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A Veterinary Notification Service for Livestock Farmers

A Case study of Bumula Subcounty, Bungoma County

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P51/85774/2016

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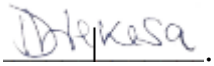
AUGUST 2020

Submitted in partial fulfillment of the Master of Science Degree in Applied Computing.

Declaration

Student

I declare that the project is my original work and has not been submitted to any other institution of higher learning.

Signature: .....  ..... Date: ....15th November 2021.....

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Supervisor

This research project has been submitted in partial fulfillment for the award of Master of Science in Applied Computing degree with my approval as the Project supervisor.

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Acknowledgement

I humbly give glory to the Almighty for the far he has brought me in undertaking this project; Moreso, I appreciate my Supervisor for the guidance he accorded me in this journey.

I recognize constructive criticism from the panelist comprising Dr.Mburu, Dr. Chepken, Dr. Wanjiku Nganga and my supervisor Dr. Evans K. Miriti for guiding me to complete the project.

I appreciate and recognize my dear wife Hellen, Sons Ian and Ryan, for the great support and prayers they accorded me thoughout the journey.

Final appreciation goes to the interviewees, respondents for their patience in feedback provision and critical inputs towards this project.

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Abstract

The problem of timely access to Veterinary Doctors by Livestock farmers has paused great deal on livestock mobile health (mHealth) in Bumula Sub County, Bungoma County.

This problem is traceable at the initial stage of locating and communicating to veterinary doctor for the veterinary service.

The project's aim was to investigate application of modern Information Technology (ICT) in addressing accessibility to veterinary doctors by locating the nearest veterinary doctor and request for livestock treatment.

The specific objectives that project sought to address include; Determining communication needs for the livestock farmers, propose & design Veterinary Notification Service prototype in which livestock farmers would locate and request the nearest Veterinary Doctor as soon as livestock fall sick.

In this project, a case study of Bumula Sub County in Bungoma County was used to study livestock farmers' challenges in reaching out to Veterinary Doctor.

Tests and evaluation findings indicated that application of integrated services of simple message service (SMS), Web application and Mobile application have positive outcome in veterinary notification process necessitated by mapping the nearest Veterinary Doctors to the livestock farmers' treatment requests.

The introduction of veterinary notification service for livestock farmers is a solution that would greatly improve in animal husbandry healthcare, treatment and real time consultancies in Bumula Sub County.

Further study should also explore methods that can be used to facilitate other services on the prototype such as information and videolized basic livestock care

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Abbreviations:

GDP – Gross Domestic Products

SOA – Service Oriented Architecture

SMS – Simple Message Service

XML - Extensible Markup Language

CCK - Communication Commission of Kenya

USSD - unstructured supplementary service data

VNS – Veterinary Notification Service

Definition of terms

Accessibility – it is ease with which information can be input or retrieved regardless of the location where the user is located.

Animal welfare services refers to welfare of an individual animal in its state as regards its attempts to cope with its environment. Usually expressed in freedoms of animal welfare; that is freedom from thirst, hunger and malnutrition; freedom from discomfort, pain, injury, and disease, freedom to express normal behavior, and freedom from fear and distress.

Low-fidelity prototype - is a sketchy and incomplete prototype , it has some characteristics of the anticipated product, it usually used to quickly produce the prototype and for broad concept testing.

Focused interview - It is a technique whereby qualitative data is collected in an interview situation, hence enabling respondents in talking about a subject by giving their opinions.

Structured interview- is a standardized interview where quantitative research methods are employed in research survey. The purpose of the approach is usually to ensure each interview is presented with identical questions in the similar order.

RESTful services – Representation of State Transfer. Is a stateless client-server architecture where web services are resources and can be identified by their URIs. REST Client applications can use HTTP GET/POST methods to invoke Restful web services.

Usability- Making application easier to operate and matching it more closely to user needs and requirements.

User Interface- It is the means in which a person controls and interacts with a software application.

Modern Information Technology - is the use of any computers, storage, networking and other physical devices, infrastructure and processes to create, process, store, secure and exchange all forms of electronic data

CHAPTER ONE:

INTRODUCTION

The status of Kenya's Livestock sub sector accounts for about 12 per cent of the entire GDP and about 42 per cent of agricultural GDP, it also accounts for about 30 per cent of the total marketed agricultural products (National Livestock Policy, February 2019).

It employs about 50 percent of the country's agricultural sector labour-force.
The National census of 2009 showed that Kenya's animal resource base comprised of 17.5 million cattle, 27.7 million goats, 17 million sheep, 3 million camels, 31.8 million domestic birds, 1.8 million donkeys and an undetermined number of companion, game and aquatic animals (KNBS, 2010). About 60% of the livestock population is found in the Arid and Semi-Arid Lands (ASAL) where the industry employs nearly 90% of the population.

Livestock diseases and pests are among the most serious constraints limiting development of the livestock industry. They contribute significantly to low productivity of farm animals and impact negatively on both local and international livestock trade.

Livestock input suppliers are few and poorly distributed as they are concentrated in towns hence limiting availability and access to inputs and services such as veterinary services.

Veterinary services are to curb the key concerns and their control measures and should be timely and convenient regardless of the location of the livestock farmers.
The veterinary doctors provides veterinary services directly to the livestock farmers upon request for animal treatment. However, the means of availing treatment have been facing challenges, mainly due to scarcity of veterinary doctors and the long wait experienced by livestock farmers.

One extension officer currently serves 1,000 livestock farmers instead of 400 livestock farmers (Guidelines and Standards for Agricultural Extension and Advisory Services, Ministry of Agriculture, Livestock and Fisheries, September 2017).

According to quarterly statistics report of Communication Commission of Kenya (CCK), statistics for quarter two 2012/2013, it showed that 30.70 Million subscribers were on the network, the figure represented an upward growth of 1.0 percent from the previous quarter period.

In 2014, the penetration of mobile was at 78.0 percent, this was an increase of 0.8 percent from the previoues year 2013 which had 77.2 percent (Communications Authority of Kenya (CAK) 2014 Report).

Talbot (2013) reported that Android phones are increasing in the Kenyan market and becoming more affordable with more than 350,000 Android users.

Thus, most people (including livestock farmers) own or have access to Android mobile phones. Mobile phones can be used to meet the challenge of accessing veterinary doctors' demand by providing access to mobile applications that can assist in mapping the nearest veterinary doctor to attend to sick animals, diagnosing diseases affecting their livestock and possible solutions to the diseases. This is scientifically proven that healthy animals would produce high products as compared to unhealthy ones, thus betterment of Kenya's economy.

The study suggests that mobile phones can be efficient in providing notification of the nearest veterinary doctor since they can be accessed from anywhere, anytime and have a wider reach, as pointed out by Lawal-Adebowale & Akeredolu-Ale (2010).

Designing a mobile application that considers the user interface shortcomings due to mobile phone type can enable the majority of the livestock farmers to access the information with ease, Christina W. (2010). This would improve on

ease access to much needed veterinary doctors services and save the livestock farmers the stress of long wait and difficulty in reaching out to the veterinary doctors for the services required.

Considering the goals of the livestock farmers and the context to which they may need veterinary services, effective and efficient user interface for mobile application would greatly provide an effective means of veterinary services provision to the livestock farmers, Christina W. (2010). Shows that, effective user interface on mobile phones can promote access to information due to its wider coverage. During this study, existing mobile solutions are mostly unstructured supplementary services data (USSD) which can only provide limited details in the data thus not supporting appropriate interaction with the users(Long V., 2009). There is a need for a veterinary notification service application that can provide options of reaching out to the veterinary doctors in a varied number of forms like text and videos.

1.1. Problem Statement

Faced with the scarcity of veterinary doctors, the Government has not managed to find viable solution to the large number of livestock farmers requiring veterinary doctors' services.

One extension officers currently serves 1,000 farmers instead of the recommended 400 farmers (Kibett, J.K., et al, 2005).

Due to this scarcity of veterinary doctors, this has led to livestock farmers relying on their traditional myths in identifying livestock diseases when they are affected.

According to National Livestock Policy, February 2019, Livestock keepers have limited access to Veterinary professional's services this has necessitated customizing communication solutions that geared towards addressing the delays in locating veterinary doctors.

1.2 Main objective

The project's aim was to determine whether use of Veterinary Notification Service Application in locating the nearest veterinary doctor by livestock farmers could improve livestock health services.

1.2.1 The Specific Objectives of the work

- To determine communication needs for the livestock farmers and veterinary doctors
- To propose and design Veterinary Notification Service prototype in which livestock farmers would locate and request the nearest Veterinary Doctors' services.
- To evaluate performance of the developed prototype

1.3 Justification

The Veterinary Notification Service App plays a key role in enabling livestock farmers track availability of veterinary doctors from a registered veterinary doctors, hence enabling to contact the nearest veterinary doctor through location mapping.

Livestock farmers have a variety of veterinary doctors to contact from the Veterinary Notification Service App that would be an ideal solution to the communication turnarounds.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This section is broken down into; service oriented architecture and the proposed ICT solutions in livestock farming.

2.1 Service oriented architecture back ground

Service Oriented Architecture is an evolution of distributed computing based on the request/reply design paradigm for synchronous and asynchronous applications. An application's business logic or individual functions are modularized and presented as services for consumer/client applications.

SOA applications shows that capabilities are autonomous, in that many services can be intregrated in solving multifaceted client requirements.

The SOA application levels interfaces in order to attain seamless communication on different entities in the Veterinary notification service.

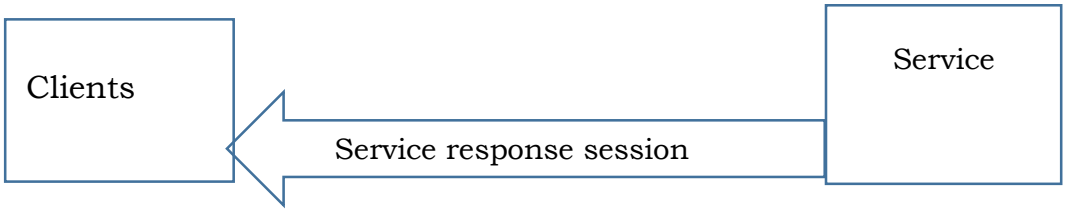

Fig 1: The service request and service provider interaction for Veterinary Notification service

Service-oriented architecture outlines the integration for web-based in electronic business and uses several platforms in its implementation. Service-oriented architecture shows protocols interfaces for electronic business and functionality, (Papozoglou, 2006).

2.2 Related Work

2.2.1 Existing work done in Kenya

According to Tabitha Kihara[1], David Gichoya, The study highlighted on the emerging trends of mobile health (mHealth) which provide livestock farmers with opportunity to receive and share information.

The aim is in disseminating information to livestock farmers in Karura village in Kenya.

The benefits which highlighted includes; livestock care monitoring, responding to emergencies, keeping track of infectious disease spread patterns, empowering livestock professionals though trainings and provision of information to livestock farmers.

From this research, there is evidence of scarcity of information and accessing certain critical aspects in livestock farming including disease identification, professional services access and high cost of the service. The research worked on adoption of a model for mHealth applications for livestock farmers in Karura village in Kenya.

The shortcomings in the study is that farmers were not able to afford smart phones which could access the livestock information systems. There was poor infrastructures in the rural areas which made it hard for charinge mobile phones.

While illiteracy among livestock farmers made it hard in operating the smart phones.

[1] The Adoption and Use of mHealth System for Livestock Farmers in Karura village in Kenya , research by Tabitha KIHARA, David GICHOYA.

The study identified some strengths whereby some livestock farmers were able accessing information on mhealth regardless of their locations with their phones. Livestock farmers communicated with ease with Livestock officers when need aroe such as disease breakouts.

The gap in the study is that, though ICT tools used predominantly, but for solely reason of educational research and not to have a direct benefit to the livestock farmers. For those organizations using it, it is purely based on their mandate and nothing more.

According to Macire Kante[2], Robert Oboko, and Christopher Chepken, ICT plays a significant role in disseminating information on mhealth, the research used grounded theory in sysnthsizing status of ICT use on agricultural input.
Some observation were the relative advantage perception, simplicity and the ICTs influence that positively affected developing countries' agricultural input use.

ICTs' high cost on its services was identified as a challenge, thus negatively affecting their use.

The research also established that there was no clear appreciation on whether livestock farmers had access to mhealth. It was also noted that in India, usage of IFFCO-Airtel Kisan(Indian Farmers Fertilizer Cooperative Limited and Airtel—a telecom operator service for Indian farmers on agricultural input information launched in 2008) by farmers was very low.

Key strengths highlighted in this research was that; most small-scale farmers reported increase in convenience and cost savings through mobile phones usage in seeking information such as input availability.

[2] Factors affecting the use of ICTs on agricultural input information by farmers in developing countries

The research also noted that in India the delivery of real time information and customized knowledge to the farmers tends to improve their decision making ability for better alignment of produce to the market and improving the quality of their products.

M-Farm is a mobile service which aims in improving Kenya's agricultural sector via interconnecting farmers through peer-to-peer collaboration that seeks to improve mhealth market information.

It assists farmers in knowing key seasons such as platn time, and selling their produce. Farmers are able to access agricultural inputs prices and hence make decision affordable buying and selling outlets.

With M-Farm, Kenyan farmers are able to send text messages and get information on products and their retaing values, purchase farm inputs from economical outlets at fair prices and connect to buyers.

According to the research, approach undertaken by M-Farm can be adopted by livestock farmers in collaborating among themselves through sharing vital information, it can enable livestock farmers to know the available veterinary doctor to attend to their requests at any given time through sending text messages and be mapped to the nearest veterinary doctor.

The challenges identified in M-Farm study include; Information quality and adequacy of information, the relevance and completeness for livestock farmers to apply, the questioning of effectiveness of information.

What is different in the Proposed Veterinary Notification Service Prototype?

As far as the challenge on information quality and adequacy of information is concerned, the veterinary notification service app sort to address the challenges by validating only qualified and certified veterinary doctors to share diagnosis research output with the livestock farmers through the prototype, thus authenticating source of information shared.

2.2.2 Existing Solutions Worldwide

According to Andhra Pradesh[3], the study was based on data collected from 33 organizations which were actively involved in Animal Husbandry activities on "Utilization of Information and Communication Technology (ICT) tools by various organizations in Animal Husbandry – A study in Andhra Pradesh."

This found out that ICT solutions are regularly used for information dissemination, whereby 100% of Private Organizations regularly use ICT tools for marketing since their primary motive is the marketing of their products. While 62.5% of Educational and Research Organizations reported regular use of ICT tools in the area of development programs. The role of Information and Communication Technology (ICT) cannot be overruled in the provision of faster and newer ways of delivering and accessing information. At present, the ratio of the farmers to the extension workers is 1000:1(Kumar, 2005), vast gaps between the research and farmers linkages.

The problems cited were inadequate use of new areas of information dissemination in various development programs.

The gap identified in the study is that, ICT solutions employed solely for purpose of educational research and not to have a direct benefit to the livestock farmers. For those private organizations using it, it is purely based on their mandate and nothing more in relation to improving productivity for the farmers.

2.3 Summary of the Gaps

In Macire Kante study, the gap is that the research did not come up with a prototype or the framework to undertake in solving the identified challenges.
The research recommends a study could be undertaken to support/or not support these hypotheses and consequently inform the ICTs' designers.

In M-Farm, the problems cited were inadequate use of new areas of information dissemination in various development programs.

As far as the challenges highlighted in M-Farm on information quality and adequacy of information is concerned, the *veterinary notification services* prototype seeks to address this through validating only qualified and certified veterinary doctors to share diagnosis research output with the livestock farmers through the portal, thus authenticating source of information shared.

2.4 Envisioned solution

The Mobile App solution for veterinary notification was developed, evaluation done on its performance, in line with the research findings which included quality of information, ease of use and social influence on usage.

2.5 Theoretical Framework

This research was guided by the Technology Acceptance Theory. The technology acceptance theories and models were designed to predict the individuals' behaviors and measure the degree of acceptance and satisfaction for the individuals against any technology or information.

Venkatesh and Bala (2008) combined TAM2 (Venkatesh & Davis, 2000) and the model of the determinants of perceived ease of use (Venkatesh, 2000), and developed an integrated model of technology acceptance known as TAM3 shown in **Figure 2**. The authors developed the TAM3 using the four different types including the individual differences, system characteristics, social influence, and facilitating conditions which are determinants of perceived usefulness and perceived ease of use of the developed Veterinary Notification Service App. In TAM3 research model, the perceived ease of use to perceived usefulness, computer anxiety to perceived ease of use and perceived ease of use to behavioral intention were moderated by experiences. The TAM3 research model was tested in real-world settings of IT implementations.

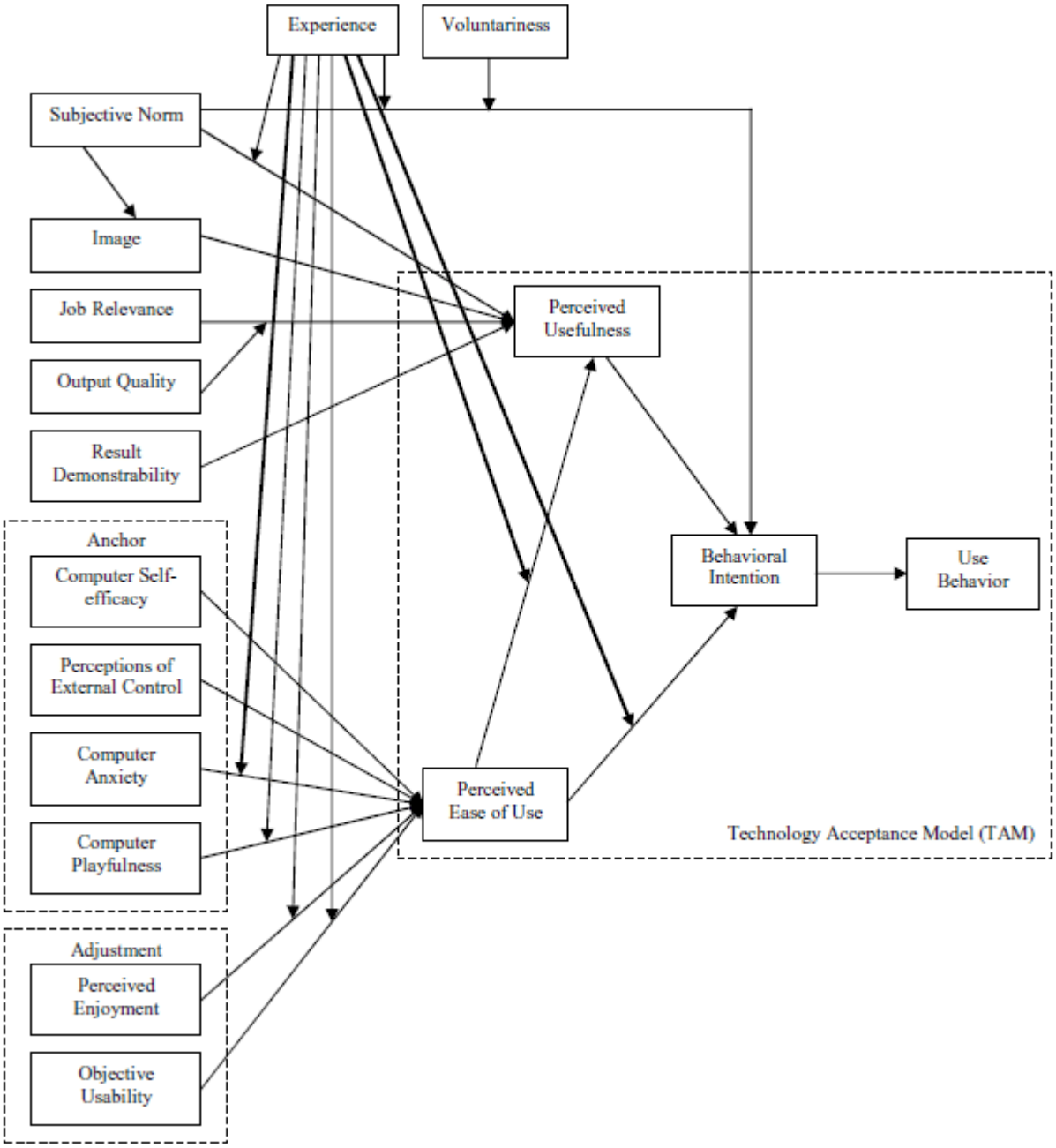

Figure 2. Technology Acceptance Model (TAM 3) (Venkatesh and Bala, 2008).

The key constructs of the TAM are Perceived Ease and Usefulness as shown in Figure 2 above. The Variables of TAM are highlighted below:

Perceived Usefulness (PU)

Lombardi (2007:2) Access to information offers the possibility for improved human competence. observed that the acquisition of capacity to access authentic information is

Prevented by users' reluctance to accept and use available strategies and techniques to access the information. Perceived usefulness, according to Davis (1989: 320), is the extent to which a person believes that utilizing a particular method or technique would enhance his or her job performance or routine responsibility. This perception, he explains, is anchored on the consideration that the capacity acquired will strengthen performance.

Perceived Ease of Use (PEOU)

Davis (1989: 320) argued that perceived ease of use is the extent to which an individual considers that making use of a specific system would be effortless and hassle free; in other words, ease of use means freedom from complexity and trouble. Application that is perceived to be easier to use is generally accepted and utilized by more people. Zhu, Linb and Hsu (2012: 968) add that Perceived Ease of Use signifies the degree to which an individual accepts that using certain technology would be effortless and hassle free. The system characteristics can help the ease of use of technology and system usage can equally lead to the acquisition of Information Literacy skill.

External variables

Winarto (2011: 16) confirms that there are many external variables that can be used along with the TAM that can be a pointer to methods that must be followed in the use and adoption of new skills. Winarto (2011: 16) identifies more than 70 external variables that have been popularized to explain the procedure people go through in acquiring new skills. Yousafzai, et al. (2007: 252) classifies the variables into four categories as indicated in Table 1 below.

Table 1: Variance of External Variables Source: Winarto (2011: 17).

Organizational Characteristics	**System Characteristic**	**Users Characteristics**	**Other Variables**
Competitive environment	System design	Age	Cultural affinity
Users Support	System operation	Cognitive ability	External computing support
Internal training	System maintenance	Information anxiety	Facilitating condition
Management support	System development	Computer anxiety	Subjective norms
Policy support	System auditing	Computer literacy	Social pressure
Organizational composition	Access cost	Educational level	Social influence
Peer influence	Interface	Experience	Argument for change
Training and Development	Convenience	Gender	
	User friendliness	Intrinsic motivation	
	Information quality	Personality	
	System quality	Perceived enjoyment	
	Cyber security	Perceived playfulness	
		Self-efficacy	
		Tenure at work	

The four variables are quite applicable within the environment, largely within the development of veterinary notification service.

Information anxiety

Another factor that can affect the Perceived Ease of Use is information anxiety as access to an overwhelming amount of information is a major challenge of the modern world which is producing an information overload. As a result of the abundance of information, the problem of authenticity arises (Jungwirth, 2002: 94). Thus, information anxiety occurs as a result of information overload which is a condition where the amount of information input exceeds the processing capacity of personnel and the negative effects of this can lead to poor decision making (Girard and Allison 2008:112).

Computer self-efficacy

Yussoff (2009:77) notes that many studies have been conducted to reveal the relationship between computer self-efficacy and technology acceptance as a psychological quality. Thus, computer self-efficacy is a determinant of acceptance of technology and Perceived Ease of Use. Advances in computer technology and the diffusion of personal computers, productivity software, multimedia, and network resources heralded the development and implementation of new and innovative teaching strategies (Hong, et al., 2006: 1819).

Behavioral Intention to use

In the opinion of Walker and Pearson (2012:2), behavioral intention to use and apply new skills is the willingness or extent to which an individual is consciously prepared to execute or not execute a particular action. Intention is a dependent variable that predicts the actual usage of a particular skill that will ultimately lead to attitude formation.

System quality

The quality of information system can be a possible moderator of perceived usefulness, for this reason the quality of systems and technology adopted by Veterinary Notification Service App developed must be capable of providing sufficient output quality that influences the users' perception of its quality (Nanthida 2011: 13).

Perception of external control

In the view of Nanthida (2011:13), external control is a function of available knowledge, ease of use of relevant resources, and a proficiency that is required in carrying out a particular task. Therefore, if livestock farmers easily have access to veterinary doctors and their needs addressed within short time, the livestock health will improve hence increasing farmers' income.

Internet Self-efficacy

According to Torkzadeha and Thomas (2002), it is a fundamental concept that facilitates the understanding of technology acceptance, performance, and use.

This quality may also be considered as a way to gauge the level of success in technology planning. It has been observed that self-concept has positive implications for learning and development, especially in program appraisal, change in behavioral patterns, relationships between others, innovation and even fear (Torkzadeha, and Thomas: 2002).

Perceived enjoyment and objective usability

Perceived enjoyment and objective usability refers to how functional and utilizable a system is and the effect it has on Perceived Ease of Use. Objective usability and perceived enjoyment influence a user's perception of a system's ease of use (Nanthida, 2011: 24).

Criticism of Technology Acceptance Model

TAM is a theory that has been extensively used in Information System (IS) research and regardless of the wide acceptability; the model has a number of limitations (Chuttur 2009: 17). Chuttur stated that scholars are doubtful about the application and theoretical precision of the model; therefore, it is persuasive to conclude that research on the Technology Acceptance Model (TAM) may have attained a saturation stage. This means future research may focus on developing new models that would take advantage of the strengths of Technology Acceptance Model (TAM) whilst discarding its weaknesses as noted recently by the increasing popularity of Unified Theory of Acceptance and Use of Information Technology (UTAUT) (see Venkatesh, et al. 2003).

Khan and Woosley (2011:713) identified certain noticeable limitations of the TAM and conclude that most of the studies validating it involved students in academic atmospheres not business environments, the types of applications studied were predominantly introduction of office software or development applications rather than business applications, and the problem of self-reporting. The TAM measures the variance in self-reported use, which is not necessarily precise. Factors measured in the adaption of Information Technology are also influenced by organization dynamics that are not included in the TAM and also studies only 40% of IT usage. Khan and Woosley (2011:713) recommended that there is need to expand the TAM to embrace social and human factors.

The TAM is also inadequate in explaining technology adoption by ignoring the societal influence that dictates technology adoption. It is not enough to examine the adoption of technology from an individual perspective because environment, exposure, society and economic status in the vicinity where technology is exposed to individual can collectively affect the adoption and use (Bagozzi, 2007: 212).

2.6 Conceptual Framework

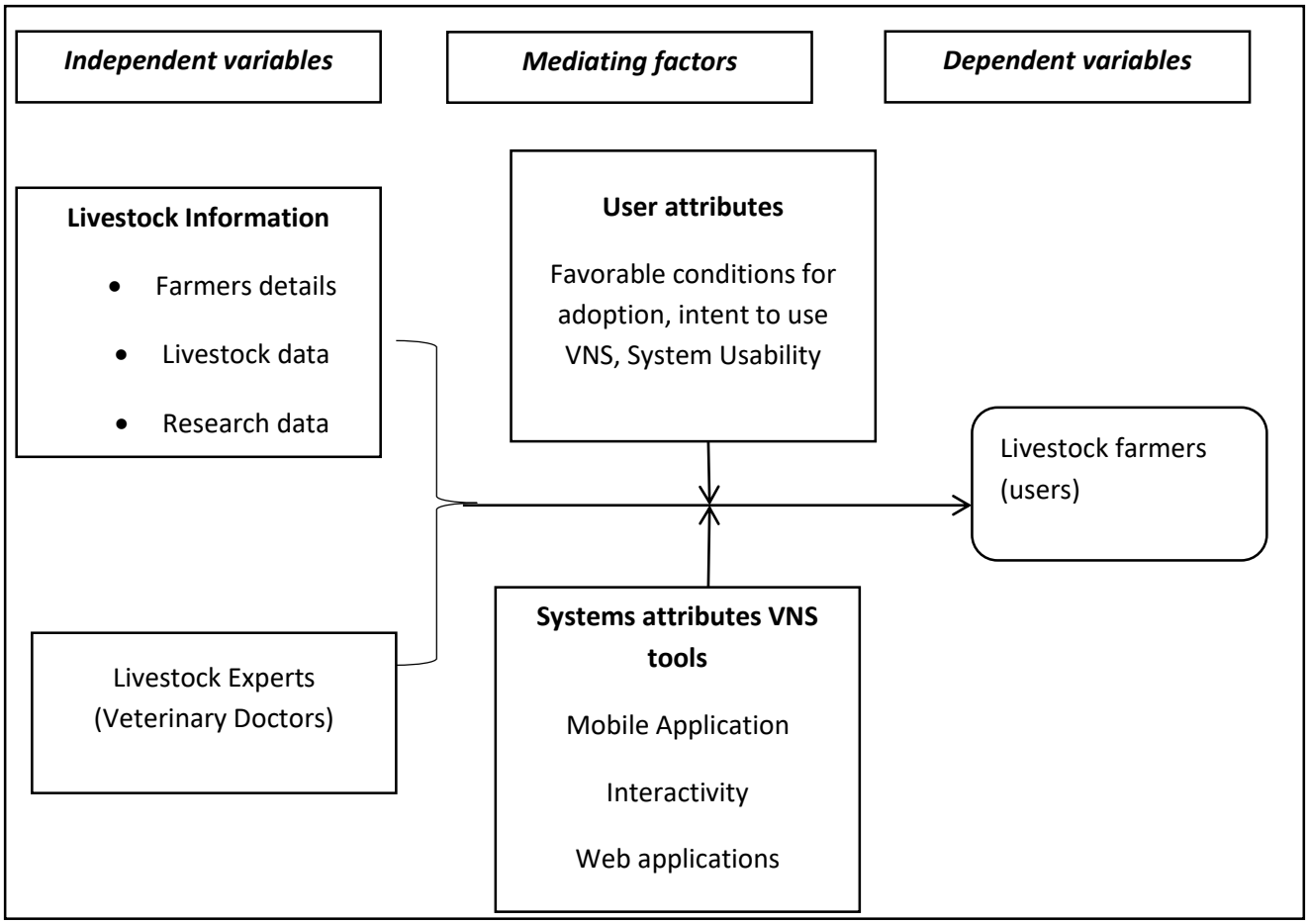

Figure 3: Conceptual Framework, (author 2020)

The framework proposed has five components, Namely: Veterinary Notification Service App, Livestock Experts -Veterinary experts, User Attributes, Channels for ICT and Livestock farmers. Livestock notifications adopt a two way. The significance being feedback as shown in **Figure 3** above.

Livestock Information

A repository point containing key information needed by livestock farmers. The repository interlinks veterinary doctors with the ICTs in enabling mhealth information sharing.

Livestock Experts (Veterinary Doctors)

This is the team of Veterinary Officers who should receive farmers' requests through the VNS, interpret and provide services requested to the livestock farmers through ICT channels. The Veterinary experts responds to requests from the farmers.

Channels for ICTs

Livestock farmers, Veterinary doctors and Administrators of the system majorly use it in mhealth service provision.

User Attributes

The users' attributes relate to the Veterinary Notification Service usability among livestock farmers and Veterinary experts. The underlying assumption was that Veterinary Notification Service is influenced by ICT self-efficacy, the attitude and usefulness of the livestock famers. The proposed prototype incorporates this system attribute.

Livestock farmers

Livestock farmer maps and engage Veterinary experts via mapping the nearest one, but also sometimes engage directly the veterinary experts who can attend to his /her requested service.

2.7 Conceptual Architecture

The conceptual architecture, indicates the relational entities, Key are the Livestock farmers who initiates a request either for animal treatment upon animal falling sick or simply advisory / professional consultation services. The Livestock farmer in return gets an alert mapping to the nearest available Veterinary Doctor, who in return acknowledges availability to attend to the request by Livestock farmer. Upon acknowledgment by the farmer, the Veterinary Doctor provides veterinary service as requested, then updates service as shown in **Figure 4.**

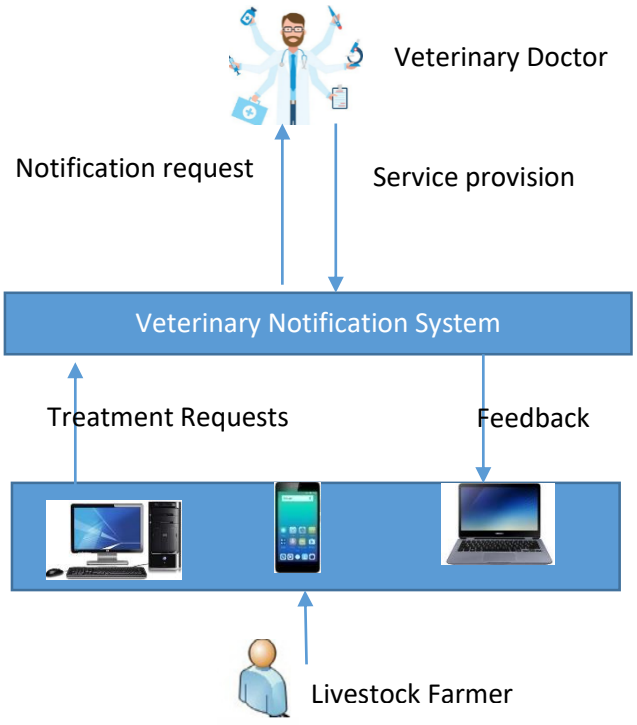

Figure 4: Veterinary Notification Service Interaction

2.8 Proposed system

Analysis of the veterinary notification service application and the related functions requires mapping the veterinary doctors available and the livestock farmers seeking services, in a manner that allows interactions to take place.

During the notification process, location where the veterinary doctor is, forms part of the system, since livestock farmers have to contact them based on proximity and availability.

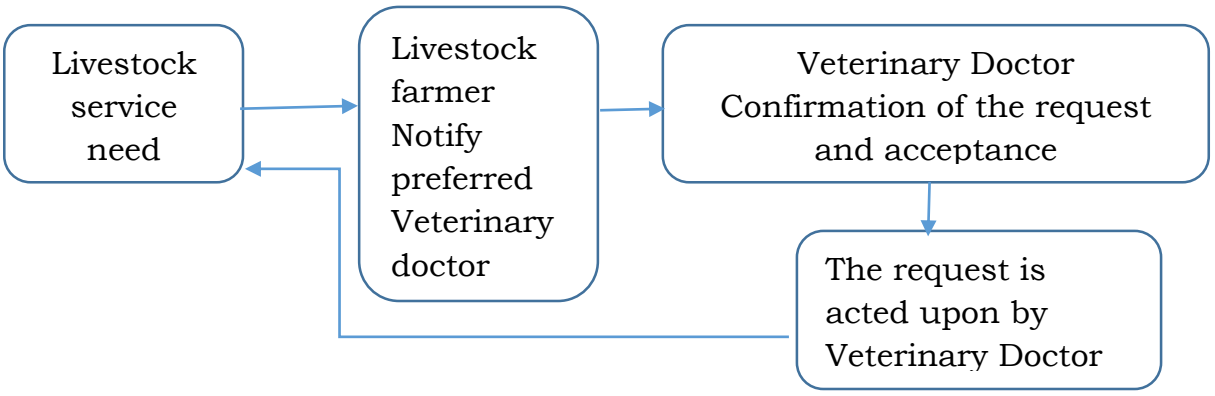

Figure 5: Livestock treatment process

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter outlines the method used in developing veterinary Notification Service prototype. It adopted service oriented methodology for software application development and explains seven phases involved in the development which includes needs analysis, conceptual design, development, and testing and usability evaluation.

It also outlines the perception of farmers' experiences in receiving timely livestock services upon requesting veterinary doctors.

3.2 Software Development Life Cycle (SDLC) Methodology

The mobile software application that has interface modules which react immediately to user interactions, and since this is an environment with rapidly changing user requests, the development of incremental process that comprises one preparatory and eight distinct main phases that concentrate on business processes which can be carried out iteratively.

These are planning, analysis and design (A&D), construction and testing, provisioning, deployment, execution and monitoring.

3.2.1 Planning phase

In the planning phase of this project the researcher was concerned with the feasibility study, nature and scope of service-solutions in the context of the veterinary notification service, usage of the service.

The key requirement in this phase is therefore to understand the usage environment and ensure that all necessary aspects of the system are incorporated and considered in the design of the proposed prototype.

The planning phase considered selection of the study location, feasibility study and listing livestock farmers' challenges.

Analysis and design (A&D)

This is where application of the requirements gathered during design of Veterinary Notification Service. It highlighted the best methods of system requirements.

It enables conceptualization new environment requirements and the effects on the existing solutions then map to the new prototype solution.

Construction and tests

Coding of the system components was done by use of construction tools.

Various functionalities were constructed and interfaces setup.

Provisioning phase

The phase comprised of technical and business characteristics that supported services and client activities. It involved choices in the governance and service certification.

System Deployment

It involved publishing of service interface and implementing descriptions on how applications and livestock users would make use the veterinary notification services.

System Execution and monitoring

In this phase, Web services were fully deployed. It involved a service requester that colud find specified service definition which invoked related operation tasks.

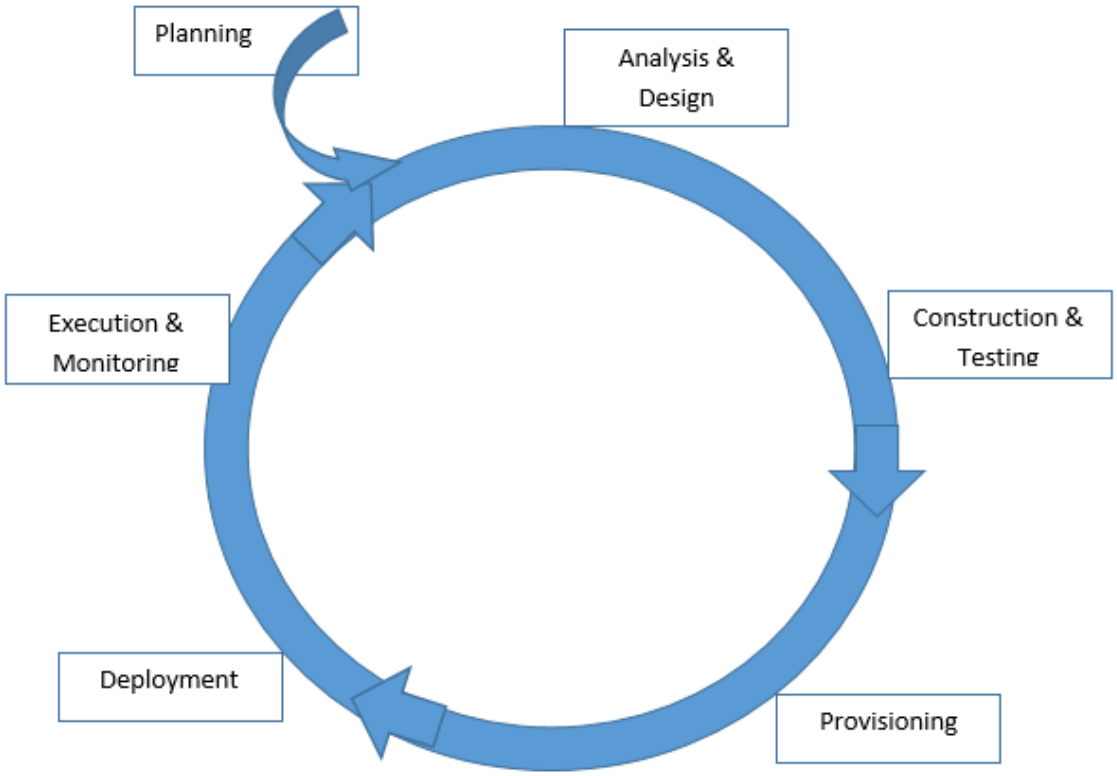

Figure 6: Phases in the SDLC Methodology

3.2.1 Planning phase

This phase looked into feasibility, scope of veterinary service notification solutions in the context of the Veterinary notification service the integration with various related service. The main key aspect was to understand research environment and ensure all key facets of the system are factored in the design of prototype.

Selection of location, feasibility study and listing veterinary notification service needs were the key items in this phase.

3.2.1.1 Location and scope

The main concentration was on describing what livestock farmers go through in accessing the veterinary services from the veterinary doctors.

The improvements that be could implemented to enhance veterinary notification service.

In the gathering of information, multiple design approaches were adopted in meeting the objectives. Bumula subcounty in Bungoma county was selected for case study in the analysis and system evaluation.

The design was adopted since it was a key in understanding activities of livestock services provided in the locality.

3.2.1.2 Feasibility study

It refers to the summary of the cost and benefit analysis of the project. It is the initial investigation that was carried out and informed by pre-study analysis results.

Feasibility	**Outcome of the study**
Operational	It was found that system would work after deployment. System was evaluated according to initial plan
Technical	It was found that resources are available to develop, install, and operate the system in full production on livestock farmers. Supporting infrastructure for the system is sufficient for deployment and usage in Bumula sub county, evidenced by good mobile coverage.
Economic	Financial benefits of the system outweigh costs since it would have a handful benefits to the livestock farmers as per system requirements analysis.
Schedule	Initial project schedule worked well and time was enough. This project is to be carried out in set of three milestones
Political	Existing structures would support the system deployment

3.2.1.3 Population

The research project relied on a number of methods in the collection data. These methods included interviews to livestock farmers; face to face interviews, interviews over the phone and questionnaires.

Interviews enabled providion of detailed usage of existing practices applied in reaching out to veterinary doctors.

The interviewees in this category were;

a. Livestock farmers.

b. Veterinary doctors

Interviews were chosen because feedback would be immediate and it allowed interviewee describe all possible angles of the challenges or the situation.

Focused interviews was used by the researcher in getting significant information. Interviewees had freedom in answering questions in details. Livestock farmers with experiences in livestock farming in Bumula subcounty were interviewed structurally.

Some of the areas sampled, accessibility and or availability of interviewee was a challenge researcher employed telephone interview as an alternative.

3.2.1.4 Requirement Analysis

It is a key step in understanding livestock farmers' environment and processes involved in daily operations.

Survey was conducted in Bumula Sub County between 16th December and December 30th 2019

These informed the processes and services as listed below.

i. Livestock farmer seeks livestock service
ii. The farmer locates nearby relevant Veterinary Doctor
iii. Livestock farmer notifies Veterinary doctor
iv. Veterinary Doctor receives notification request
v. Veterinary doctor accepts farmer's request
vi. Veterinary doctor may record in the event book
vii. Treatment of the livestock
viii. Transaction for the service offered
ix. Process completed

Analysis and findings from existing practices is so challenging with no time-bound promise for accessing of veterinary services.
Majority of livestock farmers hoped for veterinary notification service to help access veterinary doctor service on time and reduce the likelihood of their animals succumbing due to delayed treatment.

3.2.1.5 Data Collection and Analysis

The views and inputs of system users were collected from livestock farmers and veterinary doctors. From the data collected and analyzed, results of the process indicated significance need of a veterinary notification service.

3.2.1.5.1 Analysis of Responses from livestock farmers

The livestock farmers initiates the request upon the animals falling sick.
The requests involved finding their waiting time in receiving services for their requests, challenges, views in the process of communication and locating the doctors.

3.2.1.5.2 Analysis of Livestock farmers Inputs in Requirement and Use Analysis

This was carried out on pre-analysis study **(see Appendix I)**.

3.2.1.5.3 Analysis of Implementation Inputs from livestock farmers request

The current system of accessing Veterinary Doctor is very challenging, late responses from veterinary doctor, it's too manual, hence some livestock goes for several days if not weeks unattended thus loss of lives for the livestock.

The solution to these problems is a system that can enable timely locating of veterinary doctors, reduce turn around and wait time, lead to automation of a number of functions and that can enhance delivery of services.

3.2.2 Analysis and design phase

Is the process involving actual data collection, reviews and the study of processes involved, it also identifies and recommends appropriate solutions of the problem which then can be actualixed in a systematic manner.

It poses queries such as; identifying involved processes, ways of doing things, the relationship links that exists, identifies inputs and outputs, points out improvements which can be done, general creativity and the insights in solution finding to the challenges that exists and identifying future developments.

3.2.2.1 Services Decomposition

1. Reporting services as a request

a. Notification of animal sickness occurrence

b. Requesting Veterinary services by livestock farmer

c. Sending acknowledgements of received requests

d. Mapping the livestock farmer to the nearest Veterinary Doctor

e. Receiving feedback on availability of Doctors

2. Verification services

a. Verification of users (livestock farmers and veterinary doctor)

b. Accepting request by Veterinary Doctor

c. Viewing reports on livestock farmers requests

d. Generating the notification message

3. Data Consumer services

a. Viewing records on requests and treatment done

b. Using data from the database to validate records

c. Data exports into other applications further usage and analysis

4. Administration Services

a. Register of Livestock farmers, veterinary doctors

b. Registering data for Livestock farmer

c. Registering locations in the sub county

d. Accessing the Reviews on treatments carried out and pending livestock farmer requests

5. Integration services

a. Communication with other applications and devices

3.2.2.2 The system architecture

The design of the system used the client-server architecture; the client was a mobile device, SMS requests and web application and on server side used a PHP and JavaScript Script, Android Studio and MySQL database.

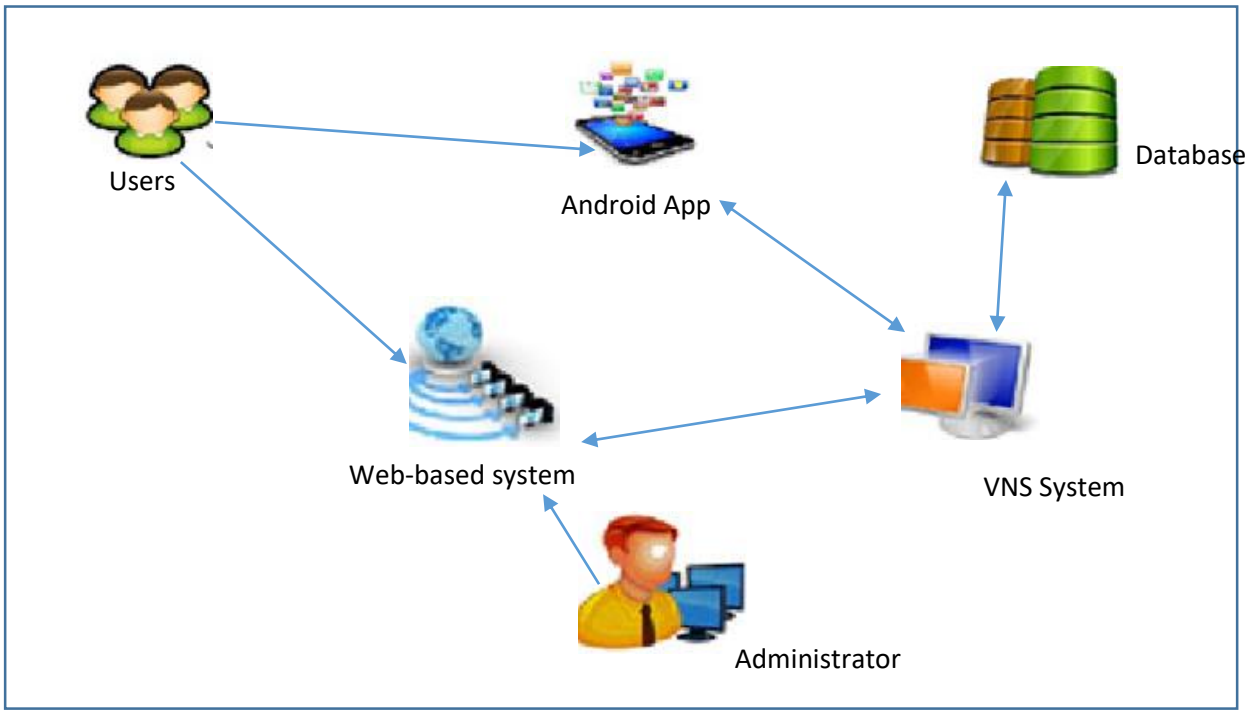

Figure 7: System architecture design

3.2.2.3 Clients Infrastructure

The infrastructure for access is as follows:

1. Smartphone which has internet is used by the livestock farmers and veterinary doctors to view requested veterinary services and verify the request after confirmation.

2. A mobile phone which can send and receive SMS. This was used by the livestock farmers to receive doctors' availability notification updates.

3.2.2.4 Servers and DBMs

Apache server was used to host the web application and the central database. The messaging successfully interracted with the web app via gateway for SMS. The Simple Message Service server received and routed messages successfully.

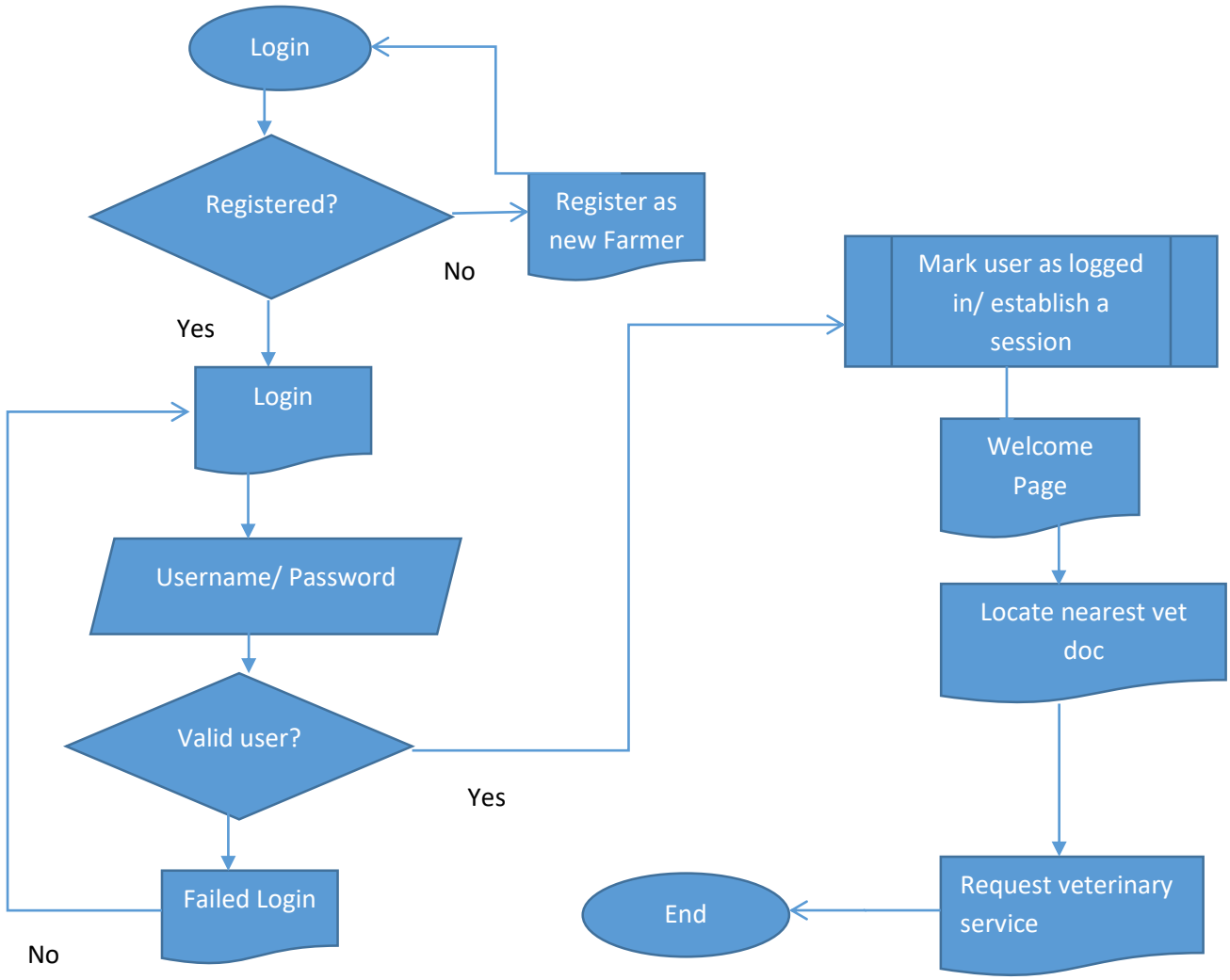

Figure 8: Data Flow Diagram – Livestock farmer request

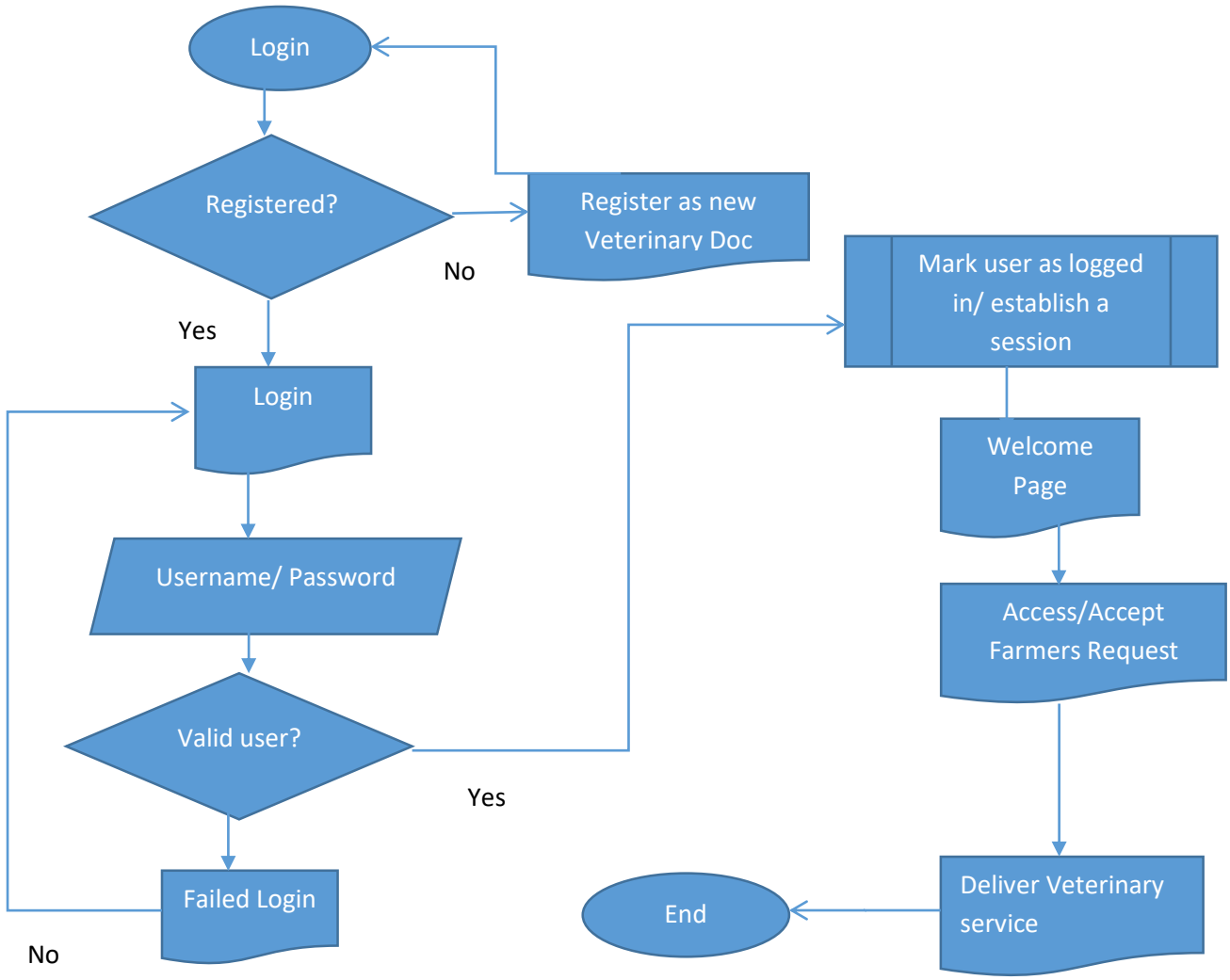

Figure 9: Data Flow Diagram - Veterinary Service delivery

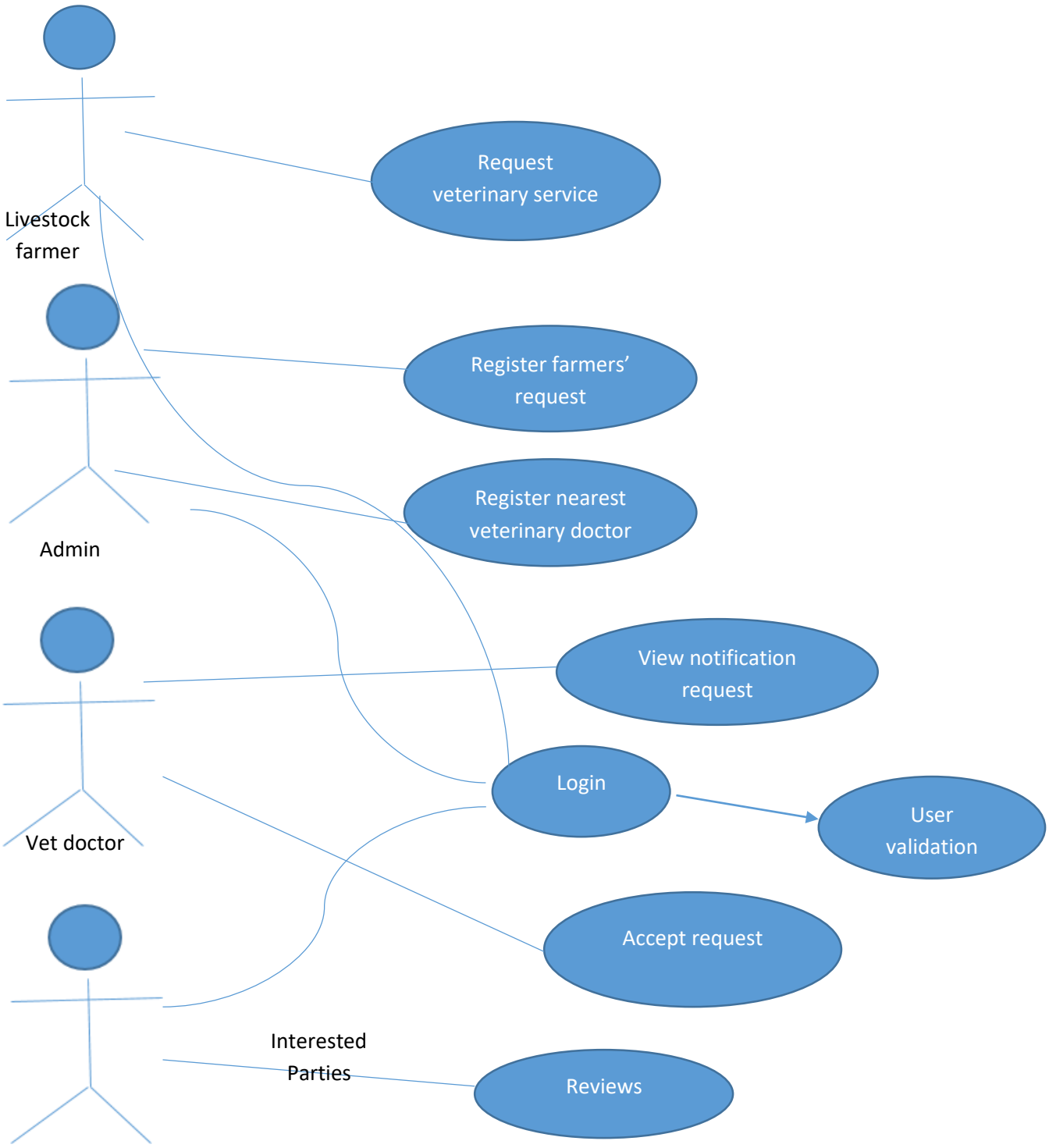

Figure 10: Use Case Model

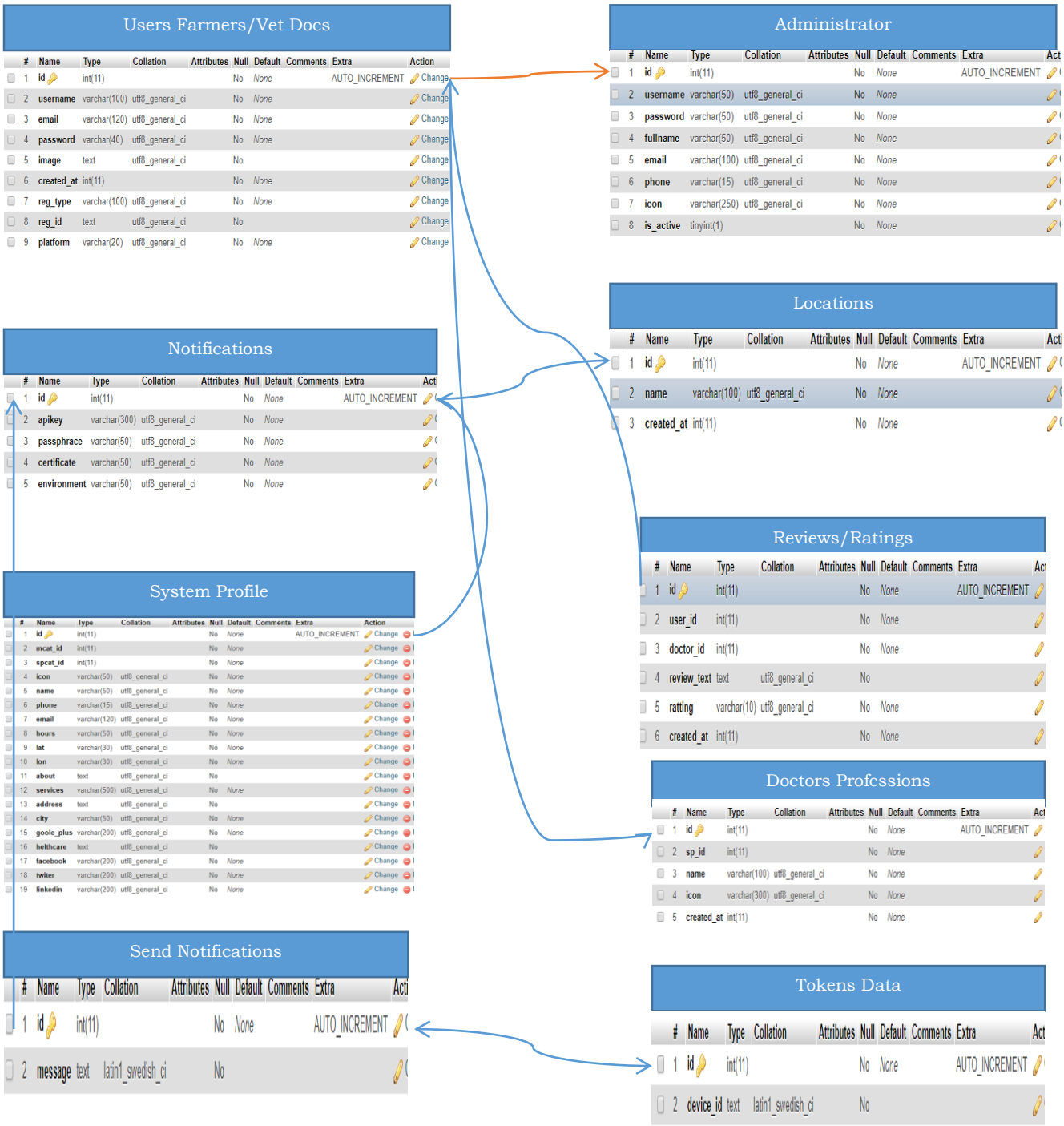

Figure 11: VNS Database Design Structure

3.2.2.6 Description of the system components

A Web server refers to the internet server which responds to HTTP requests.

A database server is a computer program that provides database services to other computer programs or computers defined by the client – server model.it was used to service clients and external consumers' requests.

The livestock farmers and veterinary doctors used the mobile phones that would access the web and (or) send mobile messages.

These devices offered services through appropriate interfaces that the end users used to interact with the system.

The SMS system also enabled the livestock farmers to report animal health status. The other options were through mobile application was downloadable and installable in a mobile device.

A web application for Veterinary service notification was constructed.

3.2.3 The service construction phase

This phase was concerned with development of the web app services implementation, service interfaces definition artifacts that define processes.

3.2.3 The VNS Services Architecture

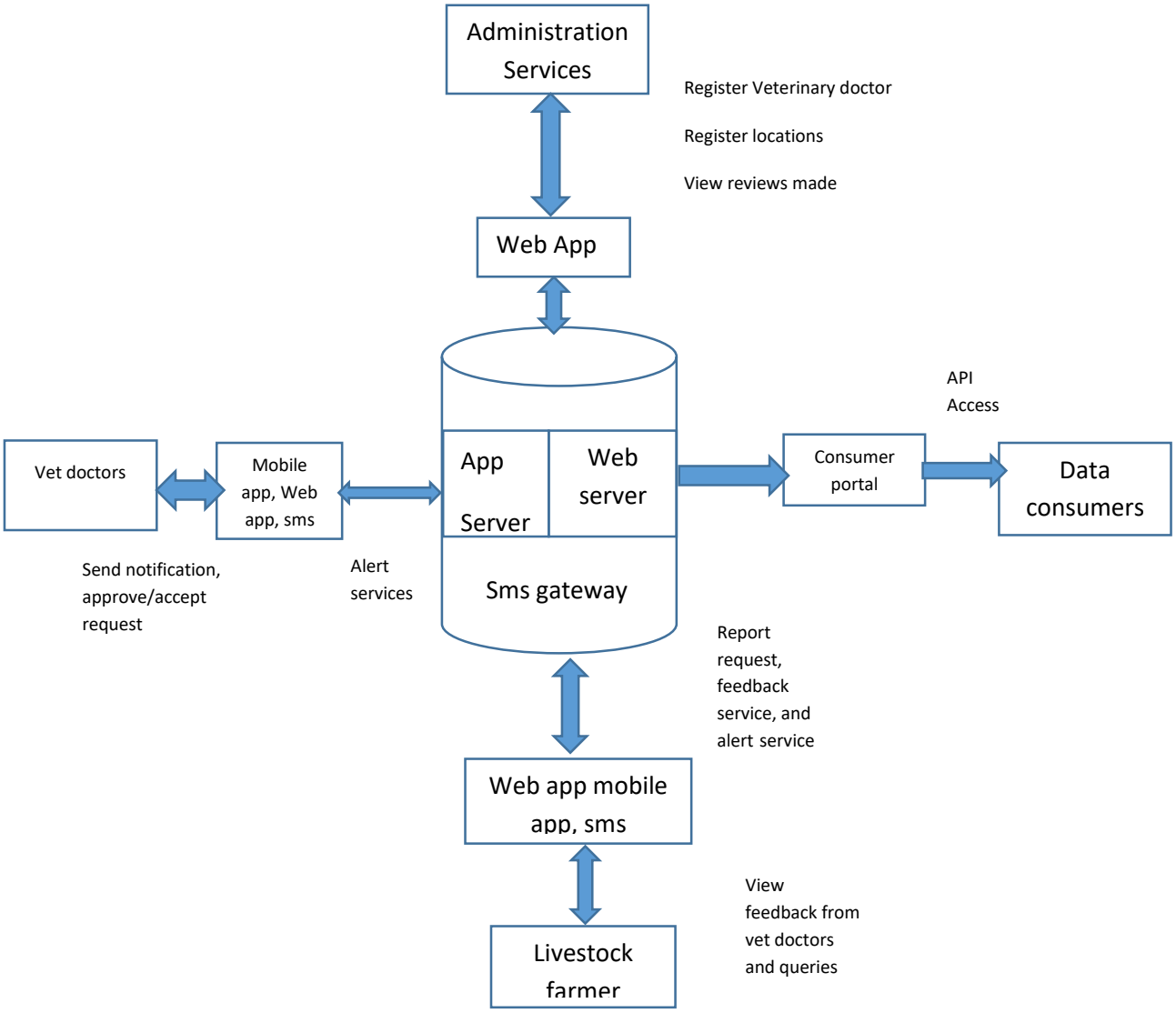

Figure 12: The Services Architecture model for Veterinary Notification Service

3.2.3.1 Services use description

The clients interacted with the system via a three-tier, consting of SMS , Mobile App and web–based app.

The location proximity of veterinary doctor to the livestock farmer's was identified by the service through the three tiers of interaction stated.

Veterinary doctor would visit the livestock farmer and offer treatment to the livestock, an update in the notification service is then done by the provided communication platform.

3.2.3.2 Construction tools

3.2.3.2.1 Hardware Resources

1. Laptop
2. Modems
3. Phones

3.2.3.2.2 Software Resources

Success of the Veterinary Notification service relied on the listed applications.

Android Studio is the official integrated development environment for Google's Android operating system, built on Jet Brains' IntelliJ IDEA software and designed specifically for Android development. It is available for download on Windows, macOS and Linux based operating systems

The success of this project relies on several software applications.

Sublime Text Editor is a free android application for text editor (the same with to Notepad++) for android tablets and phones with the more features: Support multi languages (.txt, .html, .js, JavaScript, c++, c, python, ruby, sql, json ….)

Adobe Dreamweaver CS6 - is a development framework that is used in development of websites and web.

Bootstrap – an open-source front-end application used in constructing websites and web applications.

PHP (Hypertext Preprocessor) is a server-side scripting language designed for web development but also used as a general-purpose programming language.

4. **JavaScript** this is a small and lightweight web scripting language.

5. **Ajax** refers to applications used in creating fast and dynamic web pages. AJAX allows web pages to be updated asynchronously by exchanging small amounts of data with the server behind the scenes. This means that it is possible to update parts of a web page, without reloading the whole page.

6. **JQuery** Mobile this is a cross platform mobile framework for constructing mobile applications through integrating various standards so as to get robust, sustainable and organized applications.

7. **Cordova** application for packaging a web application to be a native application, installable in a mobile phone. It helps to create cross platform mobile applications.

8. **JSON**, or JavaScript Object Notation, is a minimal, readable format for structuring data. It is used primarily to transmit data between a server and web application, as an alternative to XML. In this project it is used to export data to external data consumers and between applications.

9. Apache - this is an open source Web server.

10. MySQL Database - a popular open source software database which web developers uses in various web applications.

3.2.3.3 System Testing

1. Validation Tests

The fields in the data entry forms were validated using JavaScript to ensure data integrity. The data types were specified. One could not be allowed to enter invalid data types. There is an appropriate error message displayed if wrong data was typed in the fields and the wrong data was not inserted into the database.

2. Unit Testing

Units were tested independently for the web app, mobile app and sms system. The essence was ensuring that individual units worked well before interaction done.

3. Access Tests

The system users with other roles than just requesting veterinary services were authenticated. The process of aunthenticating checked on validity of usernames and passwords. If username and password were in tandem with database record stored, then access granted. If either of the two entries was wrong, then a descriptive error message was displayed guiding the user in another login attempt.

4. Data Entry Tests

Various tests done with varying data in ensuring validity of data captured it into the database.

Below is the message from this test. If the data entry was not successfully written in the database, the descriptive error was passed, otherwise successful message is displayed for the record entered.

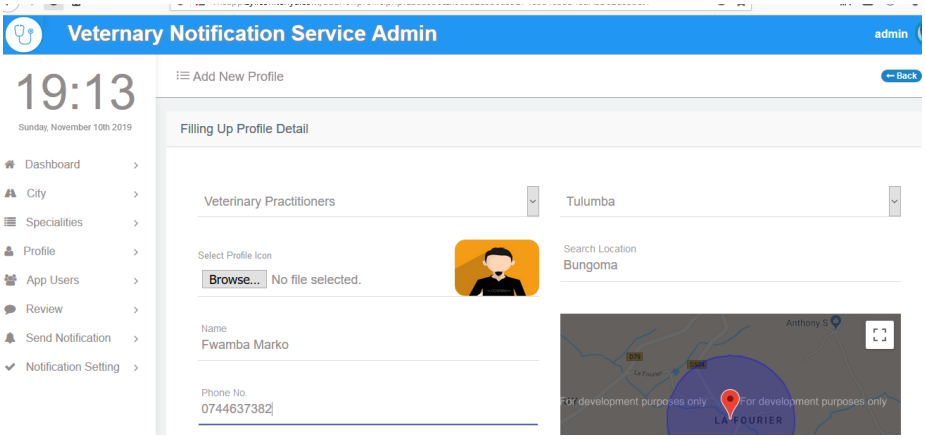

Figure 13: VNS Data entry test

5. External User Services Test.

We also tested the ability of the livestock farmers to get access to the data from the system. First the logging in was tested, then the system ability to locate the veterinary Doctor was tested. The livestock farmer simply search the veterinary doctor that is within a specified radius range and data is pulled from the database.

6. Service Integration Tests

Then integration is effected through the records of activities carried out in the back-end of the system.

Service request from livestock farmers led to alerting the veterinary doctor on requested event.

3.2.4 Service provision phase

Refers to a technical aspects that supports system users activities. It involves the choice for service, certification and enrolment that manages operations that are responsible for service behavior control.

In this regard, only the registered farmers were able to access system and perform functions like locating the nearest farmer, locating Agro vets and order for service.

3.2.5 The Service Deployment Phase

The tasks associated with this phase of the Web service development includes, the publication of the service interface and service implementation definition. The publication was done using Restful services.

3.2.5.1 Publication of Livestock farmer Services

Services were implemented using a Restful services (Fielding 2006). Components were Mmobile, Web and SMS used in the communicating over VNS app.

3.2.5.2 Service Dependencies

The integration of services is dependent of level of dependencies in data and processes.

In realization this, the data consumption by livestock farmer is dependent on verification by Veterinary Doctors. The livestock farmer request event also becomes registered after verification by system administrator.

Data consumers in Bumula Sub County could be able to access report reviews from the system by livestock farmers for treatment that have been requested and acted upon.

3.2.5.3 Services Orchestration

The services were orchestrated in a manner that various applications would consume and interact almost seamlessly. A report done using the mobile application, SMS and web application are well mediated in enterprise service.

3.2.5.4 Services Integration and Data Sharing

The service integration was made possible through integrating Web and SMS servers for routing messages to mobile plartform.

Json, JQuery mobile, Cascaded Style sheets and HTML standards used in data integration. This tools enabled information carried on mobile platform.

3.2.6 The service execution phase

In this stage, a livestock farmer can locate Veterinary Doctor and invoke request operation.

This can be confirmed in this project through generation of a reviews made by livestock farmer.

The system was reviewed to ensure that it produced correct output from the Notification services modules. This was done by reviews generated by the system and it was confirmed as correct execution as per the requirement analysis. .

1. Sample Veterinary notification mapping.

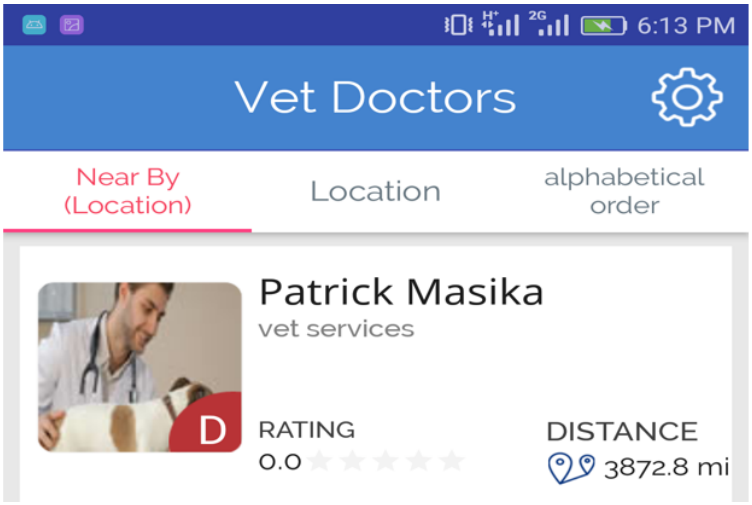

Figure 14: Sample for Livestock Farmer locate Vet Doctor from prototype

3.2.7 The service monitoring phase

This is a closed-loop procedure of measuring, monitoring, reporting and improving the quality of service of systems and applications delivered by service-oriented solutions.

3.2.7.1 System acceptance

The system acceptance testing was done on a sample of livestock farmers and Veterinary Doctors to analyze user requirements.

The main objective was testing the success of the prototype in a working scenario. Futhermmore, system acceptance aim was to identifying gaps that might have been overlooked by unit test, hence provide more indepth in system wellness.

Table 2.Summary of livestock farmers' ability in performing tasks in VNS APPLICATION

	SMS use	**Web Service**	**Mobile App**	**Feedback**
Success	4	4	4	12
Failure	2	0	1	3
% Success	66%	100%	80%	80%

Challenges faced by Livestock farmers was keeping in mind telephone numbers while sending message. Wrong entry was noticed severally with some farmers. Message formats and grammar also a challenge.

Table 3. The summary of Veterinary Doctors in using the VNS

	Web Service portal	**Mobile App**	**Feedback**
Success	5	4	5
Failed test	0	1	0
% Success	100%	80%	100%

Challenges observed by the Veterinary Doctors was the use of the mobile app with little training process.

3.2.7.2 System Evaluation

This was carried out to find out the users perception and the usage of sytem and its ratings. Key items evaluated were the interface and its design architecture, navigating through the system, simplicity of use, and accessingthe feedback provided upon service request.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1. Results

The first objective was to determine communication needs for the livestock farmers and veterinary doctors

This objective was achieved and managed to evaluate and investigate the existing communication process and request systems. The review of the current form of communication revealed that livestock farmers request processes are unreliable and does not enable livestock farmers locate veterinary doctors at any given time.

The results from this project revealed that over 80% believed introduction of ICT technologies at the locating the nearest veterinary doctor would make animal treatment fairly convenient.

The livestock farmers revealed that real time access to veterinary doctor would reduce the likelihood of animal succumbing to diseases hence improve and increase on production.

The second objective was to propose & design Veterinary Notification Service prototype in which livestock farmers would locate and request the nearest Veterinary Doctor as soon as livestock fall sick.

The prototype was designed, built and tested. The veterinary notification service was found to be working well; consisting of integrated SMS module, mobile application and web portal.

The nearest veterinary doctor to the livestock farmer's location was also notified about the treatment request event through SMS.

The veterinary doctor would visit the livestock farmer and offer treatment to the livestocks, using the veterinary notification service provided channels, the veterinary doctor would updates the process carried out.

Evaluation of its applicability and usability revealed that it can reduce time taken in waiting for veterinary doctor in attending to livestock in Bumula Subcounty. The aggregated data in database system can then be shared with relevant interested parties.

The first question to find out experience for livestock farmers to get service from veterinary doctors upon request.

Table 4. Livestock farmers experiences in receiving timely service upon request to veterinary doctors

Choice	**Frequency**	**Percentage**	**Cumulative percentage**
Easy	11	28.21	28.21
Very easy	2	5.13	33.33
Difficult	10	25.64	58.97
Very difficult	16	41.03	100.00
Total	39	100.00	

Based on 39 respondents, 28.21% of them said that receiving timely service upon request to veterinary doctor was easy. 5.13% said that it was very easy. Another 25.64% said that it was difficult and the last 41.03% said that it was very difficult receiving timely service.

From the study the researcher noted (combination of difficult and very difficult) which is 66.67% found a big challenge receiving timely service upon requesting the veterinary doctor.

The second question was to find out the major challenges that livestock farmers undergo when trying to reach out to the veterinary doctor in their locality

Table 5 Livestock farmers' major challenges in reaching out to veterinary doctor within locality

Choice	Frequency	Percentage	Cumulative percentage
Failure to reach Veterinary doctor	4	19.05	19.05
Time taken to reach out to the veterinary doctor	8	38.10	57.14
Lack of technology to locate the veterinary doctor	8	38.10	95.24
Very difficult	1	4.76	100
Total	**21**	**100**	

Out of 21 respondents, 19.05% of livestock farmers said the major challenge they undergo in trying to reach out on communication to the veterinary doctors within their locality. 38.10 % said that time taken to reach out to the veterinary doctor was major challenge. Another 38.10% said that lack of technology to locate the veterinary doctor was the challenge. And 4.76% did not have substantive answer but generally felt there is a challenge as regards reaching out the veterinary doctor.

From the table above, it is evident that the major challenges that the livestock farmers undergo when trying to reach to veterinary doctor on animal treatment request is time taken to reach out to the veterinary doctor.

The questions intend was also to investigate how the use of veterinary notification service to inform the veterinary doctors about the livestock farmers' requests for animal treatment would be helpful and responses were as below.

Table 6 Livestock farmers thought on veterinary notification service

Choice	Frequency	Percentage	Cumulative percentage
Little help	11	34.38	34.38
Helpful	9	28.13	62.50
Very helpful	9	28.13	90.63
Am not sure	3	9.38	100.00
total	**32**	**100.00**	

From a total of 32 responses, 34.38% of the respondents said that veterinary notification services would be of little help. 28.13% said that it would be helpful. A further 28.13% said that it would be very helpful while 9.38% of the population was not sure if it would be helpful or not.

This indicates that if a veterinary notification service was used in request for treatment process, 56.26% of the livestock farmers would find it helpful.

Researcher asked the respondents, if they were to be provided with a list of technologies to use in veterinary notification upon animal falling sick in assisting to reach out to veterinary doctor, which method they thought would be more suitable.

Table 7 Response on most suitable technology for the livestock farmers

Choice	Frequency	Percentage	Cumulative percentage
Mobile application	11	31.43	31.43
Web application	3	8.57	40.00
SMS	16	45.71	85.71
Voice call	4	11.43	97.14
Not sure	1	2.86	100.00
Total	35	100.00	

Out of 35 responses, 31.43% of the respondents preferred a mobile application as the most suitable method. Another 8.57% preferred a web application. Respondents who preferred SMS were 45.71% against 11.43% who preferred a

voice call. 2.86% of the respondents were not sure. So we can conclude that the preferred mode of pre-notification was SMS and Web based application.

The researcher sort in finding out from veterinary doctor, how fast it would take them to offer veterinary services should a notification request from a livestock farmer came in services.

Table 8. Time it takes veterinary doctors to offer services to farmers upon requesting service via notification

Choice	Frequency	Percentage	Cumulative percentage
1 day	4	12.90	12.90
1 week	17	54.84	67.74
2 weeks	8	25.81	93.55
1 month	1	3.23	96.77
not sure	1	3.23	100.00

From above question, 31 responded. Out of which 12.90% would take them a day. 54.84% take a week. 25.81% take two weeks, 3.23% take a month, a further 3.23% not sure. This means that 87.10% of the Veterinary doctors said it would take them a week or more to attend to livestock treatment request after pre-notification.

The researcher sought in knowing interraction level the system would impact among Veterinary doctors and livestock farmers.

Table 9. Responses on system intervention on increasing interaction between livestock farmers and veterinary doctors

Choice	Frequency	Percentage	Cumulative percentage
Yes	19	63.33	63.33
No	4	13.33	76.67
May be	7	23.33	100.00
Total	30	100.00	

There was 30 responses, 63.33% provided Yes response. 13.33% provided responded No, another 23.33% not sure. Guided by the responses, the researcher had conclusion that most of livestock farmers found Veterinary nofication system intervention key to increasing level of interraction.

System acceptance testing on livestock farmers and Veterinary Doctors was done to analyze on whether user requirements had been achieved.

The main objective was testing the success of the prototype in a working scenario. Futhermmore, system acceptance aim was to identifying gaps that might have been overlooked by unit test, hence provide more indepth in system wellness.

Table 10. The summary of ability for Veterinary Doctors to use the system

	Web Service portal	Mobile App	Feedback
Success	5	4	5
Failed test	0	1	0
% Success	100%	80%	100%

The most challenge Veterinary Doctors faced was using mobile app with minimal guidance.

Evaluation of the System

Table 11. VNS App Evaluation

	Excellent	Good	Poor	Very poor
User Interface	21	8	1	0
Navigation	12	16	2	0
Feedback time	8	19	2	1
General rating	16	11	2	0
Overall Rating%	47.50%	45.00%	5.83%	0.83%

Accoriding to the sample on evaluation of VNS App, 47.5% said was excellent, 45% was good. 5.83% was poor and 0.83% had a feel VNS was very poor. Thus, VNS App evaluation indicated 92.5% were satisfied with it.

4.2 The Veterinary Notification Service App Interfaces

Interface provides point of interaction between the users of the systems. The interfaces are used to expose the functional components of the systems. Interfaces were designed as follows.

The Landing Page

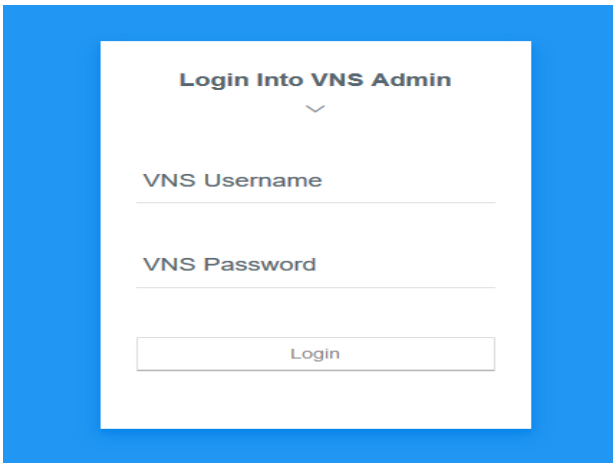

Figure 15: The VNS App landing Page

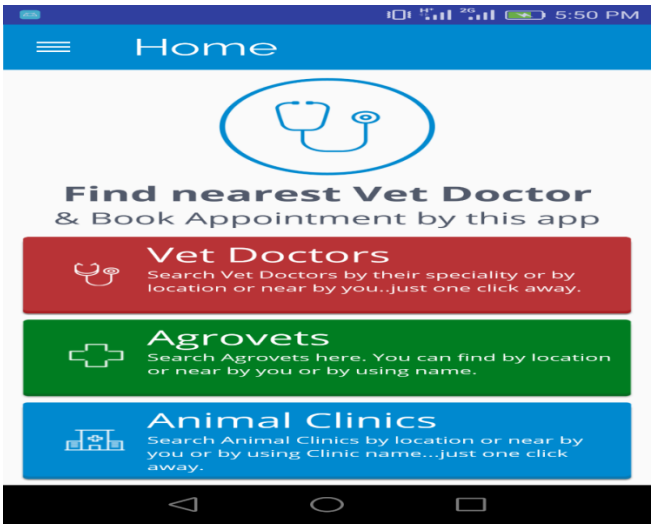

Figure 16: The VNS App Service Page

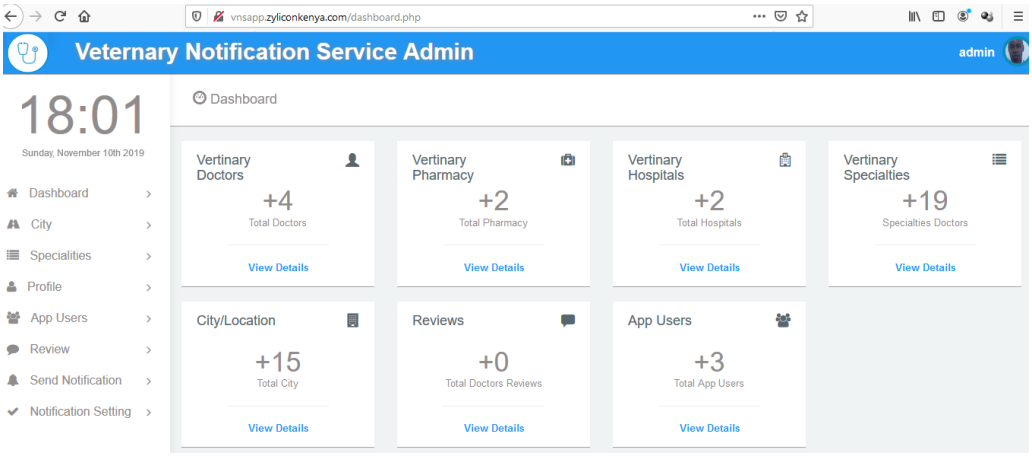

Figure 17: VNS App - Back-End Administration

4.3 The SMS Service Interface Design

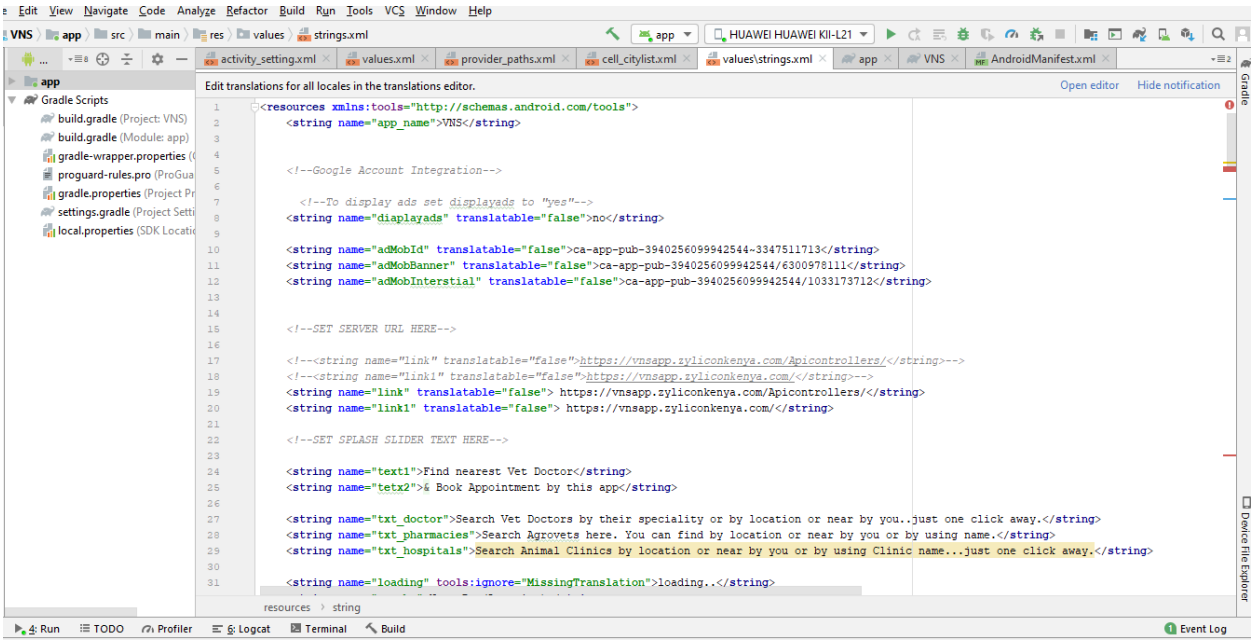

Figure 18: The VNS App SMS interaction code

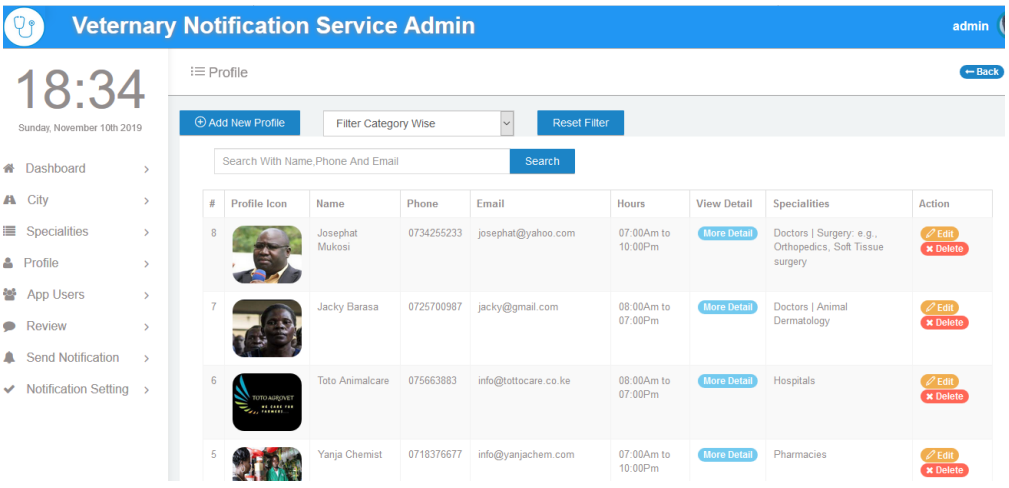

Figure 19: List Veterinary Doctors registered in VNS App Web based Service

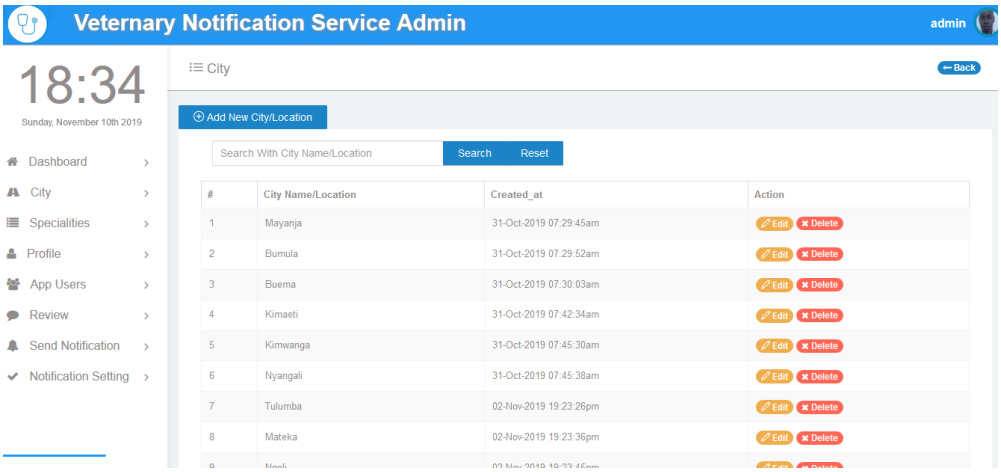

Figure 20: VNS App Access Points in Bumula Sub county Web based service

CHAPTER FIVE

RECOMMENDATIONS AND CONCLUSION

5.1. Introduction

This chapter summarizes the recommendations and conclusion which were arrived at after analysis of the data. It also gives suggestions for further research reference to the general objectives of the study.

5.2. Summary of findings

Research was carried out in Bumula Sub-county, Bungoma County.

The study found 84% of livestock farmers believed introduction of ICT technologies which enables them to locate nearest veterinary doctor would make animal treatment fairly convenient.

From the analysis of the study, livestock farmers indicated that the time to access veterinary doctor would relatively reduce likelihood of livestock succumbing to diseases thus improve and increase on production.

The study noted that majority of respondents 66.67% found it difficult to receive timely service upon requesting the veterinary doctor.

Veterinary Doctors to attend to requests by livestock farmers is the major challenge.

This indicates that if a veterinary notification service was used in request for treatment process, 56.26% of the livestock farmers would find it helpful.

This means that 87.10% of the Veterinary doctors said it would take them a week or more to attend to livestock treatment request after pre-notification.

From the study, user interface, navigations, feedback time and general ratings revealed acceptance level as 92.5% after evaluation phase.

Furthermore, the study further found that the VNS system can reduce time taken in waiting for veterinary doctor in attending to livestock in Bumula Subcounty

The study showed most livestock farmers agreed that there has been a greater level of access and engagement with Veterinary Doctors since they started locating the nearest Veterinary Doctor by use of ICT devices.

The study found that majority of the Livestock farmers in Bumula Subcounty felt that the VNS system gave accurate information in regard to locating nearest available Veterinary Doctor.

It was also noted from the study that most of livestock farmers preferred SMS and Web based app as the preferred mode for locating the nearest veterinary doctor.

The findings informed the researcher in developing a framework that locates the nearest veterinary doctor by use of VNS is seamless to the livestock farmer.

The developed framework ensures livestock farmer is able to locate and contact the nearest available veterinary doctor. It would reduce the gap experienced by livestock farmers in locating and contacting nearest veterinary doctor, through mapping locations to ensure that livestock farmers' needs are addressed within reasonable time period.

The study had challenges in rural data collection which spanned a large geographical area with overlapping availability of interviews, thus wide scope in requirement analysis in SOA model design and implementation.

Some technology tool which were required in development of prototype were valid freely for access in a short period of time thus posing serious development challenges.

5.3. Conclusion

The project findings indicated the methods applied in today communication has a gap to address in reaching out to veterinary doctors for livestock services effectively.

The study also revealed that the introduction of ICT technologies based on service architecture model would improve mapping and notifying veterinary doctors.

The model also provided means of providing services on different platforms which ensures resilience in offering livestock notification services.

The prototype testing revealed that the model for mapping and notifying Veterinary Doctors was seamless service, since other livestock operations can be integrated, thus improving the existing veterinary related activities and services.

The Veterinary Notification Service demonstrated significance reduced time in locating, notifying and receiving livestock services since it could happen in almost real time and guaranteed by the available veterinary doctor which under current system takes a couple of days if not weeks the requested service.

5.4. Future research recommendations

The introduction of VNS for livestock farmers is an enhanced solution that would improve in animal husbandry healthcare, treatment and real time consultancies in Bumula Sub County.

A more focus should also address on expanding and intergarting of the notification system and expand its usage in other regions of the country that practice livestock farming in large scale.

Eexplore and innovate possibilities to increase realted services on the prototype including videolized simulation on some of the veterinary specialties that require little intervention of a professional such as deworming animals and animal behavior captcha.

This would help the Bumula subcounty get relatively quality veterinary services of almost all animals that need veterinary attention, thus improving lifestyle and economy of its population.

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APPENDICES

Appendix I: Pre-study Analysis

Table 12: Summary of Pre-study findings

Method of communication	18 through phones	2 apply manual system		
Accessibility of doctor	16 doctors hardly available	2 it depends with timing	1 easily accessible because of proximity	1 not sure
Is the delay of Doctors affects animal health	15 yes	2 no	3 not sure	
Can Technology to improve locating doctors assist animal health?	16 yes	2 may be	2 not sure	

Appendix II: Project budget

Table 13 Project Budget

Item	Description	Amount (Kshs.)
Project Personnel	Data collection assistants	20,000
Administrative cost & Support	Approval / authorization fees for needed to conduct research	5,000
Travel	During the data collection period	10,000
Tools and equipment	Computers, data collection and analysis tools	50,000
Stationery	Printing costs and related costs	10,000
Miscellaneous		10,000
Grand total		**105, 000**

Appendix III: Project schedule

Table 14 Project Schedule

TASK	TIME(Weeks)	COMPLETION PERIOD IN YEAR 2020
Project Proposal	8 Weeks	Start of November 2019
Collection of data	3 Weeks	End December 2019
Analysis of data	2 Weeks	Mid-January 2020
Prototype Design	4 Weeks	Start of Feb 2020
Prototype Development	4 Weeks	End of March 2020
Final Report	3 Weeks	Start of April 2020