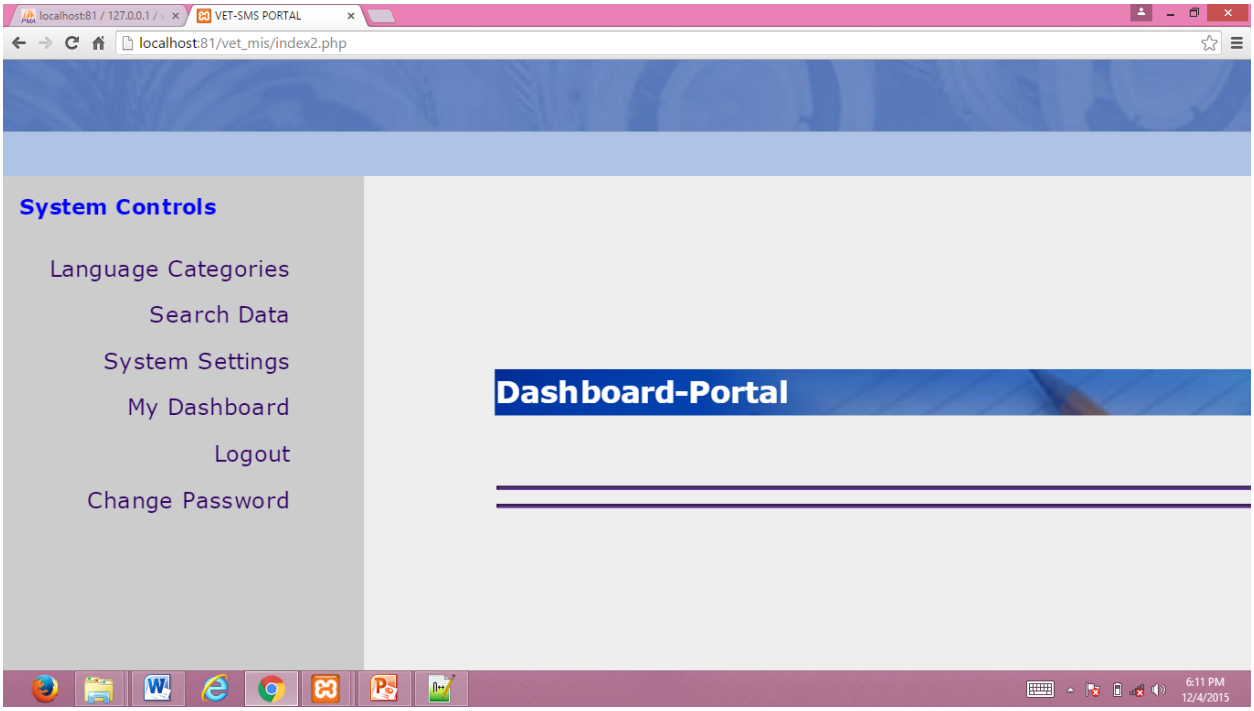


Figure 22:System Menus

Once you click the Language categories menu the following screen comes for you to add new language and the codes given to you by your ISP

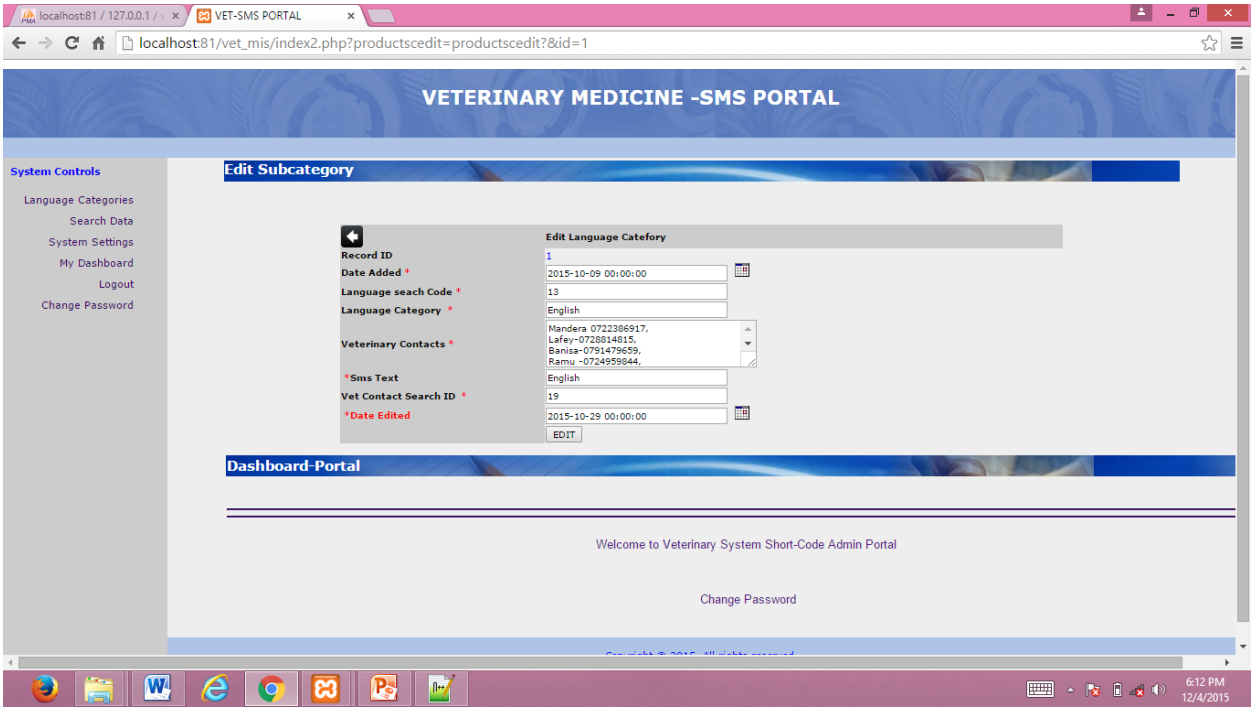


Figure 23: Adding New Language and code

Once you save the following screen comes up as shown in figure 24 below

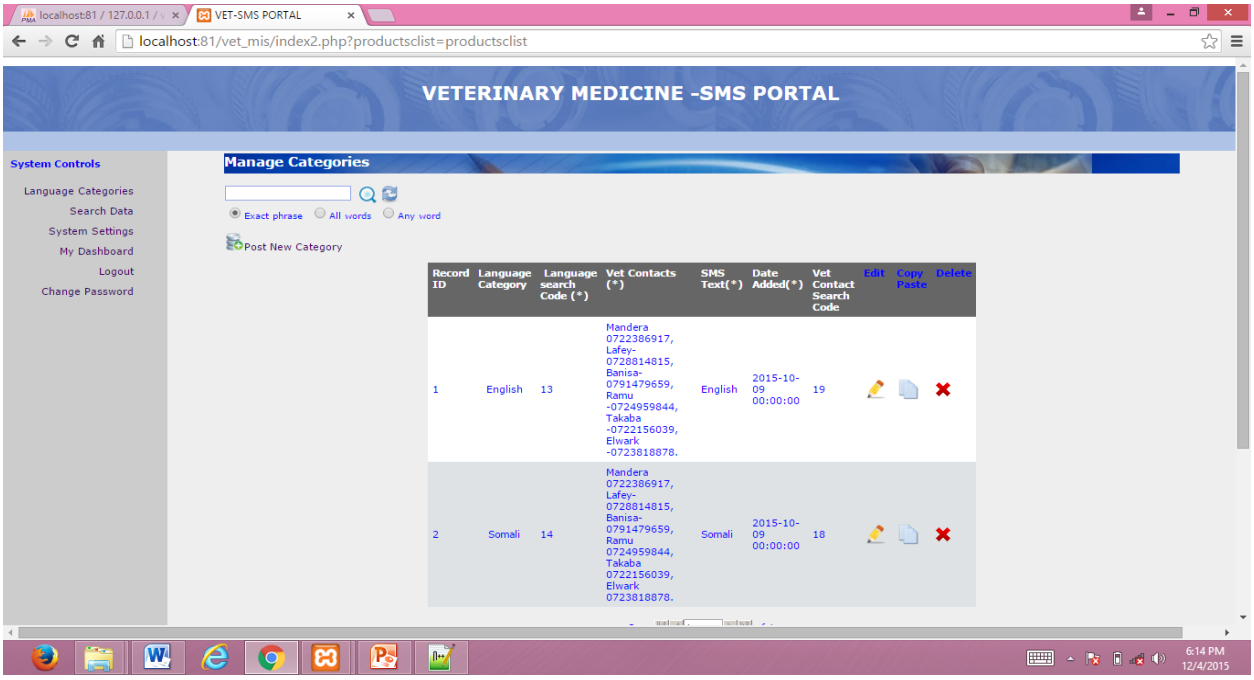
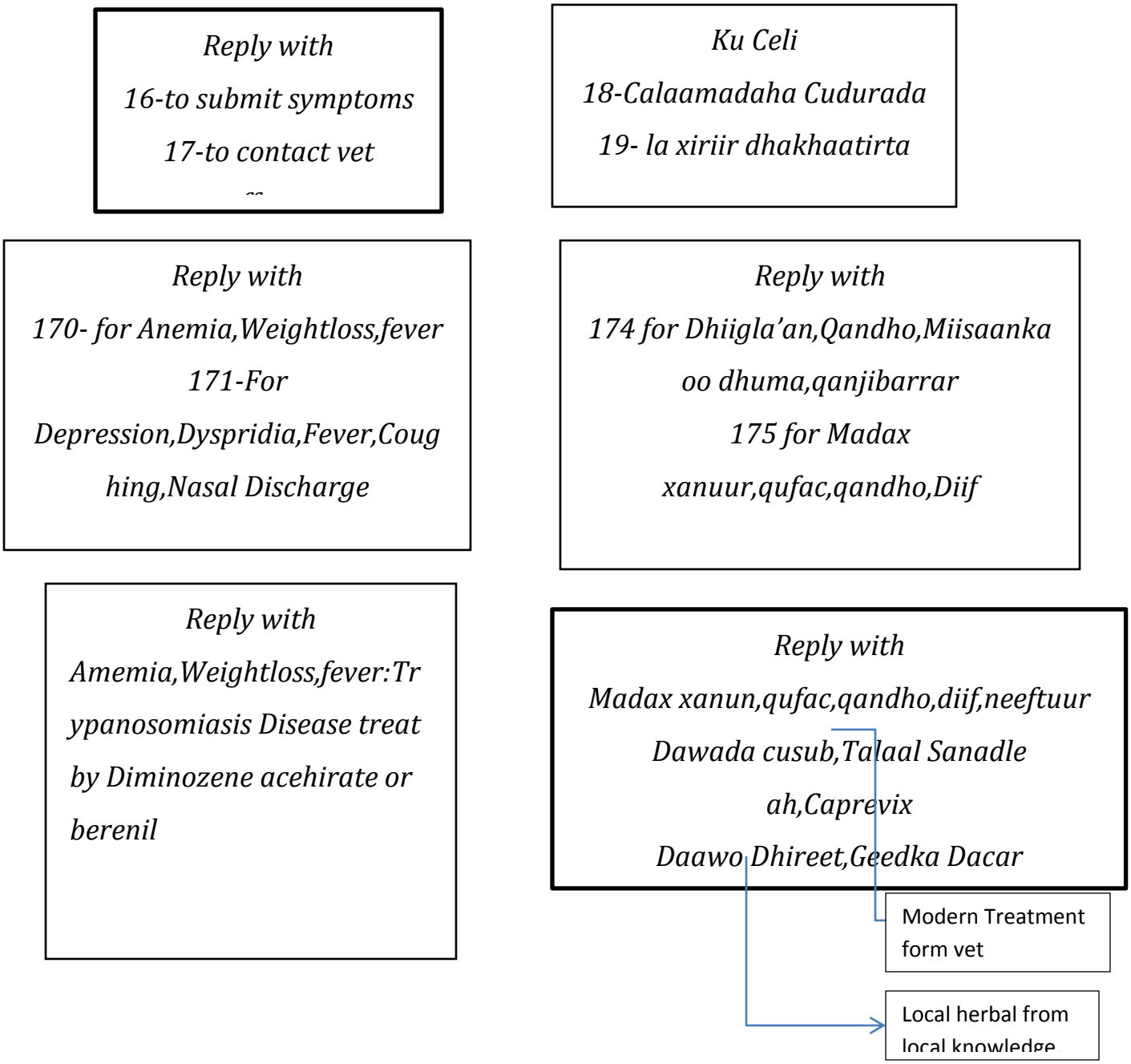


Figure 24: Language Listing

Appendix 7: Sample System SMS



Appendix 8: System Usability Results

Domain	Statement	SA	A	N	D	SD	Median
	Overall, I am satisfied with how easy it was to use this system	37 (80.4%)	8(17.4)	1(2.2)	0(0)	0(0)	SA
Interaction	It was simple to use this simple	10 (21.7)	25 (54.3)	11(23.9)	0(0)	0(0)	A
	I was able to get information I needed quickly using the system	17(37.0)	21(45.7)	5(10.9)	3(6.5)	0(0)	A
Speed	I liked using the interface of this system	21(45.7)	15(32.6)	7(15.2)	3(6.5)	0(0)	A
	I felt comfortable using this system language	20(43.5)	17(37.0)	7(15.2)	2(4.3)	0(0)	A
Language	It was easy to learn to use this system	17 (37.0)	21(45.7)	6(13.0)	2(4.3)	0(0)	A
	The information provided with this system was clear	15(32.6)	21(45.7)	8(17.4)	2(4.3)	0(0)	A
Clarity	The interface of this system was pleasant	14(30.4)	18(39.1)	6(13.0)	0(0)	8(17.4)	A
	The information was effective in helping me get information I needed	16(34.8)	19(41.3)	7(15.2)	3(6.5)	1(2.2)	A
Accuracy	This system has all the functions and capabilities I expect it to have	24(52.2)	13(28.3)	6(13.0)	2(4.3)	1(2.2)	SA