

Mobile Application Based Expert System for Cattle Disease Diagnosis and Treatment in Afan Oromo Language

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Abstract

Ethiopia is best known for its cattle population in Africa. Nonetheless, cattle diseases is the major constraint to cattle production and its safe utilization. For the developing countries, cattle disease creates a considerable effect on the livelihood and lives of the farmers. In this research work we have developed a mobile application based expert system in afan oromo language for diagnosing and treating cattle diseases. Knowledge Base regarding the various diseases affecting cattle's in the study area was acquired by using both secondary and primary sources. The primary knowledge source was collected from West Guji and Bornea zonal area domain experts and the secondary sources of knowledge was collected using document analysis. Purposive sampling technique was used for selecting domain experts for knowledge acquisition process. The proposed expert system was developed using rule based knowledge representation approach and using decision tree knowledge modeling technique. After knowledge is acquired it was represented using rule based knowledge representation method using Java Programming language and a user interface was designed and developed using XML that fits into the present day smart phones and the application will be cross platform. User acceptance testing and overall system performance testing was made after the prototype was developed. Accordingly, the mobile application demonstrated 81% of accuracy and among the users who were made a user experience evaluation, 84% of them got satisfied by the performance of the mobile application.

Keywords: Expert System, Cattle Disease, Mobile Application, Android OS

1. Introduction

Ethiopia owns the largest number of livestock in Africa. Around 80% of the population, particularly the pastoral communities and farmers are greatly dependent on it. Moreover, it serves as a source of income, a source of milk and meat for families. Among the available livestock population, cattle is the primary contributor to the farmer's economy in the country. In addition, it is also the main source of foreign exchange of the national economy. According to Ethiopian central statistics agency's (CSA) official livestock survey report of 2020/2021 (*Livestock and Livestock Characteristics*, 2020a), the total cattle population of the country is estimated to be about 70 million and there is net cow milk production of about 4.96 billion liters. Moreover, the livestock population has a contribution of 45 % in Agricultural GDP, 15-18 % of National GDP, and 5-17 % of total exports.

Nonetheless, there are many factor that hamper the cattle production in the country namely; genetic resources, shortage of feed and water, climatic factor, diseases, and poor housing (Andualem, 2016). Among these, livestock diseases are the leading cause for livestock mortalities and its follow up socio-economic effect to the Pastoral communities,' and farmers. According to a study made by CSA in 2014/2015 fiscal year the annual losses caused because of livestock mortality rate is estimated to be close to 3.23 million cattle. Additionally, the annual livestock production loss declined by 30-50 percent annually. To alleviate this problem various mitigating strategies could be put in pace this include; appropriate disease control measures; vaccination (preventive measures) and effective diagnosis and treatment (curative measure). This mitigating strategies are a helpful l tools to avert the negative impacts the aforementioned problems incur on the household and national economy(*Livestock and Livestock Characteristics*, 2020b). Cattle disease doesn't solely affect castles it does also affects humans. Various zoonotic diseases expose people to different disease causing bacteria, protozoa, fungi, viruses and parasites.

Productivity of the cattle can be enhanced though prior identification of production constraints and incorporating various new technologies and tools or by refining existing practices in production environment. One among many technologies that can be used in this domain is solutions that emanate from the Information communication technology. Expert System is the one of the broad study areas in the ICT sector and is one of the study areas in the field of Artificial Intelligence (AI) which strives to mimic human beings reasoning and decision making capability. This system will help in the animal health sector in order to make diagnosis and treatment based on predetermined symptoms. This application can be further used as a tool to disseminate the available important health information and serve us a tool to mitigate the effect caused by the diseases.

In agricultural sectors the applications of expert system are mainly found in the area of disease diagnosis and pest control which serve as a tool to generate awareness for human experts and farmers in decision making process (Sarma et al., 2010). The expert's knowledge will be available when the human expert might not be available physically and so that the knowledge can be available at all times(Abu-Naser et al., 2010).

The cattle production system is greatly affected by various cattle management problems this include prevalence of major endemic diseases, poor feeding and high stocking rate on grazing lands, inadequate extension service to reach out to the farms ,clinical veterinary services, insufficient and inaccessible information on how to improve animal breeding, marketing, and processing .

Even though animal health is vital for the socio-economic and livelihood of the pastoral community formal veterinary services often does not reach the remote areas where many pastoralists live. When cattle suffers from an abnormal behavior the farmers mostly intimate veterinary extension officers or community-based animal health workers (CAHWs), or also dubbed as para-vets who provide a surveillance role on behalf of the district veterinary officer as primary disease monitors to come and diagnose the animals. In some cases veterinary officers might not be available or may take time before they come, these may make the condition of the affected cattle worse and even lead to death. Thus an immediate action has to be taken to avoid cattle losses. Due to the above mentioned causes, we are motivated to explore mobile based application expert system technology by developing prototype of for Zoonotic Cattle disease diagnosis and treatment. This Mobile application based expert system entails the Knowledge and analytical skills of one or more human experts in a particular

problem domain priority in Afan Oromo language which is the working language in the research area.

Furthermore, in the study area i.e. West Guji and the Borena pastoralists, the mobility of the pastoral community is high and essentially they aren't bound to a single place to make the dwelling for a long time. Therefore, this situation makes it difficult to visit a vet clinic in a regular basis. This hindrance is addressed through community animal health workers (CHWS) which only took very basic training regarding cattle diagnosis and treatment. These workers are in great need of professional and expert assistant during any professional inquiry. Hence, the proposed solution will immensely help the aforementioned CHWS. Additionally, the following problems do also exhibit in the area:

1. Inadequate availability of laboratory equipment
2. Less sufficient number of experts
3. Inadequate and poorly maintained infrastructure
4. In adequate budget for training of the animal health assistance to advance their knowledge
5. Less advanced treatment by Animal health assistant Delay time to diagnose the diseases

A number of mobile applications both open source and proprietary, do exist which primarily focus on general advice and tips on veterinary medicine. To the best Knowledge of the researchers no afan oromo language based mobile application based expert system domain. Therefore, this research work aims at the development of an android application based Expert system in afan oromo language for the diagnosis and treatment of cattle diseases.

2. Literature Review

2.1. Background of Expert System

Expert System is one of the subdomains of artificial intelligence (AI), which has the aim of mimicking some features of the human intelligence through the creation of computer systems (Raza, 2009), (Sasikumar et al., 2007). In this subdomain various computer programs were introduced to solve problems in various domain areas in place of a human expert. According to (Sasikumar et al., 2007), knowledge base expert systems are defined as a computer system that uses a particular knowledge and inference procedure to solve a domain of problem. Moreover, they are an essential tool in medical information technology for mimicry of human reasoning capability and expert problem solving skills. These systems have brought my benefits for the medical domain. For example, it supports and facilitates the clinical decisions and help improve the quality of patient care, optimize the cost-benefit equation and ultimately transform the traditional structure of the health care provision (Nilsson & Sollenborn, 2004). Some of the application areas of such systems include; advisory system to assist clinicians with the diagnosis of diseases, protocol design and maintenance tools, and laboratory systems to assist the interpretation of measured values. For further read on the list of the available application read (Aboneh, 2013a). The architecture of a typical knowledge based Expert system has four components viz: Knowledge-Base, Inference Engine, and user Interface (UI) (Tomar & Saxena, 2011). Accordingly, the use of this component is discusses here below:

Knowledge-Base: It entails general facts and heuristic rules of thumb for a particular knowledge base. It is the underlining building block for generating a particular decision.

Inference Engine: It is a program which entails the reasoning logic for the utilization of the knowledge in the knowledge base and drive new conclusions from it. In this section of the system two manipulation techniques are involved namely backward chaining and forward chaining. **Backward Chaining:** - in this technique the inference starts with conclusion and works backward to the supporting facts. It establishes goal in the order in which they appear in the knowledge base. It tests each rule in turn until an answer fired or until answer not found. **Forward Chaining:** - in this technique the inference engine it keeps on firing rules until there are no rules, which can be used, or the goal has been reached.

UI: - The gateway where the dialog between the user and the system is made;

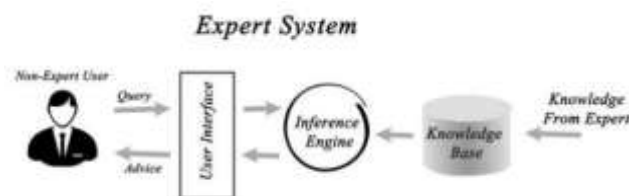


Fig.1. Architecture of Knowledge Based Expert System

2.2. Review of Related Works

Various research works have been reported in the Knowledge based expert system domain area. Accordingly, major finding are presented here below.

The research work in (Esseynew, 2011) demonstrated a knowledge based expert system to diagnose patient with anxiety mental disorder. The acquired knowledge was represented using Decision tree Model. Rule Based Reasoning approach using followed. In addition, backward chaining reasoning mechanism was followed to inference the rules. The work is aimed at filling the gap that existed in medical domain for mental disorder patient problem and lack Knowledge, to address problems the research study provide alternative solution to diagnosed mental disorder. The prototype system was developed using SWI-prolog editor tool. The researchers reported that the proposed work was 86% performance wise validated and 85% accuracy wise validated approach in the development of Knowledge Based System for Hospital triage service to enhance the decision making ability of medical doctors in order to give effective service to the patient. The research study used decision tree knowledge representation technique to represent the acquired Knowledge and the rule structured using if then rules. The research study starts to fill the gap observed in triage treatment in Hospital which includes not properly categorize the disease type, patient forced to pay addition cost and spending a lot of time to get service in hospital.. The research study also assist human expert by providing the required knowledge at the right time for decision making process. The proposed system was developed using SWI-prolog editor tool. The system evaluation result shows 85% of the performance of the prototype was validated and 80% of the prototype system accuracy was evaluated.

In a research in (Abetwe, n.d.). Application of knowledge based system for woody plant species Identification was presented. The paper attempted to design prototype of KBS for woody Plant species identification. The system uses rule based approach for the ES. The system is modeled in decision laddering, domain knowledge is represented using production rules in prolog to construct the knowledge base. The prolog built in backward inferring mechanism is used for the identification of the species. . Finally, the system is tested and evaluated by the users. The result shows that, the system identifies the woody plant species correctly and can be applicable in woody plant species identification. As compared to existing way of identification we come up with new knowledge/rules with minimum features that registers comparable performance.

Additionally, R. Mosissa (Mosissa, 2019) reported development of knowledge based system for coffee disease diagnosis and treatment that assists agriculture experts, development agents and whole the community to make timely decisions. The system is designed to provide information for non-experts about coffee production system. Decision tree model was used to represent the acquired knowledge and Knowledge structured using if then rules. The system was developed using SWI-prolog editor tool. The authors reported that the proposed system has demonstrated 83.6% of the performance of the prototype was validated.

Similar to this, a prototype for a knowledge-based system for the diagnosis and treatment of cereal crop diseases is provided in (Tefera, 2012) and helps agricultural professionals and development agents make quick decisions. Decision trees were utilized in the research study to reflect the knowledge that was learned. It employed an if-then approach to rule-based reasoning with a backward reasoning technique to deduce the rules. The SWI-prolog editor program was used to create the prototype system. The research study's findings indicate that 80.9 percent of the prototype's performance was validated.

J. Stephen (Carse, 2013) demonstrated a Diagnosis expert system for remote use research with the goal of diagnosing illness in livestock. This system is accessible on low-end mobile phones in rural areas with weak cellular coverage, which may make it possible for livestock owners to access medical

Another research in 2013 (Aboneh, 2013b) presented an investigation of the applicability of rule based reasoning

Care for their animals that was previously inaccessible to them. The drools rule engine and web-based interface were used to create an expert system that can recognize disease in cattle. The system's user interface has been tested on a number of mobile browsers, and it works in each one. In order to diagnose cattle sickness, this paper presented a web application based expert system for low-end mobile phones. The authors sought to develop a system that is capable of providing a front-line diagnosis to rural and developing farmers and livestock owners in poor communities who couldn't have access to professional medical care. The system was developed using Drools rule engine as to store the knowledge base and the user interface(UI) was developed by a JavaServer page (JSP), which contains HTML and JavaScript code. The Communication between the UI on the mobile phone and the data in the server is done using a custom developed HTTP servlet on an instance of JBoss Application server.

A research work on mobile phone based expert system was presented in (Isinkaye et al., 2017). In this work the authors developed a rule based mobile expert system and implemented it to perform a diagnosis and make a medical advices to ten common diseases that are

prevalent in Nigeria. The mobile system was implemented on Android operating system (OS) technology which was widely used mobile OS in Nigeria during the time of presentation.

Therefore, to the best knowledge of the researchers no research has been made on Mobile application based Expert system for cattle disease diagnosis and treatment in Afan Oromo Language

3. Research Method

In order to realize the objectives we sought out to achieve at the outset of commencing this research work, following methods, tools, programming languages and techniques to were used.

3.1.Data Collection

Knowledge base was acquired through document analysis; both primary and secondary (documented and undocumented) source of knowledge. The primary knowledge was gathered from yabello regional veterinary laboratory using both unstructured and structured interviews, to collect knowledge from domain experts regarding cattle disease most prevalent in the study area. In addition, secondary source of knowledge were collected by using document analysis such as, the internet, cattle diseases guide lineS

3.2. Sampling Techniques and Sample Size

In order to select domain experts for knowledge acquisition, Purposive sampling technique was used. The domain expert's selection criteria for this study based was based on their year of professional experience, educational qualification, and their position in the particular veterinary health institution they are working. In view of this, five experts were used to acquire the domain expert knowledge.

3.3. Knowledge acquisition

Knowledge acquisition is the process of extracting, analyzing and interpreting the knowledge that human expert uses, and then transferring these knowledge in to machine representation method (Hamilton & Breslawski, 1996). It also serves as prerequisite and an important phase of knowledge based system development that deals with the activities of acquiring knowledge from human experts, books, documents or computer files (Hamilton & Breslawski, 1996). It entails two tasks: knowledge elicitation and knowledge representation. In knowledge elicitation, domain knowledge is obtained through various means including interviews with experts and book and journal references. In knowledge representation, the elicited knowledge is converted to a form that computer capable to manipulate.

(1) Primary Knowledge Acquisition Process

The Primary knowledge was gathered from experts from yabello regional veterinary laboratory by using structured and unstructured interview techniques.

(2) Interviewing Domain Experts

In this research study for knowledge acquisition process interviewing the domain experts through purposive sampling technique was used. The domain experts from yabello regional veterinary laboratory were purposively selected. Interview was made with selected domain experts regarding major cattle diseases prevalently presented in the study area and their corresponding symptoms and treatment.

The experts were asked mainly the following questions: “which diseases mainly attack cattle in the study area?”, “which bodies of cattle mainly affected by diseases”, “what are the symptoms of cattle diseases?”, “what are the basic treatments and preventions had to be taken?”, and “What are common cattle disease?” Initially disease, symptoms and treatments were identified.

3.4.Document Analysis Process

Document analysis was carried out to acquire knowledge that are found in different secondary source, this include; books, Internet resources, scientific journals and Standard Veterinary Guidelines, Manuals which are great source of information about Epidemiology, clinical symptoms of ruminant animals.

After a thorough document analysis an interviewing of domain experts the information gathered is changed to a solid knowledge and represented in to knowledge based structure form. This representation is used as a rule in a manner which is going to be used by the inference rule engine. To do this all selected diseases are categorized into four main categories. Those diseases categories are taken from Ethiopian Drug Administration and Control Authority for Veterinary manual guide according, to DACA cattle diseases categories. These disease categories are Infectious diseases, Non-infectious diseases, Respiratory System diseases and Reproductive System disease. According to domain experts those selected diseases are most significant disease in the domain areas during clinical diagnosis process. From those categories the researchers had taken as common diseases that mostly occurred in the domain areas. The selected cattle summarized as the following diagram.

3.5. Conceptual Knowledge Modeling

During this phase the knowledge obtained from the domino experts is represented using knowledge model. It is an organized representation of the knowledges gathered using symbols to designate a piece of knowledge. It is important because it helps to create a common understating with stakeholders involved in the development process so that a common language and terminology is used to deliver important information (Emberey et al., 2007).

1) Decision Tree Structure

Decision tree was used to Model the knowledge. These decision tree structures are the base for the prototype knowledge based system development. The prototype knowledge base system is developed based on the model presented in this decision tree structure.

The following decision tree diagram shows, how proposed system knowledge model for cattle diseases category works according to knowledge structured model.

Therefore, the system follows the following sequence; a after the system start/load, then user ticks the symptoms s/he observes on the cattle. If all the symptoms of symptoms of rule-1 match with knowledge base then the rule would be fired the matching disease, otherwise the system tells no matching disease is found. The user then will be promoted to go to the ensuing activity page for a list of symptoms to choose which are categorized under rule-2. Similarly the diagnosis procedure will follow for the remaining rules in a similar fashion up until the end of the rule symptoms. Finally, if the symptom would not match in all rule symptoms then the system would be terminated

2) Knowledge Representation

Knowledge representation is concerned with designing and using systems for storing knowledge (Syazwan Abdullah et al., 2006). In this study rule based knowledge representation technique using if....Then production rule technique. If certain condition full filled then some action is done in this case if, a given symptoms or condition fit then, fired the goal by checking all condition which match by using back chaining reasoning mechanism. The following rules shows the knowledge structure if then rules. For instance for the first rule:

Rule: 1

If the cattle has difficulty for breathing

And cattle has unclothed blood exude from body openings and the body not stiffen after death

And the cattle has high fever

And the cattle has muscle tremors

And the cattle has abdominal pain

Then Anthrax would be diagnosed

3.6. Knowledge Based Reasoning Techniques

There different types of knowledge based reasoning techniques, the most common are rule based reasoning, case based reasoning and fuzzy logic are mostly used in area of AI research.

1) Rule Based Reasoning

The term 'rule' in AI, which is the foremost commonly utilized type of knowledge representation, it can be defined as an IF-THEN structure that relates given information or facts in the IF part to some action in the THEN part. A rule provides a predefined set of instructions on how to deal with a particular problem. It will have two sections namely: the IF part, called the antecedent (premise or condition) and the THEN part called the consequent (conclusion or action). The basic syntax of a rule is: IF <antecedent> THEN <consequent> (Alemayehu Mengistu, 2004),(MacGraw & Harbison-Briggs, 1989) . In this research work we have used the rule based reasoning technique for our knowledge base.

2) Case Based Reasoning (CBR)

It is one of the sectors in the field of AI were decision is deducted based on previously encountered similar problem. It works based on the observation that human reasoning processes are founded on specific experience rather than a set of general guidelines.

For the case of our research work we have used rule based reasoning techniques to develop and implement the mobile application system

3.7.Langauge Localization

In localization of the knowledge based system, translation of the domain knowledge is the primary task as it is a crucial component of localization. Translation is the process of actually converting the written word of a source language into the written word of a target language. In the localized knowledge based system, the user interface and all related words are translated

into Afan Oromo language with the help of domain experts. In addition to the domain experts, the researcher used the following resources to translate English documents of TB into Amharic language:

3.8. User Interface Development

In order to create the gate way that the core of the application to interact with the user. Currently, users not only expect that handheld device has strong applications, but also a friendly user interface. Products which possess good UI design will achieve better user's demand (Maoqiang Song et al., 2011). Accordingly, we have developed a friendly and interactive lay out and user interface (UI) of the application using extensible markup language (XML). This UI is designed to fit into the present day smartphones and other handheld devices like tablets with android OS.

3.9. System Development tools

1) Android Studio

Android Software development Kit version (SDK) 29 which is an open source Operating System for Mobile devices, initially was rolled out by Google in 2007 was used to develop the proposed system . It is the most prevalent and commonly used mobile operating system in Ethiopia and Africa as of now. The implementation was designed to be suited for offline diagnosis recommendations in very interactive ways. The implementation was done using the Android Studio (an Integrated Development Environment) by Google which supports the use of XML (eXtensible Markup Language) for the development of an attractive and friendly user interface. Java programming language was used for the development of the inference engine that runs in background to match patient's input with rules for diagnosis. SQLite database (an SQL database similar to MySQL but specifically built to work on the Android operating system)

The proposed expert system was implemented using Android Studio Integrated development Environment (IDE) version 3.5.2. The knowledge base was built using XML, a textual language quickly gaining popularity for data representation and exchange on the Web (Marinov, 2004).

To build the inference engine and logic a java programming language is used along with XML activity page. The java development kit Version employed for the work was 1.8.0.202release.

4. Results

4.1. User Interface of the Application

When the user launches the application from the app icon of his/her phone s/he will encounter with the main activity page, which entails the basic information regarding the application (See figure2). It also invites the user to start to work of diagnosis.





Figure 2 Screenshot of the splash scree of the application

Figure 3. Disease category activity window in Afan Oromo Language

After selecting the appropriate disease category that the cattle has shown symptom the user is directed to an android activity page that entails the list of possible symptom with a selection

checkbox to choose from(see figure 3) . After the user chose symptoms that correspond to a particular disease and the selected symptoms fulfill all the rules to be labeled to a particular disease the user will be directed to an activity page that tells the possible cattle disease. This android activity page entails the local name of the possible cattle disease along with the possible pathological causes of the disease and the proper treatment or interventions that can be used to alleviate the issue (see figure 4).



Figure 4 Screenshot of the list of symptom of the diseases



Figure 5 Screenshot of the name of the diagnosed disease, its cause and treatment suggestion section of the application

4.2. Mobile Application User Acceptance Testing

After the application was developed an overall performance evaluation and user acceptance testing was performed. The performance testing helps to know how it properly works to achieve the presented goal in the domain under investigation. On the other hand, the user acceptance testing the ease of use of the system from the user perspective.

For user acceptance testing ten domain experts were purposefully selected. Among these six experts were selected from Yabello veterinary laboratory and four experts from Bule Hora University Department of Veterinary Medicine were selected.

To evaluate the application open ended and close ended type of questionnaires were adapted from (Esseynew, 2011) and (Leta & Mesele, 2014) and were customized for this study. Closed ended questionnaires was used to evaluate the user satisfaction level with the mobile application's user interface design and the apps problem solving capability.

A total of seven questions were used to evaluate the system. Among them, the first three questions were used to evaluate the look and feel, ease of use and loading time of the application. The remaining questions were used to evaluate the accuracy, adequacy, problem solving ability and the importance of developed knowledge based expert system.

For each seven close ended questions in Table 1, the domain expert put the value of their satisfaction level on a scale of one up to five where a value 5 corresponds to be a Satisfaction level of Excellent, a value 4 corresponds to be a satisfaction level Very Good, a value 3

corresponds to be a satisfaction level of Good, a value 2 corresponds to be a satisfaction level of Fair and a value 1 corresponds to be a satisfaction level of Poor.

Table 1. User experience validation questionnaire

No	Questions	poor	Fair	Good	Very Good	Excellent	Average	Total average performance
		1	2	3	4	5		
1	Is the User Interface (UI) of the app easy to use and interact With it?	0	0	1	4	5	4.4	90%
2	Rate the Look and Feel of app?	0	0	2	5	3	4.1	82%
3	Is the app more efficient in loading Time?	0	0	0	3	7	4.7	94%
4	How accurately does the application on correctly making the Diagnosis s?	0	1	1	5	3	4	80%
5	Sufficient and practical knowledge to diagnose Cattle Diseases?	0	1	3	2	4	3.6	72%
6	Right description about the disease and treatment for the identified cattle Disease?	0	0	2	4	4	4.2	84%
7	How do you rate the significance of the system in the Domain area?	0	0	1	4	5	4.4	88%
Total Average							4.2	84.29 %

To quantify the response of the users on their experience on the application the following formula form [8] was used

$$avp = sv1x \frac{nr1}{tnr} + sv2x \frac{nr2}{tns} + sv3x \frac{nr3}{tns} +$$

Avp = Average performance,

SV = Scale Value,

nr = number of respondents in each question, and

tnr = total number of respondents in each scale.

The average performance can be presented out 100 % as:

$$avp \times \frac{100}{NS}$$

Where : NS is number of scales.

This approach of testing the user experience of the application will help to get the systems overall performance in meeting the need of the application users. Accordingly, 10% of the users rated the UI of the app for easy to use and interact as Good, while 40 % rated it as very good and the half of the respondent, that is 50 % replied that is excellent. As for the look and feel of the application 50 % of the respondents found it very good, while 30 % excellent and 20% good. Similarly, regarding the loading time efficiency 70% of the users responding that it is excellent and the remaining 30 % said it is very good. For the question “how accurately the application reach on decision to diagnose cattle disease”, 30% of the respondents find it excellent, 50% of the respondents find it very good, 10% of the respondents find it good and the remaining 10% found it fair. In the manner, as for the incorporation of sufficient and practical knowledge of to diagnose in the application, 40% of respondents rated it excellent, 20% of respondents rated it very good, 30% of respondents rated it good and the 10% rated it fair. In the manner, for the criteria that the system gives right description and treatment for the identified cattle disease, 40 % of respondents evaluated is as excellent, 40% very good , and 20 % good. Eventually, as for the significance of the application in the domain area, 50% of the respondents rated is as excellent, 40% very good and 10% good.

To assess the systems accuracy towards the diagnosis of the four categories of cattle disease, we have used the accuracy test method used in (Aboneh, 2013b),(Adola, 2016). In this technique a total of five cases were selected in each four disease category found in the mobile application. Then a comparison of the number of correctly diagnosed disease with the number of incorrectly diagnosed diseases was made. Accordingly, as shown in table 2, among the total of 16 cases selected for testing, the system is able to diagnose 13 cases correctly, and 3 cases incorrectly. Among the disease categories the application was able to diagnose non-infectious disease cases 100%, 75% of infectious diseases respiratory, and reproductive cattle disease cases.

As presented in table 2 below, the total accuracy of the system is calculated using confusion matrix (*Simple Guide to Confusion Matrix Terminology*, 2014) technique which is calculated as below:

$$Accuracy = \frac{(TP+TN)}{N}$$

Where, TP = cases in which we predicted yes (they have the disease), and they do have the disease,



TN = we predicted no, and they don't have the disease.

N = total Number of cases selected for testing

Accordingly, the system as has Demonstrated to be 81.25% accurate in making diagnosis of cattle disease and there is a deviation from the human expert diagnosis result with 18.75%.

Table 2 System Accuracy testing result

Total no of respondent respond for a given scale values	(1)	(2)	(3)	(4)	(5)	Average Performance
Total no scale values	0	2	10	27	31	4.2
Out of 100%	0	2.85%	14.28%	38.57 %	44.28%	84.29 %

Where, **A**= Total Number of Cases Selected, **B**= Number of Correctly diagnosed cases, **C**= Number of Incorrectly diagnosed cases

From the result of the performance evaluation of the application, the application has received a good acceptance from the user end. Therefore, it can help in providing an assistance for the target beneficiaries of the system. Nonetheless, for better accurate decision, the system requires a tuning in making it more intelligent and have an autonomous learning capability using recent AI technologies like Artificial Neural Network (ANN) and deep learning techniques.

Additionally, table 3 presents the summary of system performance evaluation (Aboneh, 2013b), (Adola, 2016) according to the total number of respondent's response for every satisfaction scale values. Accordingly, no evaluator rated the system as poor and only two times that the evaluator rated the system as fair. Similarly, the evaluators rated it as good 10 times and 27 times very good. The system was rated excellent 31 times, which is the largest value. These results show that the users are more satisfied in multiple incidents when using the system.

Table 3 Summary of User's System Experience Evaluation

No	Cattle disease category	A	B	C	Accuracy (100%)
1	Respiratory System Disease	4	3	1	75%
2	Infectious Disease	4	3	1	75%
3	Non-Infectious Disease	4	4	0	100%
4	Reproductive System Disease	4	3	1	75%
Total		16	13	3	79%

Where, (1) =Poor, (2) =Fair, (3) =Good, (4) =Very Good, (5) =Excellent

Besides, the respondents of the questionnaire were offered an open ended questions to give their suggestions without getting bound to a specific criteria. Accordingly, the evaluators were able to put forth the drawbacks observed by the system. These are:

The application lacks graphical/picture depiction when giving explanation regarding the disease cause and treatment.

It lacks to be more intelligent in making disease prediction

It is not 100% accurate hence further reliance on laboratory test is required.

Users are expected to have basic literacy level of Mobile phone usage

5. Conclusion

In this research work, we have designed and developed a mobile application based expert system in afan oromo language to diagnose cattle disease and put forth possible treatment for the identified disease. To validate the user experience and usefulness of the developed mobile app, we have made a user acceptance test using experts who are on duty dealing with cattle disease diagnosis and treatment. In addition, to check how accurately the system diagnose cattle diseases we have made an accuracy test against a set of cattle disease cases. Accordingly, the mobile application demonstrated 81% of accuracy and among the users who were made a user experience evaluation, 84% of them got satisfied by the performance of the mobile application.

From this find of facts, we can conclude that the developed mobile application based expert system can be used as a technology assistant when making an effort in diagnoses and treatment of cattle disease cases particularly in the study areas mentioned in this work. In addition, it can serve as an alternative solution to provide assistance for the front line Veterinary extension officer, CHWS and Veterinary Health Assistants. Hence, it helps the efforts made to alleviate the mortality rate of cattle population and improve the production quality for the pastoralist Community and the economy at large.

As for the future work and recommendation, we suggest the following works to be pursued by other research endeavors:

- Integration of other KBS techniques such as Bayesian network, fuzzy logic, neural network and deep learning techniques can be used for a better result.
- Development of system with other local language which are widely used usage for wide coverage of other domain areas in the country.
- Development of the system for other mobile operation system like IOS.
- To improve the system effectiveness using a case based system approach in addition to the rule based approach.

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