# ADAMA SCIENCE AND TECHNOLOGY UNIVERSITY

## SCHOOL OF GRADUATE STUDIES

## DEPARTMENT OF COMPUTING

**A MASTER'S THESIS**

**ON**

# DESIGN AND DEVELOPMENT OF A KNOWLEDGE BASED SYSTEM FOR COMMON AND ZOONOTIC CATTLE DISEASE DIAGNOSIS AND TREATMENT

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November, 2016

Adama, Ethiopia.

ADAMA SCIENCE AND TECHNOLOGY UNIVERSITY

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# DESIGN AND DEVELOPMENT OF A KNOWLEDGE BASED SYSTEM FOR COMMON AND ZOONOTIC CATTLE DISEASE DIAGNOSIS AND TREATMENT

BY

ADOLA HAILE

The Thesis Submitted to School of Graduate Studies of Adama Science and Technology University for Partial Fulfillment of the Requirements for the Degree of Master of Science in Information System

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# APPROVAL SHEET

This Research Thesis entitled "**DESIGN AND DEVELOPMENT OF KNOWLEDGE BASED SYSTEM FOR COMMON AND ZOONOTIC CATTLE DISEASE DIAGNOSIS AND TREATMENT**" has been read and approved as meeting the preliminary research requirements of the Department of Computing in partial fulfillment for the award of the degree of Master Science in Information System, Adama Science and Technology University.

Adama, Ethiopia.

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# DECLARATION

I, the undersigned, declare this thesis is my original work, has not been presented for a degree in any other university and that all sources of materials used for this thesis have been duly acknowledged.

Name: Adola Haile

Signature_____Date _____

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# ACRONYMS

| | |
|---|---|
| KBES | Knowledge Based Expert System |
| LAN | Local Area Network |
| API | Application prototype Interface |
| KE | Knowledge Engineer |
| KBS | Knowledge Based System |
| CBR | Case Based System |
| SVM | Support vector machine |
| DACA | Drug Administration and Control Authority |
| CBPP | Contagious Bovine Pleuropneumonia |
| FMD | Foot and Mouth Disease |
| LSD | Lump Skin Disease |
| CDDS | Cattle Disease Diagnosis System |
| AI | Artificial Intelligence |
| CALEX | Central Agriculture Laboratory Expert system |
| BTB | Bovine Tuberculosis |

# ABSTRACT

There are different kinds of Cattle diseases in Ethiopia. These diseases can be easily transmitted throughout the country unless appropriate measures are taken. The agents for these diseases are: Virus, Fungus, Bacteria and others which can be a combination of them. Hence, cattle diseases do not only affect Cattle but also they affect human health and wellbeing of the household, through different zoonotic animal diseases which can be easily transmitted from animal to human. To address those problems, this research work aimed to Design and Develop a Knowledge Based System for Diagnosis Cattle Diseases and to recommend future action particularly, on common and Zoonotic Cattle Diseases. The knowledge was gathered by conducting both structured and unstructured interview from the domain experts and documents analysis. Purposive sampling method was used to acquire knowledge from three domain experts: from East Shoa Agricultural office and two experts from Addis Ababa University Veterinary institutes. After the knowledge was acquired; it was modeled by using decision tree to represent the domain knowledge. The knowledge was organized in an easily to understand ways by using if–then knowledge representation method. The prototype was implemented by using JESS for the knowledge base and inference engine coding and java with Eclipse IDE for the graphical user interface development. The user acceptance evaluation scored 82.28% by the domain expert and 76.92% using randomly selected test cases. The proposed knowledge based system would recommend for future research to be integrated with case based reason and fuzzy logic that might increase the performance of proposed system.

# CHAPTER-ONE

# INTRODUCTION

## 1.1. Background of the Study

Ethiopia is one of the largest Livestock population in Africa. This livestock population rate is the main socio-economic and political factors in the country. Moreover, it Provides support for about 80% of rural population of the country particularly, the Pastoral communities and farmers are heavily depending on livestock for their livelihood. As a result, the estimated livestock population in the country are 53 million Cattle, 26 million Sheep, 23 million Goats, 6 million Donkeys, 2 million Horses, 0.4 million Mules, 1 million camels and 49 million poultry. These livestock population rate contributes 45 % of Agricultural GDP, 15-18 % of National GDP, and 5-17 % of total exports [1]. Moreover, among livestock population Cattle is one the main contribution for the for farmers economy in the country they serve as draught power, income to farming communities' as a means of investment, supply farm families with milk, meat, fertilizer, and important source for foreign exchange of national economy. They are also important for cultural resources, social safety nets and means of saving in the country [2].

Beside to this, the importance of Cattle to the farming community in particular and to the national economy at large, the sector has remained underdeveloped and underutilized. According to (CSA,2011) , Ethiopia has about 52.13 million heads of cattle that produce a total of 3.2 billion liters of milk and 0.331 million tons of meat annually (FAO, 2005; CSA, 2008). In addition, 14 million tons of fertilizer are used annually primarily for fuel and 6 million oxen provide the draught power required for the cultivation of crops [3].

The major constraints that limit Cattle production in Ethiopia are genetic resources, shortage of feed and water, climatic factor, diseases, and poor housing [4]. The Livestock diseases are the main cause for livestock mortalities and socio-economic hardship to the Pastoral communities' farmers and countries economy. According to, CSA 2014/2015, Fiscal year the Annual losses due to livestock mortality rate estimated as 3.23 million Cattle, 4.37 million Sheep, 4.90 million Goats and 41,195 of Poultry and 18,231 of Camel. In addition to these, the annual production losses results from these diseases could reach 30-50 percent. This high rate of animal disease indicates a

lack of adequate investment in animal health. To overcome livestock constraints appropriate disease control measures are required to reduce the negative impacts of livestock diseases on the household and National economy. [5].

Moreover, cattle disease also affect human health by different zoonotic diseases According to (WHO,2010), People are exposed to the bacteria, protozoa, fungi, viruses and parasites that cause zoonoses in a number of ways and therefore anyone working with or handling animal's needs to know about zoonoses and the precautions they must take to minimize their risk of infection. According to the (PAHO, 2010), every year millions of people get sick because of foodborne zoonoses such as bacterial zoonoses are anthrax, brucellosis, tuberculosis. Other hand, Rabies is a disease of carnivores and bats mainly transmissible to humans by bites. Almost all persons infected by rabid animals will die if not treated. An estimated number of 55 000 persons, mainly children, die of this disease in the world every year. According to the WHO, 2010, Zoonoses still represent significant public health threats, but many of them are neglected, i.e. they are not prioritized by health systems at national and international levels. They affect hundreds of thousands of people especially in developing countries, although most of them can be prevented.

Cattle productivity improvement can be achieved through identification of production constraints and introduction of new Technologies or by refining existing practices in the system. In Ethiopia, the Cattle husbandry practice in different agro-ecological zones is not studied fully and farmers' needs and production constraints have not been identified. Identification of overall management activities with their constraints and opportunities associated to Cattle production are preconditions for designing suitable cattle production [6] .

Knowledge Based System is a branch of Artificial intelligence which is a computer program that attempts to make the reasoning processes of a human expert. It can help to make diagnosis and perform tasks based on user input. This application can also be used as a tool to disseminate the available information and best way to combat diseases. The suitability of this Technology has been recognized and realized in the field of agriculture. In Agricultural sectors the applications of expert system are mainly found in the area of diseases diagnosis and pest control which is service as Technical awareness for human expert and farmers in decision making process. [7] The expert`s

knowledge will be available when the human expert might not be and so that the knowledge can be available at all times [8].

## 1.2. Statement of the Problem

In developing countries like Ethiopia the impact of livestock disease on lives and livelihoods of society make very difficult. The result of such diseases can also make difference between sufficient food stocks and food insecurity, between having a secure income to the loss of key household assets.

There are different kinds of Cattle diseases have been existed in Ethiopia, due to different factors these diseases can be easily transmitted throughout the country. The agents of these diseases are: Virus, Fungus, Bacteria and others which might be combination of them. The other diseases are raised from natural condition such as environmental weather conditions [9]. Due to the natural condition cattle's captured by different diseases raised from airborne, food borne, water born and combination of other borne diseases. These diseases attack both internal and external parts of their body such as; skin, respiratory organ, mouth, lung, nerve system, brain and other parts of their body. This results decrease farmers income that earn from cattle production and also decrease countries annual per capital income earning from them.

Ethiopia is one of the country which highly affected by Zoonotic diseases in Africa [10]. These Animal diseases do not only affect animal health but also it can have a major influence on the health and wellbeing of the household by different zoonotic animal diseases which can be easily transmit from animal to human. Hence, those animals disease has negatively affect the economic development and market transaction process in the country [11].

The potentials for increased Cattle production and the productivity is proportionally lowered by various Cattle management problems, prevalence of major endemic diseases, poor feeding and high stocking rate on grazing lands, lack of support services such as extension services, veterinary services, insufficient data to plan improved services and inadequate information on how to improve animal breeding, marketing, and processing [4].

In addition to the above problems the domain areas has also the following major problems:

- Lack of budget
- Lack laboratory equipment's
- Absence of sufficient experts
- Inadequate and poorly maintained infrastructure
- Absence of centralized data repository
- Absence training budget of the animal health assistance to improve their knowledge
- Animal health assistant treat the in primitive way
- Lack of information to rural experts due to this detail symptoms the disease was known
- Delay time to diagnosed the diseases

When cattle shows an abnormal behavior the farmers mostly call veterinary extension officers to come and diagnose the problems. When veterinary officers may not be available or may take time before they come, these may make the condition of the affected cattle and even lead to death. Thus an immediate action have to be taken to avoid cattle losses. In addition to this, there is no qualified experts are available in the zonal woreda due to this knowledge gap cattle mortality rate annually increasing.

Due to the above mentioned cattle constraints the researcher motivated to develop Knowledge Based System for Cattle disease and treatment. This application Software is a Computer Program which includes the Knowledge and analytical skills of one or more human experts in a particular problem domain. The idea of knowledge based system is to implement knowledge into a computer program that can be consulted in much the same way that one consults a human expert.

Knowledge based systems have been developed and applied to solve problems in many different areas. In agricultural domain, knowledge based systems are applied to diagnose diseases and suggest the proper treatment, whether plant or animal. As well as, they are applied to crop management and farm animal management [12]. Research done by CLAES animal knowledge based systems were developed to improve the experiment of the young veterinaries. They transfer the expertise from highly qualified experts to young veterinaries on diagnostic problem. Also, they were used as a learning tool by the veterinaries student. For animal breeders, the developed systems

focus on how to prepare the suitable environment for the animals and suggested the needing feeding [13].

As a result, proposed knowledge based system filled the gap of shortage of veterinary professionals by diagnosing cattle diseases, and system also provide advises for the primary Veterinary extension officer and Veterinary Health Assistant to diagnosis the immediate help for cattle disease. It also reduce mortality rate of animal population and improve Cattle production quality for the farmers and the economy of the country as whole.

This Knowledge Based System helps for any Veterinary professionals particularly in the area where highly qualified shortages of experts are available. This research explores the application of knowledge based system Technology for Cattle Diseases by developing prototype for Common and Zoonotic Cattle disease diagnosis.
In this research study the following research questions need to be answered:

- What suitable domain knowledge exists in explicit and tacit form for diagnosis and treatment of Cattle disease?
- What common and zoonotic cattle disease are needed to be diagnosed?
- Which knowledge based approach is more applicable for cattle disease diagnosis?
- To what extents domain experts are satisfied with the prototype in diagnosing cattle disease?

## 1.3. Objective of the Study

### 1.3.1. General Objective

The general objective of this research is to design and develop knowledge based system for diagnosis Zoonotic and common cattle diseases and recommend future action.

### 1.3.2. Specific Objectives of the Study

The specific objectives of this research study are as follows:

- To review previously research done in the area of cattle diseases
- To acquire knowledge from the domain experts and secondary sources

- To model and represent the acquired domain knowledge using suitable knowledge representation technique
- To develop a Prototype Knowledge Based System for diagnosing Cattle diseases
- To evaluate and test the performance of the System Prototype
- To forward research idea for future researchers

## 1.4. Scope and Limitation of the Study

There are many Cattle diseases had been existed in Ethiopia some of them occurred seasonal and others existed due to environmental weather condition. However, this research study focused on only the most common and Zoonotic Cattle diseases to diagnosis their symptom and treatment as well as their prevention mechanism in Ethiopia context particularly, the diseases that occurred in the East Shoa Zonal area. Hence, for this study the researcher selected the most economic significant and zoonotic cattle diseases on the basis of those identified and prioritized by domain experts at East Shoa Agricultural office and Addis Ababa University Veterinary Institute.

### 1.4.1. Challenges of the Study

The proposed research encountered different limitation throughout the research process, Some them are; constraints during knowledge acquisition process i.e. domain experts might not give full information about cattle diseases because of experts work over load and they forget the full procedure to diagnose the disease and the other constraint is lack of time to cover all Cattle diseases in the research study.

## 1.5. Research Methodology

The proposed research used the following research method and techniques to achieve the general and specific objectives of the study.

### 1.5.1. Literature Review

This research study reviewed literature from different secondary sources such as journals, guides and manuals are helpful for the enhancement of the research. Documents of related works on Cattle diseases are reviewed and the necessary documents and tools for the development of the prototype are also reviewed.

### 1.5.2. Data Collection Techniques

In this research, the researcher acquired and gathered the desirable knowledge from primary and secondary sources. As Primary source, the researcher gathered the knowledge from domain experts (veterinary specialists) of East Shoa Zonal Agriculture office and Addis Ababa University Veterinary Institutes through interview and observation techniques. The knowledge was acquired through document analysis technique, and it was used as secondary sources.

### 1.5.3. Sampling Techniques and Sample Size

In this research study Purposive sampling techniques were used, this because the required knowledge should be better to acquire from experienced and specialized domain experts rather than who has no experience in the domain area. Hence, those domain expert's selection criterion for interview was based on their *working profession, educational qualification level, year of experience and current position given in the office.*

## 1.6. Knowledge Representation and Modeling

After the knowledge was acquired, it is then represented by IF-THEN production rule of knowledge representation technique. Rule based technique is selected because it clearly demonstrates the domain knowledge, in a rule based system much of the knowledge is represented as a rule that is as conditional sentences relating statements of facts with one another. There are sets of symptoms that enable to identify the diseases. As a result rule based representation method is more appropriate to represent and demonstrate the real domain knowledge for diagnosing Cattle diseases. Additionally, rule based systems are the most commonly used knowledge representation technique in Agricultural sector [14].

## 1.7. Development Tools

The proposed knowledge based system was implemented by using JESS and Java programming language. JESS is chosen because it is open source software and it is the preferred programming language for developing a rule based system and helps to develop graphical user interface and well-structured knowledge base.

## 1.8. Significance of the Study

This research study helps to reduce the annual animal mortality rate. More importantly, this study has the benefit to increase the country per capital income earned from animal and/or livestock as well as increase in farmer's economic power.

### 1.8.1. Beneficiary of the Research Study

The research work benefits to all stakeholders in the sector with the following significant activities.

- To help non expert increase Cattle production and protect their Cattle from its constraints
- To improve expert knowledge as readily available.
- The researcher benefited how the different types of Cattle disease diagnosed
- In addition to this, the researcher gained experience how to develop Knowledge based system.

## 1.9. Testing and Evaluation Techniques

This research study was tested and evaluated by ensuring the performance of the system through user acceptance testing and test case. The evaluation processes tells how proposed system accurate and significant to the end users. The user acceptance testing are concerned with issues how the prototype system addresses the needs of the users. This was done by selected domain expert evaluators along with questionnaires. Based on evaluation criteria the evaluator using both close ended and open ended questions and the prototype was tested using test case to know system accuracy.

## 1.10. Organization of the Thesis

This research study is organized into six chapters. Chapter one discusses about the introduction section which contains the background of the study, statement of problem, objective of the research study, scope and limitation of the study, significance of the study and research Methodology. Chapter two deals with literature review section which contains theoretical concepts about the study and some of related works with the study. Chapter three discusses about knowledge acquisition with its technique and knowledge representation model. Chapter Four explains about system implementation which contains system prototype and user interface. Chapter Five deals

with about system testing and evaluation and finally, Chapter six is discussed about conclusion and recommendation which contain overview research study and feature works.

# CHAPTER TWO

# LITERATURE REVIEW

## 2.1. Overview of Artificial Intelligence

According to [15], Artificial intelligence refers to the ability to perform an intelligent function as human brain, such as reasoning and learning. It is also defined by [16] a Technology that making computers to simulate with human beings intelligence. According to his definition, it contains various interdisciplinary fields such as: Robotics, computer vision, philosophy, mathematics, psychology, computer engineering, linguistics and natural language processing, as well as expert systems. Similarly, [17] explained intelligent system is exhibits and possesses some basic attributes such as performing some actions, reasoning about a particular domain, making decision and goal oriented problem-solving capability.

## 2.2. Developments of Expert Systems

The First successful expert system known as DENDRAL, which is developed by Fiegenbaum, it demonstrated a focused problem solving technique which was not characterized in AI research and development. The developed program simulated with the expert chemist's analysis and decision making capability. Using the concepts of Fiegenbaum, there are number of expert system were developed in different domain areas, such as geological exploration, medical diagnosis by adding some improvement on the capability of knowledge representation and inference strategies in expert systems [18].

## 2.3. Knowledge Based System

According to [19], Knowledge base system can be defined as a computer program that attempts to replicate the reasoning processes of a human expert. It uses high quality, specialized knowledge in some narrow problem domain to solve complex problems in that domain. It can also make decisions and recommendations as well as performing tasks based on user input. The expert`s knowledge can be available when the human expert might not be physical available and knowledge can be available at all times and in many places, as necessary.

## 2.4. History of Cattle Breeding in Ethiopia

Most local Cattle in Ethiopia are zebus, Boran, Fogera, Horro, Sheko (Gimira), Abigat (Adal), are indigenous and identical with particular regions. The Fogera and Horro are known as milk producers, the first being reared around Lake Tana in Amhara State and the second in Eastern Welega in the west of Oromiya State. The Boran, famous as a beef breed well beyond the boundaries of Ethiopia, is also "indigenous" to Kenya and Somalia, it is found in the south and east of the country in the Southern Nation Nationalities and Peoples' Regional State and in Somali Regional State. [20].

## 2.5. Cattle Production System in Ethiopia

There are three Cattle production system in Ethiopia these are, a drought oriented system in high land, a milk oriented system in the Lowlands (Subsistence) and minor Commercial dairy system in per-urban area. In Ethiopian about 70% of Cattle population live in highlands. Whereas, 30% are in Lowlands. [20]

## 2.6. Socio-Economic Importance of Cattle in Ethiopia

In the mixed crop-livestock systems of the Ethiopian highlands, livestock are subordinate but economically complementary to crop production in providing draft power, which is a vital contribution to the overall farm labor requirement. Cattle also provide plough the land by Ox, meat, milk, cash income and manure, and serve as a capital asset [2]. In the semi-arid low lands, cattle are the most important species because they supply milk for the subsistence pastoral families. In the more arid areas. However, goats and camels are the dominant species reared. The former provide milk, meat and cash income, while the latter population for milk, transport and, to a limited extent, meat. Cattle are kept for all purpose. However, the purposes of keeping cattle vary with production systems. Traction ranked highest, followed by milk and reproduction/breeding in both crop-livestock and agro pastoral systems [21].

## 2.7. Major Cattle Diseases in Ethiopia

The Cattle diseases are the major causes for the economic losses to farmers and pastoralists estimated up to hundred million birr annually. This results for reduction of productivity of meat and milk, hides and dung fuel. in Ethiopia the majority of diseases agents of viral disease such as (rinder pest, FMD, pox group, LSD, PPR (Peste de petits ruminants), ORF-Contagious Ecthyma,

African Horse Sickness, Rabies, New castle disease of fowl and Also agents of Bacterial diseases Anthrax, Blackleg, Pasteurellosis, CBPP, Infectious bovine keratitis (ibk), Brucellosis in Cattle, Dermatophilosis, Actinobacillosis and Actinomycosis, Footrot and Abscess, Heartwater. protozoal diseases such as Trypanosomiasis , Anaplasmosis , Babesiosis , Endoparasites are helminthic Diseases , Haemonchus , Faciolasis , Thelaziasis ,Lungworm , Ectoparasitic Diseases [9].

**Zoonotic Cattle Diseases**

Many animal related problems, which negatively affect human health and economy, exist in all countries of the world including zoonoses, food borne diseases and pollution of the environment from animal sources. Most of the agents associated with the current worldwide increase in cases of food borne diseases. There are many disease agents that can cause disease in multiple species of animals including humans. These diseases are called zoonoses. Zoonotic cattle disease is infectious disease that the disease transmit from cattle to human being through direct and indirect contact with human. Such diseases are rabies, brucellosis, tuberculosis, anthrax, and tapeworm, Salmonellosis, Campylobacteriosis, Listeriosis and like [22]

## 2.8. Architecture of Knowledge Based System

The System architecture is the conceptual model that defines the structure, behavior and more views of a system. Moreover, architecture of a system helps to describe sets of conventions, rules, and standards that should be incorporated in the corresponding system. Similar to other systems, knowledge based system has its own architecture that describes the main components of it, the core functionalities that are carried out in the system and the basic tools that aid for development of that knowledge based systems. The following table demonstrates about the knowledge based system components.

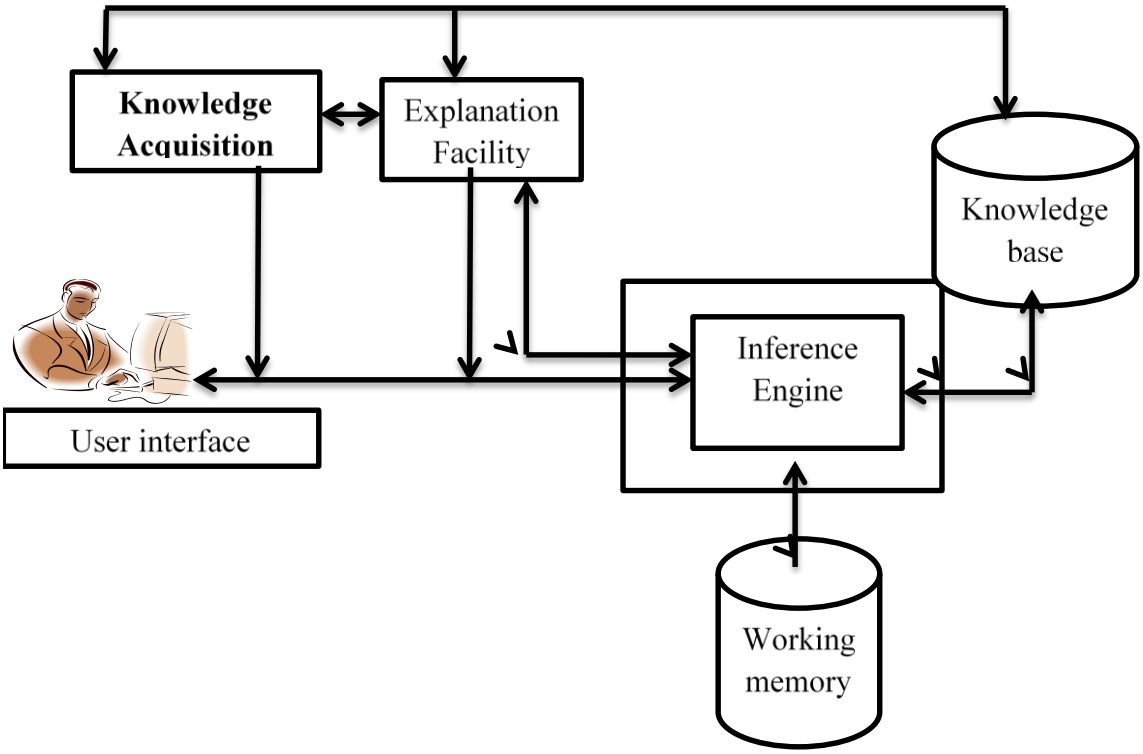


**Figure 2. 1** Components of KBS **[23]**

**2.8.1. Knowledge-Base:** The knowledge base consists of general facts and heuristic rules of thumb knowledge. A number of formalisms, such as production rules, frames (concepts), logic and semantic nets, are available for representing knowledge.

**2.8.2. Inference Engine**: - is a computer program that guides the manipulation of knowledge in the knowledge base. It can be "backward chaining" also known as goal driven, or "forward chaining" also known as data driven.

**Backward Chaining***:* - the inference is starting with conclusions and working 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 [24].

**Forward Chaining***:* it keeps on firing rules until there are no rules, which can be applied, or the goal has been reached. In other words, in forward chaining inference approach, the system is moving forward from the current state to a goal state. [25].

**2.8.3. User Interface:** - The user interface is basically a language processor which permits the end-user to communicate with the KBS. Typically, the user interface parses and interprets user questions, commands and volunteered information. Conversely, information the interface formats generated by KBS, including answers to questions, explanations and justifications for its requests for information [26].

**2.8.4. Explanation Facility:** The explanation facility allows the program to explain its reasoning to the user and allows a user to understand how a knowledge based system arrived at certain conclusions or results The explanation facility of a knowledge based system provides a mechanism for querying the context for getting the answer of what and knowing how a fact is established [27].

One of the more interesting features of expert systems is their ability to explain themselves. The system knows which rules were used during the inference process, it is possible for the system to provide those rules to the user as a means for explaining the results [25]. It is often claimed that an important aspect of expert systems is the ability to explain their behavior. This means the user can ask the system for justification of conclusions or questions at any point in a consultation with an expert system. The system usually responds with the rules that were used for the conclusion, or the rules being considered that led to a question to the user [25].

**2.8.5. Knowledge Acquisition Facility:** Knowledge acquisition facility is used to build the knowledge base and to add new knowledge into the system. It provides a convenient and efficient means for capturing and storing all components of the knowledge base component. Additionally, it acts as an interface between knowledge engineer and the knowledge base [28].

## 2.9. 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.

### 2.9.1. Rule Based Reasoning

The term ‘rule’ in AI, which is the most commonly used type of knowledge representation, 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 some description of how to solve a problem. Rules are relatively easy to create and understand. Any rule consists of two parts: 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> [29].

#### 2.9.1.2 Rule Based System by Jess Application

Among the newest applications of expert systems using rule based system the Jess language is one of general-purpose programing language, and furthermore, it can directly access all Java classes and libraries. For this reason, Jess is also frequently used as a dynamic scripting or rapid application development environment. While Java code generally must be compiled before it can be run, a line of Jess code is executed immediately upon being typed. This allows you to experiment with Java APIs interactively, and build up large programs incrementally [30].

It is also very easy to extend the Jess language with new commands written in Java or in Jess itself, and so the Jess language can be customized for specific applications. Jess is therefore useful in a wide range of situations. One application for which Jess is not so well suited is as an applet intended for Internet use. Jess's size (a few hundred kilobytes of compiled code) makes it too large for applet use except on high-speed LANs. Furthermore, some of Jess's capabilities are lost when it is used in a browser: for example, access to Java APIs from the Jess language may not work at all due to security restrictions in some browsers [30].

Jess can be used in two overlapping ways. First, it can be a rule engine a special kind of program that very efficiently applies rules to data. A rule-based program can have hundreds or even thousands of rules, and Jess will continually apply them to data in the form of a knowledge base. Often the rules will represent the heuristic knowledge of a human expert in some domain, and the knowledge base will represent the state of an evolving situation (an interview, an emergency). In this case, they are said to constitute an expert system [30].

### 2.9.2. Case Based Reasoning (CBR)

It is the part of Artificial Intelligence the Reasoning process it is based on the similar past problem solving experience that helps the designer to exploit the useful details for application to a particular similar case. The reasoning process is considering past cases and arriving at decisions on

comparison between the current situations and the old cases. It works based on the observation that human reasoning processes are founded on specific experience rather than a set of general guidelines.

Thus, when compared to rule based reasoning its method solution to problems are accomplished from past experience, stored in the form of cases, rather than from rules or first principles [31]. Its reasoning process is inspired by human reasoning, for solving a new problem by applying previous experiences adapted to the current situation. It is appropriate method to explore in a medical context where symptoms represent the problem, and diagnosis and treatment solution. [32].

## 2.10. Knowledge Engineering Process

Knowledge Engineering is a term that used to describe the Knowledge Based System jobs that includes the analysis and representation, and computer system design and implementation [24]. According to [33] Knowledge Engineering also defined as a process of acquiring knowledge from experts and building a knowledge base. Below figure shows the overview knowledge Engineering Development Process.

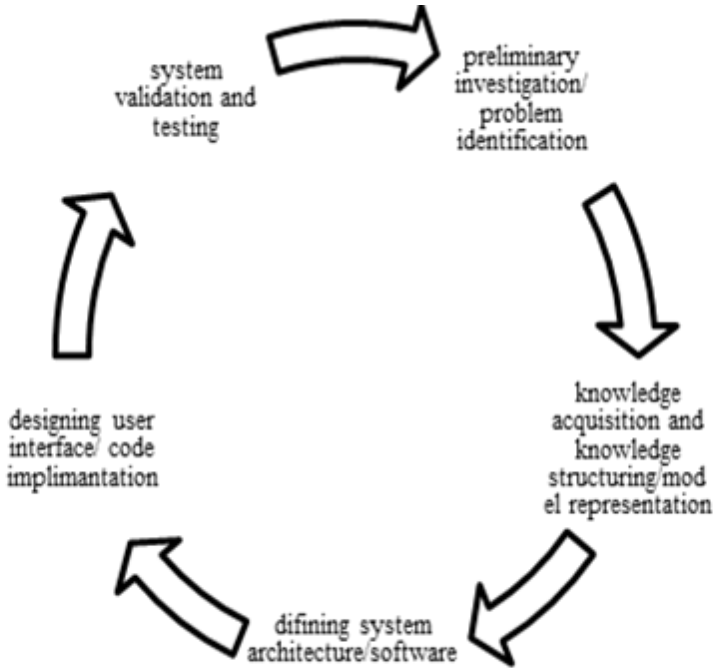


**Figure 2. 2** Process of Knowledge Engineering

Generally, the knowledge engineering development phases includes the knowledge acquisition, knowledge modeling, and knowledge representation, coding or knowledge implementation and

finally, system testing and evaluation. All these detailed description discussed in the following section.

### 2.10.1. Knowledge Acquisition

Knowledge acquisition involves the extracting of knowledge from human experts, books, documents, sensors, or computer files. The knowledge may be specific to the problem domain or to the problem-solving procedures, it may be general knowledge (e.g., knowledge about business), or it may be Meta knowledge (knowledge about knowledge). (By Meta knowledge, we mean information about how experts use their knowledge to solve problems and about problem-solving procedures in general.) [34]. There exist several methods to extract human knowledge; some commonly used approaches of knowledge acquisition include interviews, questionnaires, record reviews and observation to acquire factual and explicit knowledge [35].

**Knowledge Elicitation***:* - Knowledge Elicitation (KE) is the process of obtaining knowledge from a domain expert that describes how they perform a specific task and/or describes what general knowledge they have about the domain. One use of KE is obtaining knowledge from a person in order to transfer it to a computer program [36].

**Interviewing**: - it consists of asking the domain experts questions about the domain of interest and how they perform their tasks. Interviews can be unstructured, semi structured, or structured. The success of an interview session is dependent on the questions asked it is difficult to know which questions should be asked, particularly if the interviewer is not familiar with the domain. Its success also depends on the ability of the expert to articulate their knowledge. The expert may not remember exactly how they perform a task, especially if it is one that they perform "automatically" ***[36]***. Interview can be classified into structure, semi structure and unstructured interview.

**Structured Interviews: -** A structured interview method is questioning the domain expert directly. It is goal-oriented process. It forces organized communication between the knowledge engineer and the domain expert. The structure reduces the interpretation problems inherent in unstructured interviews and allows the knowledge engineer to prevent the bias caused by the subjectivity of the domain expert [37].

**Semi Structured Interview: -** is an interview which has a guide that usually includes both closed-ended and open-ended questions. It is more flexible than structured one. In these kinds of interview the interviewer has a chance to change the order of questions and expand the dimension of questions based on the participants' responses [37].

**Unstructured Interviews: -** sessions are conducted informally ways of making interview. Unstructured interview techniques provide complete or well-organized descriptions of cognitive processes. There are many reasons that enforced to applying unstructured interview. Domain the experts usually find it very difficult to express some of the most important elements of their knowledge.

Through structured interview it is difficult to acquire the required knowledge. With good training and personal experience knowledge engineers can use unstructured interview to acquire relevant knowledge from domain expert [37].

**Observation:-**In Observation methods, the knowledge engineer observes the expert performing a task. This prevents the knowledge engineer from inadvertently interfering in the process, but does not provide any insight into why the decisions were made. [38].

**Document Analysis:-**This technique is used to collect relevant knowledge from the existed documents of different format. These documents include professional literature, brochures, manuals, guidelines, employee handbooks, reports, glossaries, course texts, and other relevant materials [28].

**Protocols:-**The KE technique called Protocol Analysis involves asking the expert to perform a task while "thinking aloud." The intent is to capture both the actions performed and the mental process used to determine these actions. As with all the direct methods, the success of the protocol analysis depends on the ability of the expert to describe why they are making their decision. In some cases, the expert may not remember why they do things a certain way. In many cases, the verbalized thoughts will only be a subset of the actual knowledge used to perform the task [39].

### 2.10.2 Knowledge Analysis and Knowledge Modeling

Knowledge analysis is the process of making sense of knowledge acquired from domain experts and secondary sources [40]. The primary purpose of knowledge analysis is to analyze and organize the knowledge gained during the knowledge acquisition phase [16]. Similarly, knowledge modeling, also known as conceptual modeling is one of knowledge acquisition activities that help to shed light on the structure of knowledge based systems. It is the process of expressing the analyzed knowledge in an understandable and usable form such that preparing the knowledge for knowledge representation phase [40].

### 2.10.3 Knowledge Representation

Knowledge representation is the process of encoding human knowledge in computer understandable form. It is concerned with designing and using systems for storing knowledge [41]. The purpose of knowledge representation is to organize the acquired and modeled knowledge into a form that a knowledge based system can readily access for decision making [35]. There different knowledge representation methods are exist: heuristic rules, semantic networks, frames, objects, decision tables, decision trees, and predicate logic.

#### 2.10.3.1 Rules as a Knowledge Representation Technique

Any rule consists of two parts: 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>. [29].

### 2.10.4 Knowledge Based System Development Tools

A KBS tool is a set of software instructions and utilities taken to be a software package designed to assist the development of knowledge-based systems. Its shell with the ready-made utilities of self-learning; explanation and inference etc. like Java Expert System Shell (JESS), GURU, are can also be useful to develop KBS. Tailor made KBS can be developed using programming languages like LISP and Prolog. Prolog is a logic programming general purpose fifth generation (AI) language [35].

#### 2.10.4.1 Prolog

Prolog provides a very powerful facility for building programs to solve complex problems, especially ones involving reasoning, but all Prolog programs are simple in form and are soundly

based on the mathematical idea of proving results from the facts and rules available [42]. it is one of the principal languages used by researchers in Artificial Intelligence, with many applications developed in that field, especially in the form of Expert Systems programs that 'reason out' the solution to complex problems using rules [42]. You do not need to be an experienced programmer to learn Prolog. Some initial familiarity with basic computing concepts such as program, variable, constant and function would make it easier to achieve [42].

#### 2.10.4.2 Jess

It is a powerful expert system that allows the solution of rule-based problems. It is written entirely in Java and as a result, it's a programmer's library written in Java it is possible to run any Java code inside of it, with the exception of defining new classes. It is fully developed Java API for creating rule-based expert systems. It works by matching facts in the fact base to rules in the rule base and the rules contain function calls that manipulate the fact base and/or other Java code. Finally, Jess uses the Rete algorithm to match patterns.

Jess stores the contents of working memory using a set of customized indices that make looking up a particular piece of information very fast much as a relational database does. Even though Jess uses a data-centric index internally, your view of working memory will look like a simple list. Each item in working memory appears on this list in the order in which it was added. We'll begin our study of working memory by looking at the individual items it contains the working memory elements, or facts.

Jess has many unique features including backwards chaining and working memory queries, and of course Jess can directly manipulate and reason about Java objects. Jess is also a powerful Java scripting environment, from which you can create Java objects, call Java methods, and implement Java interfaces without compiling any Java code. Jess is available at no cost for academic use and can be licensed for commercial use. JESS has the following features:

- Tools for extending Eclipse, an Integrated Development Environment often used for developing Java programs
- An inference engine that supports both forward chaining and backward chaining
- The ability to perform reasoning upon other Java objects.

#### 2.10.4.3 The Difference between Jess and Prolog

Jess is different than some Rete-based systems in that it includes both a kind of backwards chaining and a construct called defquery which lets you make direct queries of the knowledge base. Both of these help Jess a better fit for some Prolog applications, but they don't make Jess into a Prolog-like system. Prolog is optimized, in a sense, for space, at the cost of speed. Jess (and its Rete algorithm) is optimized for speed at the cost of space.

The Rete algorithm is all about computing things once. So they never need to be recomputed, and then reusing them. Prolog's approach is targeted at exploring large numbers of once, while Rete is aimed at exploring medium sized numbers of possibilities repeatedly. Regarding different ways to express the kinds of relationships Prolog can express: Jess offers a rich set of possibilities. Here's one in which the mortality is encoded directly into the facts, so it never needs to be computed.

### 2.10.5 Knowledge Based System Evaluation and Testing Methods

There are different techniques that are employed to KBS testing and evaluation. These techniques are classified as qualitative and quantitative. The former employs subjective comparisons of performance and the later employs statistical techniques to compare KBS performance against either test cases or human experts [43]. There different testing and evaluating any system such as, user acceptance evaluation, system performance evaluation using accuracy measurement parameters like, recall, precision and F-measurement using confusion matrix.

## 2.11. Knowledge Based System for Integrated Development

The Knowledge based systems can be used for interpretation, prediction, diagnosis, design, planning, monitoring, debugging, repair, instruction and control [35]. This advanced technology should be made available in urban and rural areas to utilize expert Rule-based Reasoning knowledge for holistic development. Hence, knowledge based systems should be at the primary consideration while designing the development plan for a nation.

In addition, today's KBS are easier to use, less expensive and integrate well with traditional technologies, so it can provide a fundamental technology to the majority of the applications for today's scenario. The four major dimensions of the rural development process that knowledge based system are being utilized are: Economical, Social, Physical and Health development. Major resources for development are considered as Natural Resources, Human Resources, Livestock and

Agricultural Resources [35].

## 2.12. Knowledge Based System Application in Agriculture

In agriculture, expert systems unite the accumulated expertise of individual disciplines, such as, plant pathology, entomology, horticulture and agricultural meteorology into a framework that best addresses the specific, on-site needs of farmers. Expert systems combine the experimental and experiential knowledge with the intuitive reasoning skills of a multitude of specialists to aid farmers in making the best decisions for their crops [44].

In the 1990s, several expert systems have also been developed. POMME is an expert system for apple orchid management. POMME advises growers about when and what to spray on their apples to avoid infestations. The system also provides advice regarding treatment of winter injuries, drought control and multiple insect problems.

In 1987 expert system technology was identified as an appropriate technology to speed up agricultural desert development in Egypt. In Egypt, at CALEX. Several expert systems have been developed. The CALEX system has been developed for agriculture management. It is domain independent and can be used with any commodity. CALEX consists of three separate modules: an executive, a scheduler and an expert system shell [45].

## 2.13. Review of Related Works

There are a number of research had been done on Knowledge Base Expert System domain area. Among those research studies some the following research reviewed with their objective, design method, knowledge representation, modeling and implementation and final research output result are discussed as follows.

[Seblewongel, 2011] The research study aimed to diagnosed patient with anxiety mental disorder by developing prototype for Knowledge Based System that simulate the Services of Psychiatrists and psychologists. In this study decision tree used to represent the knowledge that acquired. The research study followed Rule Based Reasoning approach using, if then rules and used backward chaining reasoning mechanism to inference the rules. The research study to fill 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 research study Result shows 86% of the performance of the prototype was validated and 85% of the prototype system accuracy was evaluated.

[Tagel, 2013] the research aimed to investigate the applicability of rule based reasoning approach in the development of Knowledge Based System for Hospital triage service to improve the quality Decision made by general practitioners and to provide effective service to the patient. The research study used decision tree knowledge representation technique to represent acquired Knowledge and the rule structured using if then rules. The research study starts fill the gap of triage treatment in Hospital not properly categories of the disease type, patient forced to pay addition cost and spending a lot of time to get service in Hospital. To address those problem the research study develop KBS prototype to reduce the repetition of task and waiting time in Hospital. The research study also assist human expert by providing the required knowledge at the right time for decision making process. The prototype system was developed using SWI-prolog editor tool. The research study Result show 85% of the performance of the prototype was validated and 80% of the prototype system accuracy was evaluated.

[Birhanu, 2013] The research study focused on the area of Agriculture for coffee diseases. The research study aimed to design Knowledge Based System to diagnosis of common disease and provide treatment that occurring in the Coffee plant. It also helps to provide information for non-experts about coffee production system with its management in Ethiopia. It uses decision tree model to represent the acquired knowledge and Knowledge structured using if then rules. The prototype system was developed using SWI-prolog editor tool. Research study Result show 83.6% of the performance of the prototype was validated.

[Ejigu, 2013] The research study aimed to develop knowledge Based System for Cereal Crop disease diagnosis and treatment that assist Agriculture experts and development agent to make timely decision. In the research study decision tree used to represent the knowledge that acquired. It followed Rule Based Reasoning approach using if then rules and used backward reasoning mechanism to inference the rules. The prototype system was developed using SWI-prolog editor tool. The research study Result show 80.9% of the performance of the prototype was validated.

[Abd Ghani, 2004] The research Study aimed to develop human judgment in diagnosing the problem behavior in Horse using Knowledge Based System Application. The research study focused on the process of human judgment based on Brunswick theory and the Lens Model in diagnosis behavior problem in Horse using rule based reasoning. The development of the proposed system using LPA Win-Prolog in predicting behavior problem in Horses, it can help increase the awareness of the in noticing certain cues and signals from the environment as well as increase the accuracy in judgment.

[Stephen,2013] Veterinary Diagnosis expert system for remote use research aim to diagnosis illness in livestock and accessible on low end mobile phones in rural areas without strong cellular coverage could enable livestock owners living in such areas to access medical assistance for their animal which was previously in accessible to them.an expert system capable of diagnosing illness in cattle was built upon the drools rule engine and web based interface. The interface of the system was tested on a variety of mobile browsers and was function in each.

[T. Mueni,2011] The Aim of the research is to develop a web based livestock diseases diagnosis system with GIS mapping to support various users. It provides information to farmers on dairy cow best management practices, allows them to do some diagnosis based on visible sign on the cows. The research has been implemented using PHP and MYSQL database. A farmer selects symptoms viewed on the cow and then the system does diagnosis and gives him the first three probable diseases with the highest percentage. The system then maps the disease with the highest percentage on Google maps. Thus a user is able to view what disease has been reported recently in a particular location.

The proposed research study aimed to develop Knowledge Based system for Common and Zoonotic Cattle disease diagnosis and treatment using Java expert system shell (JESS) integrated with java Eclipse IDE for user interface development. The proposed research study focused on the diseases that are economical significant and affect Cattle as well as Human health. It can increase awareness of how cattle disease affect human life, it also helps Animal health assistant and veterinary technician to easily handle cattle disease using proposed system. The research study to fill the gap that existed in Veterinary domain for Zoonotic Cattle disease and create awareness to the community how cattle disease directly and indirectly affect the society. In addition to this the proposed system has pictorial description of the disease and well explain about disease treatment.

# CHAPTER-THREE

# KNOWLEDGE ACQUISITION

## 3.1. Introduction

Knowledge acquisition is the process of extracting, analyzing and interpreting the knowledge that human expert uses, when solving problems and then transferring these knowledge in to machine representation method. [46]. The acquired knowledge in the knowledge acquisition process may be specific to the problem domain or to the problem solving procedures. 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 [46]. Knowledge acquisition is comprised of 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 [47]**.**

## 3.2. The Knowledge Acquisition Process

In this research study the knowledge acquired from primary source by interviewing the domain experts and through observation of Veterinary clinical diagnosis of cattle disease. The other sources to acquired knowledge was using secondary sources such as, books, veterinary manual guidelines, journals, published and unpublished documents, reports, handbook and conference papers. After knowledge acquired from those sources then it should be organized into some knowledge representation model. Decision tree model was selected to represent acquired knowledge for this study. Some basic activities are done to acquire knowledge for this research study such as gathering required knowledge, analyzing knowledge, identifying the important concepts for causes and symptoms of cattle diseases.

### 3.2.1. Primary Knowledge Acquisition Process

The Primary knowledge gathered from five experts from East shoa Zonal Agricultural office and AAU National Veterinary Institutes by using structured and unstructured interview techniques.

#### 3.2.1.1. Interviewing Domain Experts

In this research study for knowledge acquisition process interviewing the domain experts through purposive sampling technique was used. This because, purposive sampling technique helps to acquire relevant knowledge from more experienced and educated experts rather than less experienced and educated experts. Three domain experts from East shoa Zonal Agricultural office and two veterinary experts from AAU National Veterinary Institutes were purposively selected. So, totally five (5) veterinary experts were participated in the interview process for this research study. Those selected domain experts were interviewed about major cattle diseases that affect cattle and the symptoms of the diseases as well as treatments undertaken to control such diseases. During face to face communication, the information obtained from experts were recorded manually by using pen and paper sheet.

Interviewing with domain experts helps to know what kinds of knowledge are required to solve the domain problems along with proposed research study. The experts were asked mainly the following questions: “which diseases mainly attack cattle in the Ethiopia?”, “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 and Zoonotic cattle disease?” Initially disease, symptoms and treatments were identified. The following table was illustrating the name and position of selected domain expert.

**Table 3. 1** Name of Domain Experts

| *No* | *Name of expert* | *Educational Level* | *Experience in year* | *position* |
|---|---|---|---|---|
| **1** | Dr. Betelihem Shiferaw | DVM | 1 | Expert of Clinical Veterinary Medicine |
| **2** | Dr. Deriba Hailu | DVM | 5 | Expert of Adama City livestock resource Development |
| **3** | Dr. Abebe Firomsa | DVM ( specialized In Surgeon) | 15 | CVM and veterinary medicine Teacher |
| **4** | Prof. Fikadu Getachew | Professor | 18 | Research and Technology Transfer |
| **5** | Ato.Mulugeta Birhanu | Diploma | 3 | Animal Health Assistant |

#### 3.2.1.2. Document Analysis Process

The other knowledge acquisition processes in this research study were through Document analysis process which is from existing documentation. Hence, document analysis has carried out to acquire explicit knowledge which is found in various secondary sources of knowledge such as; books, Internet resources, journals and Standard Veterinary Guideline, Manuals are some of sources which helps to provide information about Epidemiology, clinical symptoms of ruminant animals. As the result, technical knowledge were extracted and structured in a manner that suitable for knowledge modeling and knowledge representation methods.

## 3.3. General Categories of Cattle Diseases

After interviewing domain experts and document analysis process was done, the next tasks are converting summarized knowledge that are acquired from knowledge sources into knowledge base system structure form, for to be the rules easily manipulated by 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. Those selected cattle disease categories are Infectious diseases, Non-infectious diseases, Respiratory System diseases and Reproductive

System disease. From those cattle disease categories the researcher select the diseases based on domain expert's selection criteria. According to domain experts those selected diseases are most significant disease in the domain areas and affect cattle as well as human health that they observed during clinical diagnosis process. From those categories the researcher had taken as sample diseases those are Zoonotic and common diseases that mostly occurred in the domain areas. The selected cattle summariezed as the following diagram.

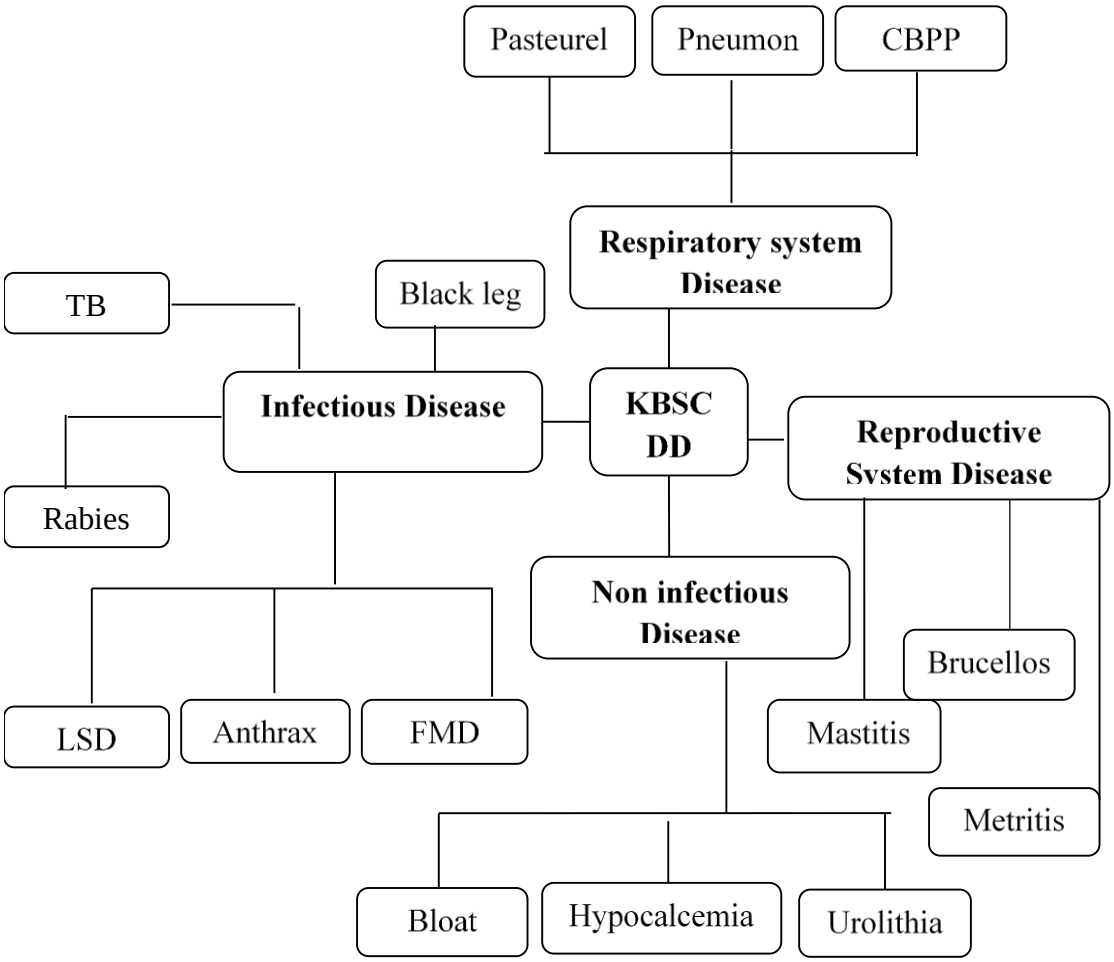


**Figure 3. 1** Block Diagram for Cattle Disease Category

The above block diagram shows, the overall proposed system concerned about cattle diseases those categories are infectious disease, non-infectious disease, respiratory disease, reproduction system diseases. Moreover, under all sub-categories there are selected sample diseases are categorized. Therefore, from infectious diseases like Anthrax, Blackleg, Foot and Mouth Disease and Lumpy Skin Disease, TB, and Rabies are selected. Similarly, from the non-infection diseases like Hypocalcemia, Bloat and Urinary Obstruction are selected. And also, from Respiratory System diseases like Contagious Bovine Pleuropneumonia (CBPP), pneumonia and Pasteurellosis are selected. Finally, from Reproduction system diseases like Brucellosis, Metritis and Bovine Mastitis are selected.

## 3.4. Common and Zoonotic Cattle Diseases

Disease can be classified as acute or chronic. An acute disease starts quickly and lasts for a short period when the animal either recovers or dies. A chronic disease lasts for a long time and weakens the animal. Diseases are said to be infectious (will spread from one animal to another) or noninfectious (will not spread from one animal to another). Most of the time Non-infectious diseases can be caused by poor feed and the lack of minerals, salts and vitamins that the body needs. There are many disease agents that can cause disease in multiple species of animals including humans. These diseases are called zoonoses. Zoonotic cattle disease is infectious disease that the disease transmit from cattle to human being through direct and indirect contact with human. In other word, common diseases are those diseases which is mostly affects the economies of house-holds and country as whole. The following section discussed more about the selected diseases categories [22].

### 3.4.1. Infectious Diseases

Infectious diseases are caused by pathogenic microorganisms, such as bacteria, viruses, parasites or fungi; the diseases can be spread, directly or indirectly, from one person to another. Zoonotic diseases are infectious diseases of animals that can cause disease when transmitted to humans. [48]

**Zoonotic Infection Disease**

Zoonotic infections that are transmissible either directly or indirectly between animals and humans are on the increase and pose significant additional threats to human health and the current

pandemic status of new influenza is a topical example of the challenge presented by zoonotic viruses. In this article, we provide a brief overview of some of the issues relating to infectious diseases of livestock, which will be discussed in more detail in the papers that follow [22].

**Anthrax**

Anthrax is a disease caused by the spore forming bacteria called Bacillus anthracis that lives in soil. It is serious zoonotic cattle disease, almost all cases of human anthrax can be directly linked to contact with infected animals, particularly cattle, or indirectly through contact with heavily contaminated soil. Most at risk are people working with carcases especially animals that died suddenly. For example knackery workers, farmers and veterinarians. Occupational exposure can also occur via animal products such as contaminated wool or hides. Human anthrax acquired in this way is confined to the skin in 95% of cases. The name of the bacteria derives from the Greek word for coal, because of the ulcers with dark centers that develop on the skin of affected people and animal. It occurs on all the continents, causes acute mortality in ruminants and it is zoonosis (a disease which primarily affects animals, but causes disease in humans). The bacteria produce extremely potent toxins which are responsible for the ill effects, causing a high mortality rate. It is typically a disease of ruminants and humans. You can get anthrax through indirect or direct contact by inhaling, touching, or ingesting Bacillus anthracis. [48]

**Clinical Symptoms**

Affected cattle characterized by fever, abdominal pain, trembling, hematuria, and blood-tinged diarrhea. Pregnant animals may abort, and milk production in lactating animals often decline or tinged with blood. Ventral subcutaneous edema may be present followed by death. Chronic infection is rare in cattle and manifested by localized edematous swelling on the ventral neck, thorax, and shoulders. Areas most frequently involved are the ventral neck, thorax, and shoulders. In this acute form there may be high fever, muscle tremors and difficult breathing seen shortly before the animal collapses and dies. Unclotted blood may exude from body openings and the body may not stiffen after death.

**Blackleg**

Black leg is an acute, febrile disease of cattle and sheep caused by Clostridium chauvoe characterized by emphysematous swelling of the heavy muscles and severe toxemia or crepitating lesions of the muscles and subcutaneous tissues in some region in the bodies such as the shoulder

or the hind quarter of the affected animals. Cattle between six months to two years old are mainly affected though at any age and condition may be affected. Black leg is common in Ethiopia during dry periods of the year. The organisms exist in the soils and also found in large numbers in the local muscle lesions and exudates around such lesions [22].

**Clinical Symptoms**

Very depressed (unwillingness to move), anorexia, rumen stasis, high fever and tachycardia marked lameness with pronounced muscle swelling of the upper part of the affected leg with crepitation, loss of appetite and rapid breathing.

**Foot and Mouth Disease**

Foot-and-mouth disease (FMD) is a highly communicable viral infection of cattle, pigs, sheep, goats, buffalo, and artiodactyl wildlife species characterized by fever, vesicles in the mouth, on the muzzle, gums, pharynx, teats, and interdigital cleft. It is caused by an Aphthovirus that is transmitted by contact and through milk. Recoverd animals remain carriers for up to 2 and half years. accompanied by severe dejection and anorexia, followed by the appearance of an acute painful stomatitis. There is abundant salivation, the saliva hanging in long, ropy strings, a characteristic smacking of the lips, and the anirnal chews carefully. Vesicles and bullae appear on the buccal mucosa, dental pad and tongue [22].

**Clinical Symptoms**

Drooling and vesicles on the nares, in the bucal cavity, and between the claws are most common. Dullness, inappetance, fever, and shivering followed by smacking of the lips, drooling saliva, and shaking or kicking of the feet are primary signs. Preganant animals may abort.

**Lumpy Skin Disease**

Lumpy skin disease (LSD) is a highly infectious viral disease of cattle and buffalo characterized by poxlike intracutaneous firm nodules, edema of the limbs, superficial lymphnodes swelling, and lymphangitis. The disease is widely distributed in Ethiopia imposing severe economic loss due to damage of hides [48].

**Clinical Symptoms**

Painfull swelling, fever, lacrimation, nasal discharge, and lameness Nodular lesions on the skin and mucous membranes and hypersalivation followed by characteristic eruptions on the skin and

other parts of the body are characteristic; the nodules are circumscribed, round, slightly raised, firm, painfull and involve the entire cutis and mucosa of the gastrointestinal, respiratory and genital tract. The regional lymphnodes are swollen and edema develops in the udder, brisket, and legs. Secodary infections may cause extensive suppuration and sloughing lesions.

**Bovine Tuberculosis (TB)**

Etiology Mycobacterium bovis Epidemiology All age groups and species are susceptible but infection is predominantly in cattle and pigs. Infected cattle are the main source of infection for other cattle. Organisms are excreted in the exhaled air, in sputum, feces (from both intestinal lesions and swallowed sputum from pulmonary lesions), milk, urine, vaginal and uterine discharges, and discharges from open peripheral lymph nodes. Cattle in the early stages of the disease, before any lesions are visible, may also excrete viable mycobacteria in nasal and tracheal mucus.3 In experimentally infected cattle excretion of the organism commences about 90 days after infection [22].

**Clinical Symptoms of TB**

The following signs are the possible occurrence of tuberculosis. Most cases combine with other signs occurs, suspicion sign for tuberculosis. Such signs are progressive emaciation, capricious appetite, Fluctuating temperature, hair coat may be rough or sleek, docile and sluggish.

**Rabies**

Rabies is a viral disease that affects the central nervous system of brain and spinal cord, of warm blooded animals, including humans. Rabies can cause brain deterioration and death. Bite from an infected wild animal, such as a fox or raccoon, is a common method of infection in cattle. Saliva is the main method of transmission of the virus being shed through infected cattle and spreading through the body via the bloodstream. It travels to the spinal cord where it can incubate for months on end, although 3-12 weeks is common and symptoms may take several weeks to appear after infection. However, once symptoms appear, rabies is always fatal in animals. The rabies virus is a lyssavirus, the name *Rhabdo* comes from the Greek and identifies the characteristic bullet or rod-shape of the viruses. From the spine the virus moves into the brain, at which point clinical signs of rabies often appear in cattle [22].

**Clinical Signs**

In the absence of anti-viral rabies drugs, progress to death is rapid once clinical signs appear. Milk production and feed intake may drop gradually before rapidly falling and cows may look very alert, staring at objects. Aggressive, excitable or exaggerated movements can be signs of rabies. Sexual activity can be increased, including mounting behavior. Bulls can have persistent erections or a prolapsed penis. Other Signs Includes Bellowing, Attack Animate, Inanimate Objects Lactation Ceases Abruptly, Behavioral Changes, Paralysis.

**Table 3. 2** Summary of Infectious Cattle Disease

| ***No*** | ***Infectious disorder*** | ***Common symptoms*** |
|---|---|---|
| 1 | Anthrax (AD) | difficult breathing, Unclotted blood ,high fever, muscle tremors |
| 2 | Black-leg (BLD) | Lameness, Pronounced swelling of upper limb, Myonecrosis of skeletal or cardiac muscles, Severe toxemia and a high case fatality rate, very depressed (unwillingness to move), loss of appetite, rapid breathing, high temperature (fever) |
| 3 | Foot and Mouth (FMD) | high fever, severe dejection and anorexia<br>Vesicles and bullae (1-2 cm in diameter) appear on the buccal mucosa, dental pad and tongue, abundant salivation, smacking of the lips, the anirnal chews carefully, painful stomatitis |
| 4 | LSD | Lacrimation, nasal discharge, salivation, and lameness, Nodular lesions on the skin, mucous membranes and lymphadenopathy and Fever. |

| | | |
|---|---|---|
| | | |
| 5 | BTB | Progressive Emaciation, Lethargy, Weakness, Fluctuating Fever, Moist Cough Dyspnea Tachypnea. |
| 6 | Rabies | Bellowing, Attack Animate, Inanimate Objects Lactation Ceases Abruptly, Behavioral Changes, Paralysis. |

### 3.4.2. Non-Infectious Diseases

Non-infectious disease can cause by poisoning with chemicals or plants, by cuts, burns and broken bones. Some diseases pass from the parent to the young (hereditary). Many non-infectious diseases are chronic but they can be acute. They can cause large losses of meat, milk and wool. Working animals do not work well and the rate of reproduction can be low with the young being born dead or dying before they are weaned. Chronic diseases are often thought to be "normal" but when the cause is known and eliminated production can be greatly increased. Some of non-infectious diseases selected are bloat, Hypocalcaemia and Urolithiasis [22].

**Bloat**

Bloat or ruminal tympany is an over distension of the rumen reticulum with the gases of fermentation, either in the form of a persistent foam mixed with the ruminal contents called primary or frothy bloat, or in the form of free-gas separated from the ingesta called secondary or free-gas bloat. This condition is very common in Ethiopia during the rainy season when legumes (that have high percentage of soltble proteins) grow abundantly. It also occur with grazing of young green cereal crops [48].

**Clinical Symptoms**

Distension of the left flank, protrusion of the paralumbar fossa above the ventral column and enlarged abdomen, dispnea and granting, mouth breathing, protrusion of the tongue, and extension of the head, and occasionally vomiting are observed.

**Treatment and Prevention**

Free gas bloat: Remove free-gas by passing a stomach tube.

**Hypocalcaemia**

Hypocalcemia can be due to a reduction in dry matter intake because of illness or it may be the earliest stages of hypocalcemic parturient paresis. Hypocalcemia or milk fever may occur in recently calved mature dairy cows that have been inappetent or anorexic for a few days. Hypocalcemia cases often mimic intestinal obstruction and create problems in the differential diagnosis. Affected cattle may not exhibit any evidence of muscular weakness and the detection of the hypocalcemic state can be elusive [48].

**Symptoms of the Disease**

The clinical findings include anorexia, mild tachycardia with a reduction in the intensity of the heart sounds and occasionally an arrhythmia, a decrease in the frequency and amplitude of rumen contractions or complete ruminal stasis.

**Urolithiasis**

Uroliths are common in cattle resulting from urinary tract obstruction by mineral-protein calculin. It is commonly reported in central Ethiopia. It is common in males than females. In the bull, the sigmoid flexure is the most common site for uroliths to lodge. Early castration predisposes to urolith-induced urethral obstruction by removing hormonal influences necessary for mature development of the penis and urethra [48].

**Clinical symptoms**

In partial obstruction, animals dribble blood-tinged urine, pain on urination & on complete obstruction tenesmus, tail twitching, weight shifting, and signs consistent with colic are observed. Inappetence, depression, and rectal prolapse may also be seen. Affected steers may elevate the tail and show urethral pulsations just ventral to the rectum. Complete occlusion results in urethral perforation or urinary bladder rupture and animals die of uremia.

**Table 3. 3** Summarized of Non-Infectious Disease

| ***No*** | ***Non-Infectious disorder*** | ***Common symptoms*** |
|---|---|---|
| 1 | Hypocalcemia | anorexia, mild tachycardia, reduction in the intensity of the heart sounds and occasionally an arrhythmia, a decrease in the frequency, amplitude of rumen contractions or complete ruminal stasis. |
| 2 | Bloat | Distension of the left flank, protrusion of the paralumbar fossa above the ventral column and enlarged abdomen, dispnea and granting, mouth breathing, protrusion of the tongue, and extension of the head, and occasionally vomition are observed |
| 3 | Urolithiasis | In partial obstruction, animals dribble blood-tinged urine, pain on urination & on complete obstruction tenesmus, tail twitching, weight shifting, and signs consistent with colic are observed. Inappetence, depression, and rectal prolapse |

### 4.3.3. Respiratory System Diseases

Respiratory disease in cattle is an interaction between the infectious agents whether bacterial and viral. The diseases were caused by environmental weather condition and immunity of the individual animal. It is the major cause of financial loss from infectious disease in growing cattle in many countries worldwide. Economic losses result from vaccination costs, antibiotic treatment and veterinary attendance, reduced short-term and lifetime growth rates and mortality. Outbreak of respiratory disease includes physiological, management and environmental factors in conjunction with viral and bacterial infectious agents. [48]

**Contagious Bovine Pleuropneumonia (CBPP)**

This disease is highly contagious pneumonia of cattle. It is caused by Mycoplasma mycoides subspecies mycoides (small colony type) and transmitted to susceptible cattle by aerosol. The disease is prevalent mainly in pastoralist areas of Ethiopia with up to 10% prevalence. A quarter of the animals may recover but remain carriers, and 50% die of infection. Outbreak in susceptible cattle morbidity up to 100%, mortality up to 50% if cattle stressed and traveling.

**Clinical Symptoms**

High Fever, anorexia, difficult breathing, grunt at expiration, cough when forced to move, standing with the elbows apart, and arched back and the head extended. Subclinical cases occur and may be important sources of infection. Aerogenous spread, no mediate contagion.

**Typical Clinical Symptoms**

Pleuritic friction rubs early and moist crackles, Anorexia, Pain on chest percussion, cough when forced to move, high fever, grunt at expiration, Dyspnea, difficulty breathing.

**Pasteurellosis (Shipping Fever)**

Shipping fever pneumonia is a respiratory disease of cattle of multifactorial etiology. Multiple stress factors that precipitate the disease include transportation over long distances in association with starvation, exhaustion, dehydration, chilling and overheating depending on weather conditions, and exposure to vehicle exhaust fumes.

**Clinical Symptoms**

Depression, toxemia, pyrexia, serous to mucopurulent nasal discharge, moist cough, and a rapid, shallow respiratory rate, increased bronchial sounds, crackles, and wheezes. In severe cases, pleurisy may develop, which is characterized by an irregular breathing pattern and grunting on expiration, mucoid or purulent nasal discharge. The animal may become unthrifty in chronic cases.

**Pneumonia**

Pneumomnia is inflammation of the pulmonary parenchyma usually accompanied by inflammation of the bronchioles and often by pleurisy. Important pathogens associated with pneumonia in cattle are Mannheimia haemolytica serotype A, Haemophilus somnus, P. multocida, Mycobacteriurm bovis, Mycoplasma mycoides subspecies mycoides small colony type,

parainfoluenza virus 3, bovine respiratory syncytial virus, bovine herpes virus 1 and bovine viral diarrhea [22].

**Clinical Symptoms**

It is manifested clinically by an increase in respiratory rate, cough, abnormal breath sounds on auscultation and, in most bacterial pneumonias, by evidence of toxemia. Broncho-pnemonia is usually accompanied by a moist, painful cough; interstitial pneumonia is characterized by frequent, hacking coughs, often in paroxysms.

**Table 3. 4** Summary of Respiratory System Disease

| ***No*** | ***Respiratory system disorder*** | ***Common symptoms*** |
|---|---|---|
| 1 | CBPP | Acute fibrinous pneumonia and pleurisy, Dyspnea, fever, deep cough, shallow, fast, elbows out, grunting respiration, Pain on chest percussion. Pleuritic friction rubs early, moist crackles. |
| 2 | Pasteurellosis (Shipping Fever) | Depression, toxemia, pyrexia, serous to mucopurulent nasal discharge, moist cough, and a rapid, shallow respiratory rate, increased bronchial sounds, crackles, and wheezes, irregular breathing pattern and grunting on expiration, mucoid or purulent nasal discharge. |
| 3 | Pneumonia | Increase in respiratory rate, cough, abnormal breath sounds on auscultation and, in most bacterial pneumonias, by evidence of toxemia, Broncho-pnemonia is usually accompanied by a moist, painful cough; interstitial pneumonia is characterized by frequent, hacking coughs, often in paroxysms, The presence of nasal discharge |

### 3.4.4. Reproductive System Diseases

Disease of the reproductive organs in cattle usually develops, so gradually that they go unrecognized until the disease is well established until the disease is well established in the herd. Infected animal usually are not dying in the most cases, especially in males, they do not even appear ill. Some animals never show symptoms of the disease, yet remain major threat to the rest of the herd because they carry disease organism. Some diseases are zoonotic diseases are easily affect human being. [48]

**Bovine Mastitis**

Mastitis, an inflammation of the mammary gland and udder tissue, it is almost always due infection by bacterial. It usually occurs as an immune response to bacterial invasion of the teat canal by variety of bacterial sources present on the farm (commonly through bedding or contaminated teat dips), and can also occur as a result of chemical, mechanical, or thermal injury to the cow's udder. It is a multifactorial disease, closely related to the production system and environment that cows are kept in. it's risk factors or disease determinants can be classified into three groups: host, pathogen and environmental determinants.

**Clinical Symptoms**

Milk quality reduced and can be used as an indicator of mastitis prevalence. The most obvious symptoms of clinical mastitis in the udder are swelling, heat, hardness, redness or pain. Milk takes on a watery appearance, flakes, clots or pus is often present. A reduction in milk yields, increases in body temperature, lack of appetite, and a reduction in mobility due to the pain of a swollen udder are also common signs.

**Metritis**

Inflammation of the uterus (metritis) may be acute or chronic, localised involving more than one uterine tissue. A list of uterine infections giving rise to infertility and abortion in the various species are observed. When it takes place prior to the act it is usually associated with the death of the foal and its subsequent abortion, with or without discharge of the whole or a part of the membranes. In such cases the inflammatory condition may persist in an acute form and the cause death of the mare, or it may assume a chronic form after the abortion and render the mare incapable of further breeding; other cases are followed by recovery [22].

**Symptoms**

Acute metritis is a severe and often fatal condition. Within 24 to 48 hours, the mare becomes greatly distressed and loses all interest in the foal. She lies most of the time and refuses food; her temperature is usually high. Greyish blood-flecked discharge escapes from the vagina and soils the tail and hindquarters. The mare may become tucked up in her abdomen and stands with her back arched.

**Brucellosis**

Bovine brucellosis is a serious zoonotic disease caused by *Brucella abortus*. Brucellosis in humans can also be caused by another species *Brucelloasuis*, which is transmitted from pigs, often feral pigs, and causes a severe "flu like" disease. Contagious bovine abortion, also known as Bang's disease, is a specific contagious disease due to B. abortus. Since the infection may exist and persist in the genital system of the bull, Brucellosis is to be preferred as a name for the disease. In females it is characterized by a chronic inflammation of the uterus (especially of the mucous membrane).

Usually, but not invariably, followed by abortion between the 5th and 8th months of pregnancy. It is important to note that not all infected animals abort. Indeed, in over half of them pregnancy runs to full term. However, any animal that has aborted once may be almost as infectious at its next and subsequent calving as on the occasion it aborted. Infection may occur by the mouth or through the vagina during service, when a bull which has served an infected cow is called upon [22].

**Symptoms**

Abortion may occur without any preliminary symptoms, and except that the calf is not a full-term one, may be practically the same as normal calving. Most cows which have aborted once will carry their next calf to full term. A continuous reddish-brown or brownish-grey discharge follows, and persists for about 10 to 20 days (often for about 2 weeks). In some instances it slowly collects in the cavity of the uterus, little or nothing being seen at the vulva, and then it is discharged periodically, often in large amounts at a time.

**Table 3. 5** Summary of Reproductive System Disease

| ***No*** | ***Reproductive system disorder*** | ***Common symptoms*** |
|---|---|---|
| 1 | Mastitis | Udder is swelling, heat, hardness, redness or pain, Milk takes on a watery appearance, flakes, clots or pus is often present, reduction in milk yields, increases in body temperature, lack of appetite, and a reduction in mobility due to the pain of a swollen udder are also common signs. |
| 2 | Metritis | Greyish blood-flecked discharge escapes from the vagina and soils the tail and hindquarters, The mare may become tucked up in her abdomen and stands with her back arched. |
| 3 | Brucellosis | Normal calving, Most cows which have aborted once will carry their next calf to full term, while only very few cows will abort a calf three times. Some calves born to infected cows will be persistently infected. |

## 3.5. Conceptual Knowledge Modeling

During the knowledge modeling phase, the knowledge Engineer acquired relevant knowledge from the domain experts represented in a knowledge model. A knowledge model is a structured representation of knowledge using symbols to represent pieces of knowledge. Its models include

symbolic character based languages such as logic, diagrammatic representations such as networks and ladders, tabular representation such as matrices and structured text. The generation and modification cycle of a knowledge model is an essential part of the knowledge modeling phase. The model helps to ensure that all stakeholders in a system understand the language and terminology being used and quickly conveys information for validation and modification where necessary. The knowledge models are also of great value during cross-validation with other specialists [14].

### 3.5.1. Decision Tree Structure

The model was built by the knowledge engineer based on information obtained during the interviews with experts and then reviewed with the domain expert. 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.

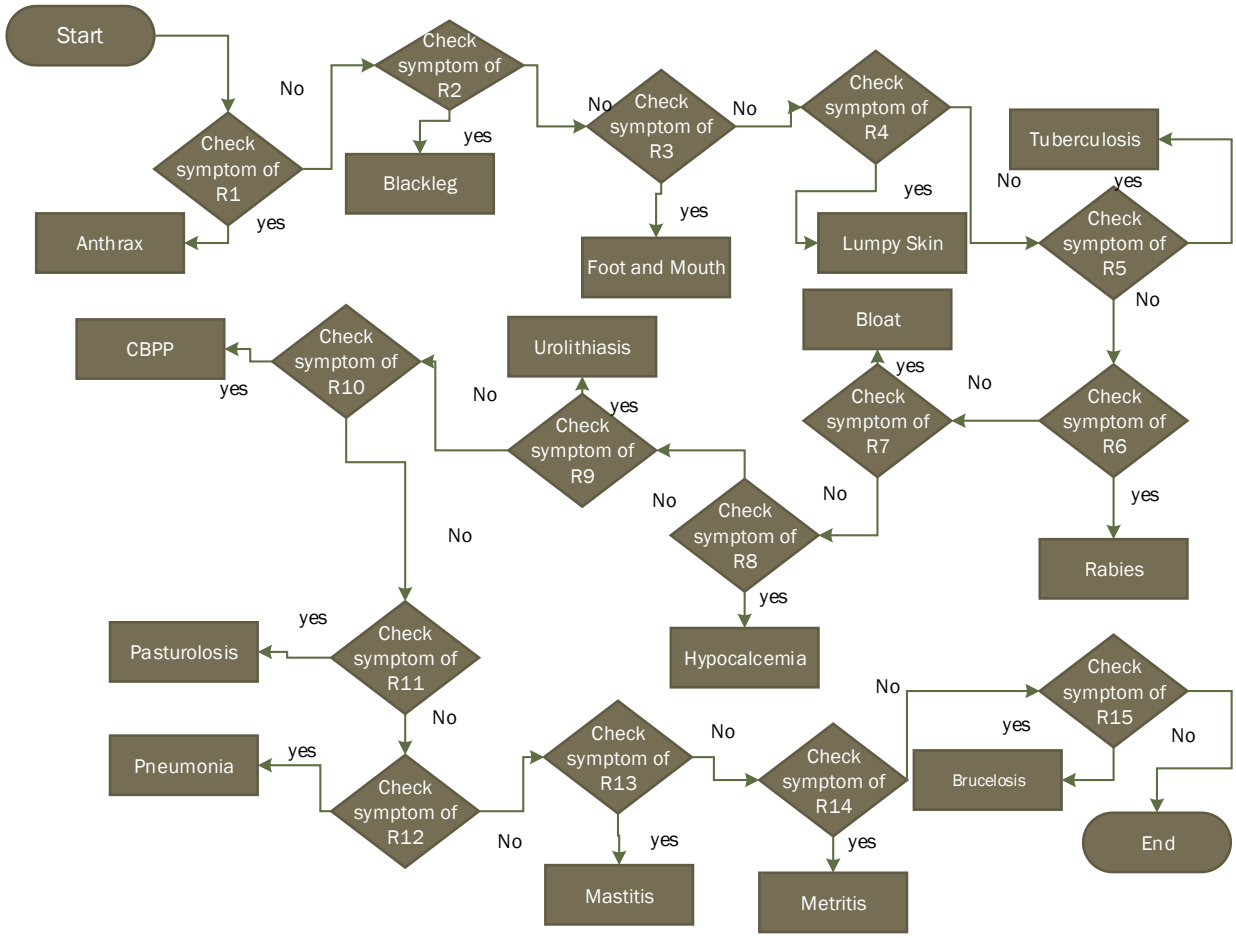


**Figure 3. 2** Decision making process for Cattle Disease Diagnosis **[49]**

The above decision tree diagram shows, how proposed cattle disease works. So, it follows the following sequential description. After the system start/load, then user check symptoms. If all the symptoms of symptoms of rule-1 match with knowledge base then the rule would be fired as Anthrax disease, otherwise the system is tells not match is found then user check the next disease which is symptoms of rule-2 again, if all symptoms of symptoms of rule-2 selected then the disease would be diagnosed. Similarly, if the user not select all the symptoms then the system check the symptoms of rule-3 rule-4, rule-5, rule-6, and rule-7 up to end of the rule symptoms it works in similar manner. Finally, if the symptom would not match in all rule symptoms then the system would be terminated.

## 3.6. Knowledge Representation

Knowledge representation is the process of encoding human knowledge in computer understandable form. It is concerned with designing and using systems for storing knowledge [41]. 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 rule are shows, how certain condition as symptoms of prototype KBSCDD fired the goal to diagnose the diseases. The following rules shows the knowledge structure if then rules.

**Rule: 1**

If the cattle has difficulty for breathing

And cattle has unclotted 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

**Rule: 2**

If the Cattle has Lameness and Pronounced swelling of upper limb in many,

And the Cattle has Myonecrosis of skeletal or cardiac muscles,

And the Cattle has patients severe toxemia and a high case fatality rate,

And the Cattle has very depressed,

And the Cattle has loss of appetite,

And the Cattle has high temperature,

Then Black-leg would be diagnosed.

**Rule: 3**

If the Cattle has severe dejection and anorexia,

And the Cattle has high fever,

And the Cattle has severe toxemia and a high case fatality rate,

And the Cattle has Vesicles and bullae (1-2 cm in diameter) appear on the buccal mucosa, dental pad and tongue,

And the Cattle has abundant salivation,

And the Cattle smacking of the lips,

And the has Cattle anirnal chews carefully,

And the Cattle has painful stomatitis,

Then Foot and Mouth would be diagnosed.

**Rule: 4**

If the Cattle has nasal discharge,

And Cattle has high fever,

And the Cattle has salivation,

And the Cattle has lameness,

And the Cattle Nodular lesions on the skin and mucous membranes,

Then LSD would be diagnosed.

**Rule: 5**

If Cattle has Progressive Emaciation,

And Cattle has Lethargy

And Cattle has Weakness,

And the has Cattle Fluctuating Fever,

And the Cattle has Moist Cough

And the Cattle has Dyspnea

And the Cattle has Tachypnea.

Then Bovine Tuberculosis would be diagnosed.

**Rule: 6**

If Cattle has Bellowing,

And Cattle has Attack Animate

And Cattle has Inanimate Objects,

And the has Cattle Lactation Ceases Abruptly,

And the Cattle has Behavioral Changes

And the Cattle has Paralysis.

And the Cattle has Tachypnea.

Then Rabies would be diagnosed.

**Rule: 7**

If Cattle has Distension of the left flank,

And Cattle has protrusion and enlarged abdomen,

And Cattle has dispnea and granting,

And the has Cattle mouth breathing,

And the Cattle has protrusion of the tongue and extension of the head,

And the Cattle has vomiting,

Then Bloat would be diagnosed.

**Rule: 8**

If the Cattle has reduction in the intensity of the heart sounds and occasionally an arrhythmia,

And Cattle has decrease in the frequency, amplitude of rumen contractions,

And the Cattle has anorexia,

And the Cattle mild tachycardia,

Then Hypocalcemia would be diagnosed.

**Rule: 9**

If the Cattle has dribble blood-tinged urine,

And Cattle has decrease in the frequency, amplitude of rumen contractions,

And the Cattle has pain on urination & on complete obstruction tenesmus,

And the Cattle has tail twitching,

And the Cattle has weight shifting

And the Cattle has Inappetence,

And the Cattle has depression, and rectal prolapse

Then Urolithiasis would be diagnosed.

**Rule: 10**

If the Cattle has Dyspnea,

And Cattle has difficulty breathing,

And the Cattle has grunt at expiration,

And the Cattle has high fever,

And the Cattle has cough when forced to move

And the Cattle has Pain on chest percussion,

And the Cattle has Anorexia,

And the Cattle has Pleuritic friction rubs early and moist crackles

Then CBPP would be diagnosed.

**Rule: 11**

If the Cattle has Depression,

And Cattle has toxemia,

And the Cattle has pyrexia,

And the Cattle has serous to mucopurulent nasal discharge,

And the Cattle has moist cough

And the Cattle has shallow respiratory rate,

And the Cattle has increased bronchial sounds,

Then Pasteurellosis would be diagnosed.

**Rule: 12**

If the Cattle has increase in respiratory rate

And Cattle has cough,

And the Cattle has abnormal breath sounds on auscultation,

And the Cattle has toxemia,

And the Cattle has painful cough,

And the Cattle has hacking coughs,

And the Cattle has nasal discharge, Then Pneumonia would be diagnosed.

**Rule: 13**

If the Cattle has udder are swelling, heat, hardness, redness or pain. Milk takes on a watery appearance, flakes, clots or pus is often present,

And Cattle has Milk quality reduced,

And Cattle has reduction in milk yields,

And Cattle has increases in body temperature,

And Cattle has lack of appetite,

And Cattle has Reduction in mobility due to the pain of a swollen udder,

Then Mastitis would be diagnosed**.**

**Rule: 14**

If the Cattle has within 24 to 48 hours becomes greatly distressed,

And Cattle has temperature is usually high,

And Cattle has Greyish blood-flecked discharge escapes from the vagina,

And Cattle has refuses food,

And Cattle has tucked up in her abdomen and stands with her back arched,

Then Metritis would be diagnosed**.**

**Rule: 15**

If the Cattle has slowly collects in the cavity of the uterus,

And Cattle has little or nothing being seen at the vulva, and

And Cattle has discharged periodically large amounts at a time

And Cattle has continuous reddish-brown or brownish-grey discharge follows

And Cattle has unexpected abortion occurred,

Then Brucellosis would be diagnosed**.**

# CHAPTER- FOUR

# KNOWLEDGE BASED SYSTEM IMPLEMENTATION

## 4.1. Introduction

This section emphases on the implementation of KBSCDD that deals with the prototype of the system demonstrates how the system diagnosis and give treatment, description and control and prevention about cattle disease and shows how different components of knowledge based system such as; knowledge base, working memory (fact base), explanation facility, inference engine and user interface are integrated each other to form cattle disease diagnosis system.

This research study implemented by rule based Java Expert System Shell (JESS) for knowledge structuring and Java programming language for graphical user interface development. The knowledge represented by using IF_THEN production rule technique. Backward inference engine used to inference the rule from the knowledge base. So, every rule is logically understandable by inference engine mechanism. The details of each the components of knowledge base system are discussed in the following knowledge based system Architecture.

## 4.2. Architecture of Knowledge Based System

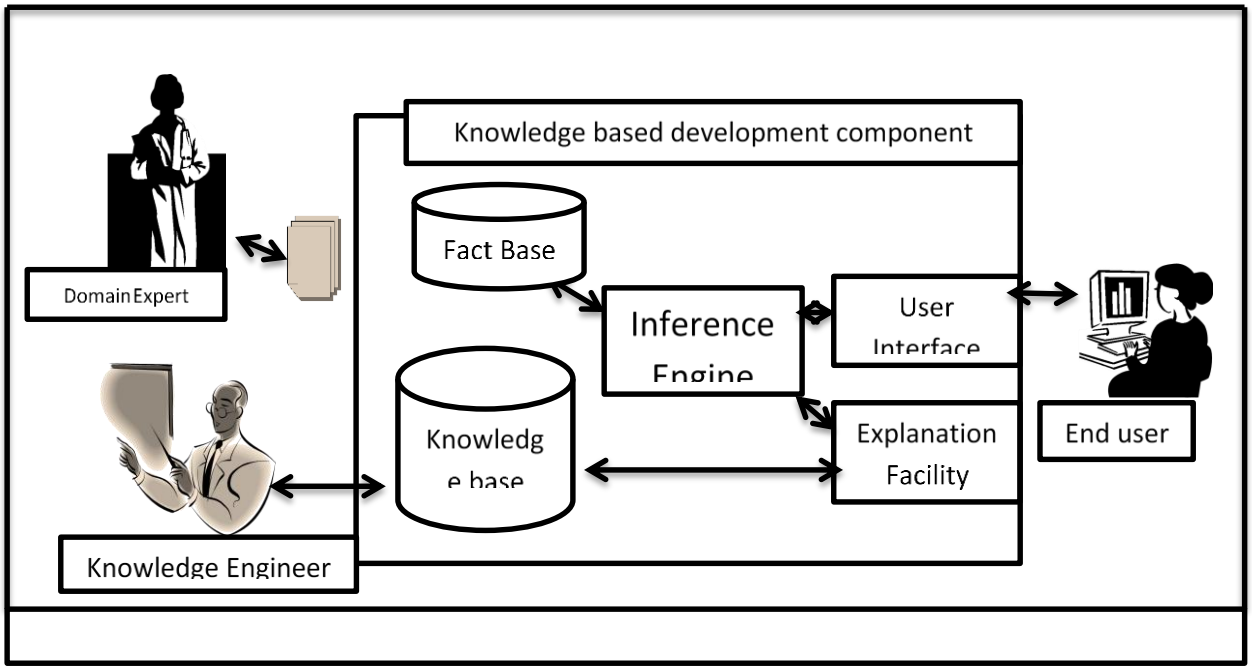


**Figure 4. 1** System Architecture of KBS **[23]**

### 4.2.1 Knowledge Base

The Knowledge base of the study was represented as set rules that was understandable by the computer which are encoded by knowledge engineer, this knowledge encoding represents about diagnosis and treatment of different cattle diseases. The knowledge base stores all relevant knowledge about, fact, rules, and relationships used by the knowledge based system. It incorporates the relevant knowledge that was acquired from the domain experts. The prototype knowledge base contains the domain knowledge which used to identify the types of disease, description and treatment of cattle diseases.

The knowledge representation process in this study was in the form of if-then; the knowledge represented using IF_THEN rules was used to construct the knowledge base of the system. The IF_THEN rules were converted to JESS code then it can be easily inferred. If there is any condition about a set symptom of disease, then conclusion as identified symptoms of the disease. Sample rules in the knowledge base of the prototype system are discussed as follows:

(Set-reset-globals FALSE)

```
(defrule infrule1

   (Difficulty_Breathing True)
        (Unclotted_Blood True)
        (Not_Stiffen True)
        (High_Fever True)
        (Muscle_Tremors True)
  =>
   (assert (disease Anthrax))
```

```
Void SetFocus () {
                Try {
                        If (Infectious.isSelected ())
                        {
                        engine.executeCommand ("(batch Scripts/infectious_anthrax.clp)");
                                Selected="Infectious";
                                Infectious_Athrax_Dialog id = new Infectious_Athrax_Dialog ();
                                id.setVisible (true);
```

```
For a total of 1 facts in module MAIN.
Bye
 ==> f-1 (MAIN::Difficulty_Breathing True)
 ==> f-2 (MAIN::Unclotted_Blood True)
 ==> f-3 (MAIN::Not_Stiffen True)
 ==> f-4 (MAIN::High_Fever True)
 ==> f-5 (MAIN::Muscle_Tremors True)
 ==> f-6 (MAIN::Abdominal_pain True)
==> Activation: MAIN::infrule1:  f-1, f-2, f-3, f-4, f-5, f-6

FIRE 1 MAIN::infrule1 f-1, f-2, f-3, f-4, f-5, f-6
 ==> f-7 (MAIN::disease Anthrax)
F-0   (MAIN::person adola)
F-1   (MAIN::Difficulty_Breathing True)
F-2   (MAIN::Unclotted_Blood True)
F-3   (MAIN::Not_Stiffen True)
F-4   (MAIN::High_Fever True)
F-5   (MAIN::Muscle_Tremors True)
F-6   (MAIN::Abdominal_pain True)
F-7   (MAIN::disease Anthrax)
For a total of 8 facts in module MAIN.
I got this: Anthrax
```

#### 4.2.2.1. Prototype Knowledge Based System Working Procedure

The following diagram shows how the users interact with the prototype knowledge based system and shows the flows of how disease diagnosed or not and how the user interact with other service of the knowledge based prototype.

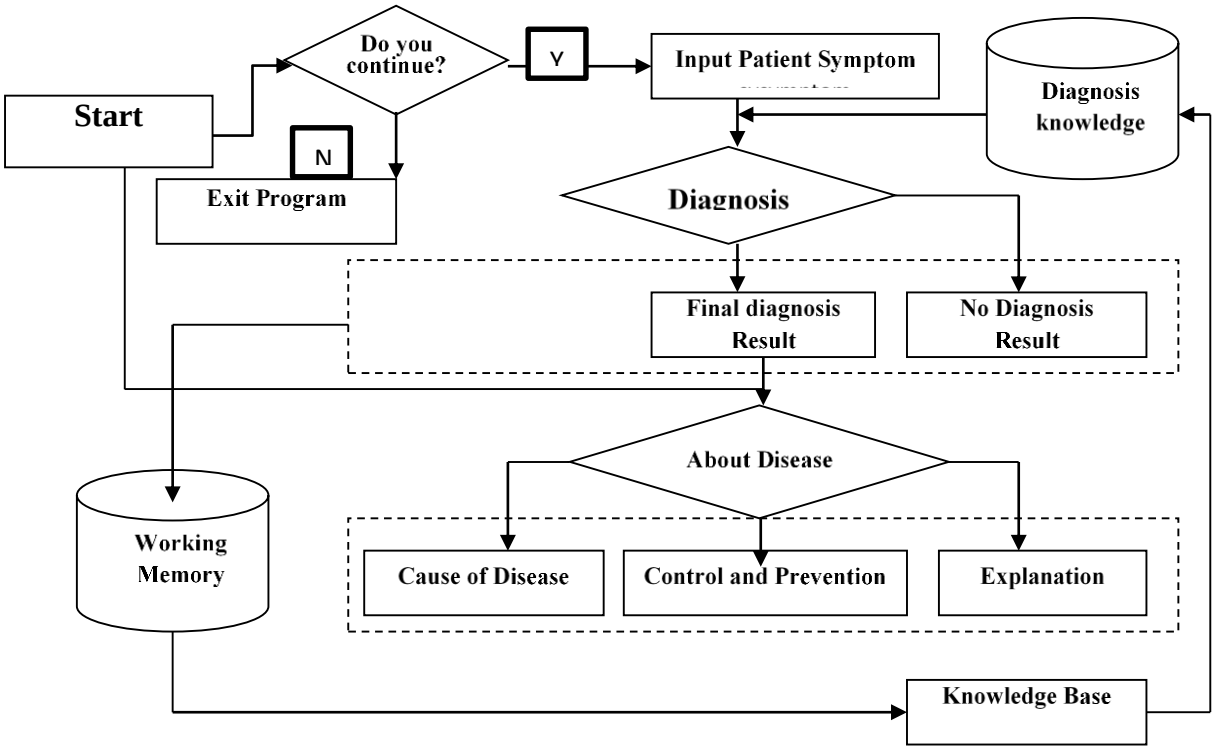


**Figure 4. 2** Cattle Disease Diagnosis System Procedure **[50]**

As shown in figure 4.2, the developed prototype system would load/start the program then the system would display the symptom of selected disease or terminated from the system, if selected disease symptoms are correct then the system would display identified disease or the system would satisfied the condition to be diagnosed with their treatment, explanation and control and control information. On other hand, if selected disease symptoms are incorrect then the system would not be identifying the disease and the system recommend to inserting correct disease symptoms or proceed to check other symptoms. After user known the disease type either exit from the system finally, if the user needs other service like description, treatment, cause of disease. About the disease the system would also have displayed.

The above knowledge representation rule in this study involves selection of the types of cattle diseases as goals (hypothesis) to be checked as set of diseases symptoms consider as conditions to make conclusions for the rule to be fired or executed. Based on this representation mechanism, the acquired knowledge is expressed in a manner that compatible with a knowledge representation which is implemented using backward chaining inference mechanism.

### 4.2.2 Fact Base (Working Memory)

The fact base component of knowledge based system includes basic facts of different rules of selected disease symptoms that are handled during system interaction with user by checking all symptoms of the diseases. The following code shows how KBSCDD working memory works and represent the facts taking from the user and check how many facts are available in the knowledge base.

```
For a total of 0 facts in module MAIN.
Bye
 ==> f-0 (MAIN::Difficulty_Breathing True)
 ==> f-1 (MAIN::Unclotted_Blood True)
 ==> f-2 (MAIN::Not_Stiffen True)
 ==> f-3 (MAIN::High_Fever True)
 ==> f-4 (MAIN::Muscle_Tremors True)
 ==> f-5 (MAIN::Abdominal_pain True)
```

### 4.2.3. The Inference Engine

The inference engine of this research is using backward chaining mechanism for reasoning the set of rules to satisfy the goals. The system always has a goals or rules it try to achieve. This inference engine works from the facts in the working memory (fact base) and the knowledge base to drive (infer) new facts. It achieves by searching through knowledge base to find rules whose condition match the facts in the working memory (fact base). This process continues until the inference mechanism is unable to match any condition with the facts in the working memory.

During KBSCDD, the rules in the knowledge base are searched for conditions that can be satisfied by facts supplied by the user. This operation is performed by the inference engine. Once all conditions of a rule are matched, the appropriate conclusion is drawn. Based upon the conclusions drawn and the facts obtained during user interaction, the inference mechanism determines which choice correctly match and provide appropriate diagnosis or any other service which satisfy the

condition. The following code shows, how inference engine inference the rule from the knowledge base to find the matched symptoms. If all typical symptoms are matched the disease would be diagnosed. Otherwise the disease could not be diagnosed.

```
==> Activation: MAIN::infrule1:  f-0, f-1, f-2, f-3, f-4, f-5
FIRE 1 MAIN::infrule1 f-0, f-1, f-2, f-3, f-4, f-5
 ==> f-6 (MAIN::disease Anthrax)
f-0   (MAIN::Difficulty_Breathing True)
f-1   (MAIN::Unclotted_Blood True)
f-2   (MAIN::Not_Stiffen True)
f-3   (MAIN::High_Fever True)
f-4   (MAIN::Muscle_Tremors True)
f-5   (MAIN::Abdominal_pain True)
f-6   (MAIN::disease Anthrax)
For a total of 7 facts in module MAIN.
I got this: Anthrax

MAIN::infrule2: +1+1+1+1+1+1+1+2+1+1+1+2+1+1+1+2+1+1+1+2+1+1+1+2+t
+2=1=1=1+2=1=1=1+2=1=1=1+2+2=1=1=1+2=1=1=1+2=1=1=1+2=1=1=1+2=1=1+1+2=1
=1=1+2=1=1=1+2=1=1=1+2=1=1+1+2=1=1+1+2+t


==> f-0 (MAIN::Difficulty_Breathing True)
 ==> f-1 (MAIN::Unclotted_Blood False)
 ==> f-2 (MAIN::Not_Stiffen False)
 ==> f-3 (MAIN::High_Fever True)
 ==> f-4 (MAIN::Muscle_Tremors False)
 ==> f-5 (MAIN::Abdominal_pain False)

f-0   (MAIN::Difficulty_Breathing True)
f-1   (MAIN::Unclotted_Blood False)
f-2   (MAIN::Not_Stiffen False)
f-3   (MAIN::High_Fever True)
f-4   (MAIN::Muscle_Tremors False)
f-5   (MAIN::Abdominal_pain False)
For a total of 6 facts in module MAIN.
I got this: False
```

### 4.2.4. User Interface

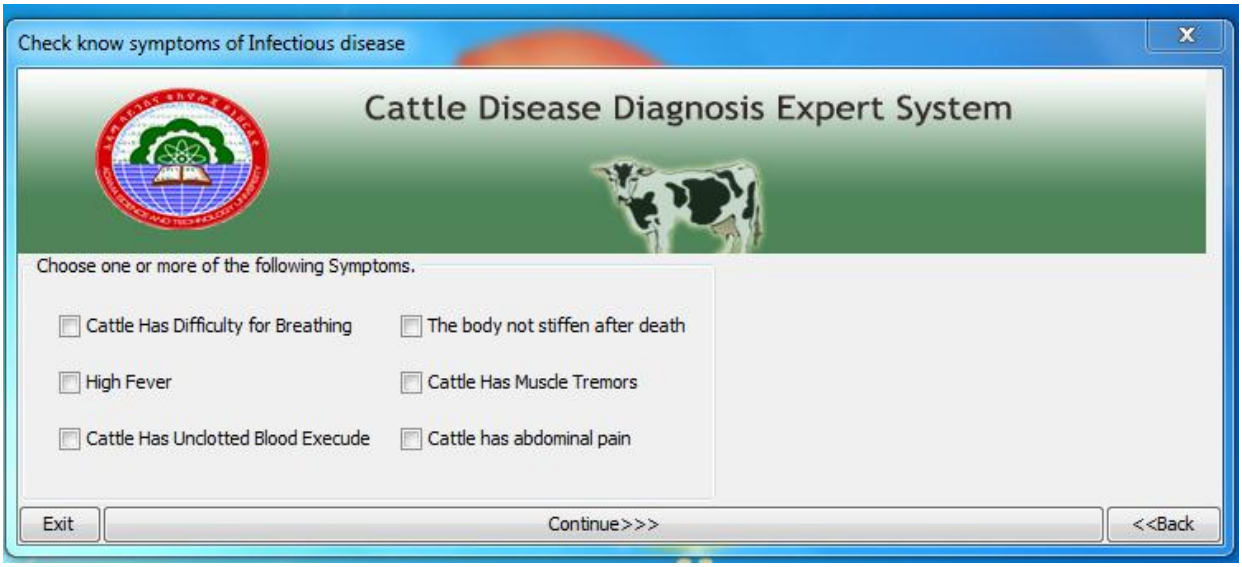


**Figure 4. 3 Symptoms to be checked**

The above figure shows, before the user diagnosed the disease first it has to be checked all the known symptoms of the disease. Otherwise the disease could not be diagnosed.

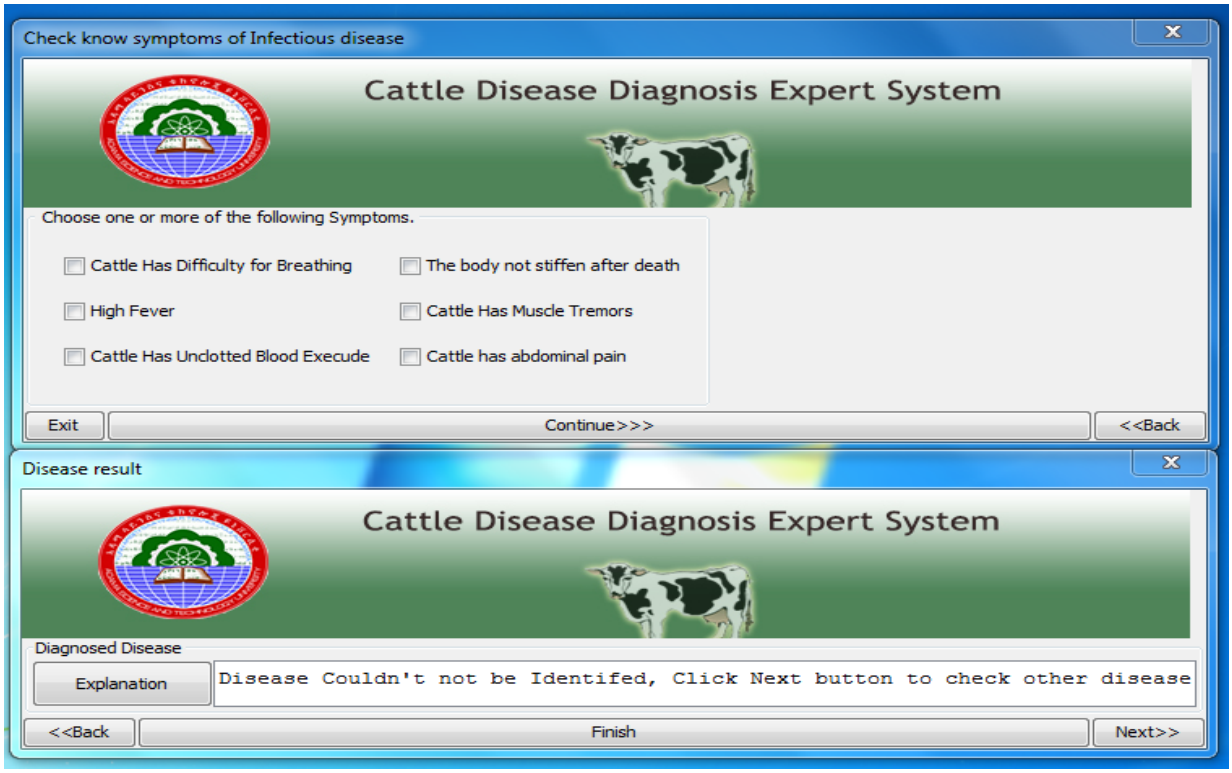


**Figure 4. 4 None of Disease Symptoms not selected**

The above page shows that if the user would not check any symptoms of disease and click continue button then, the system display as disease would not be diagnosed.

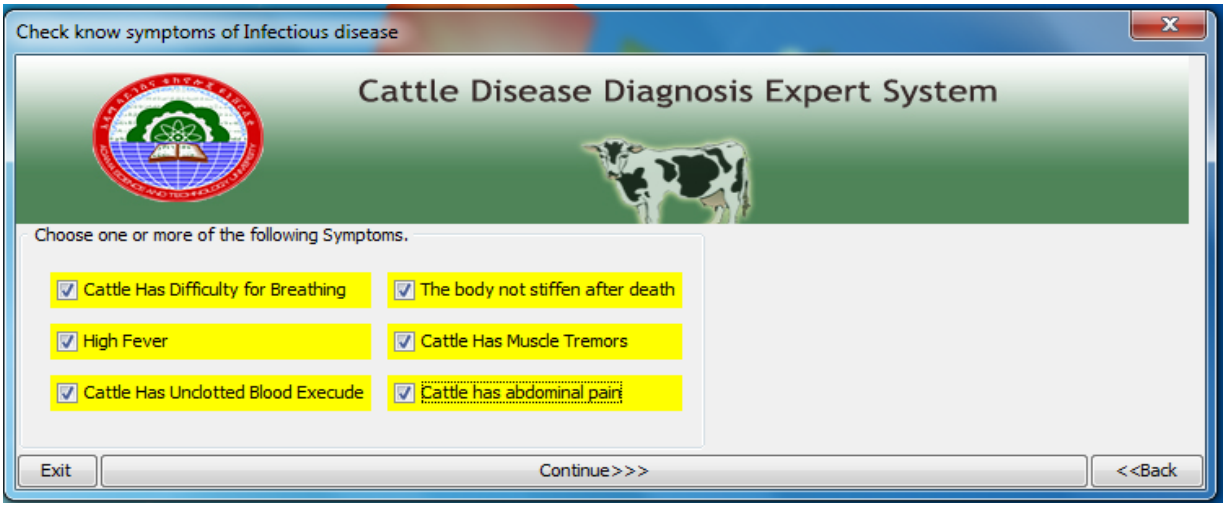


**Figure 4. 5 Selected all Known Disease Symptoms**

The above figure shows that the user check or select all known symptoms, to see the result by clicking continue button and then the result of selected symptoms is Anthrax cattle disease would be diagnosed.

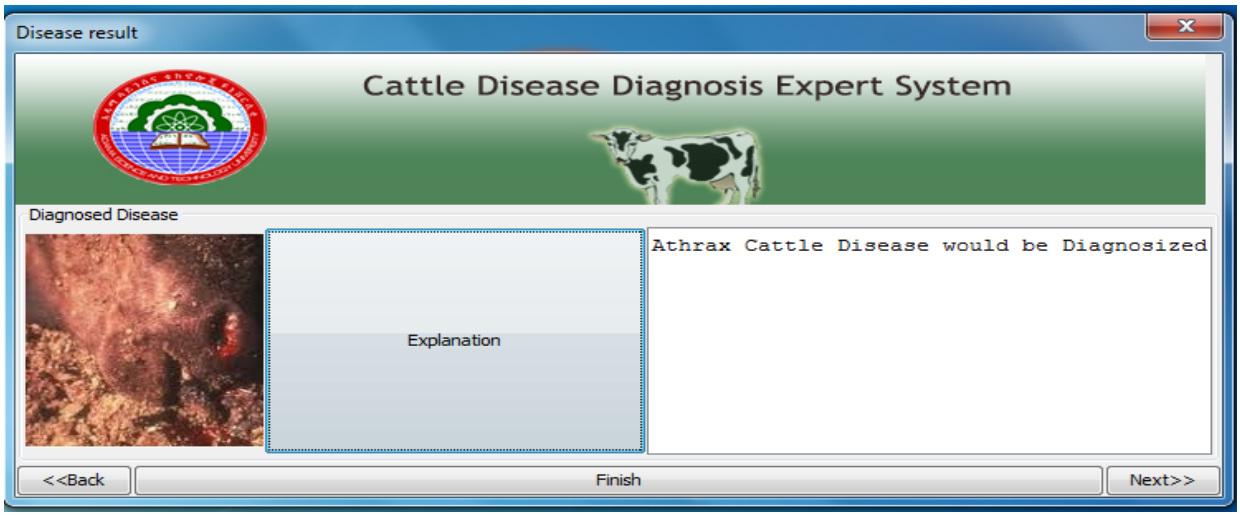


**Figure 4. 6 Result of Diagnosed Disease**

The above figure, shows that after the user select the correct known symptoms of the disease and click continue button then, then system would display the name of diagnosed disease with typical sign of disease picture.

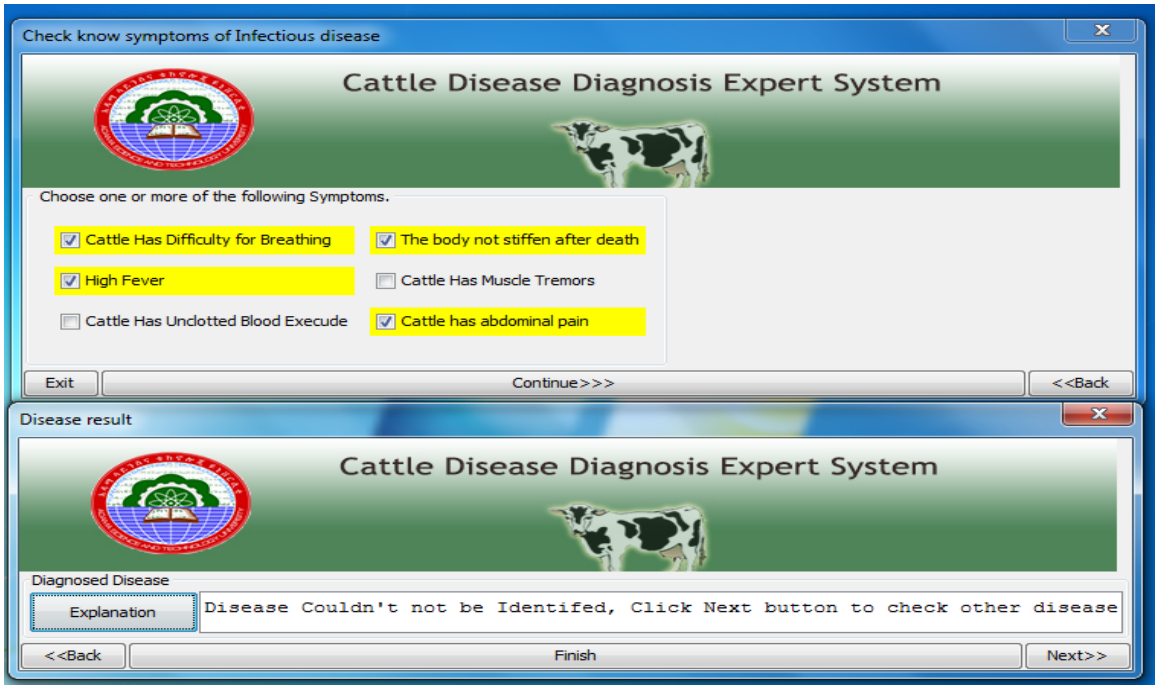


**Figure 4. 7 Incorrect Selected Disease Symptoms**

The above figure shows that, if the user check or selects incorrect symptoms or missed any of the symptom then the system would display as the disease would not be diagnosed or identified and system also recommend the user to select other symptoms of cattle Disease.

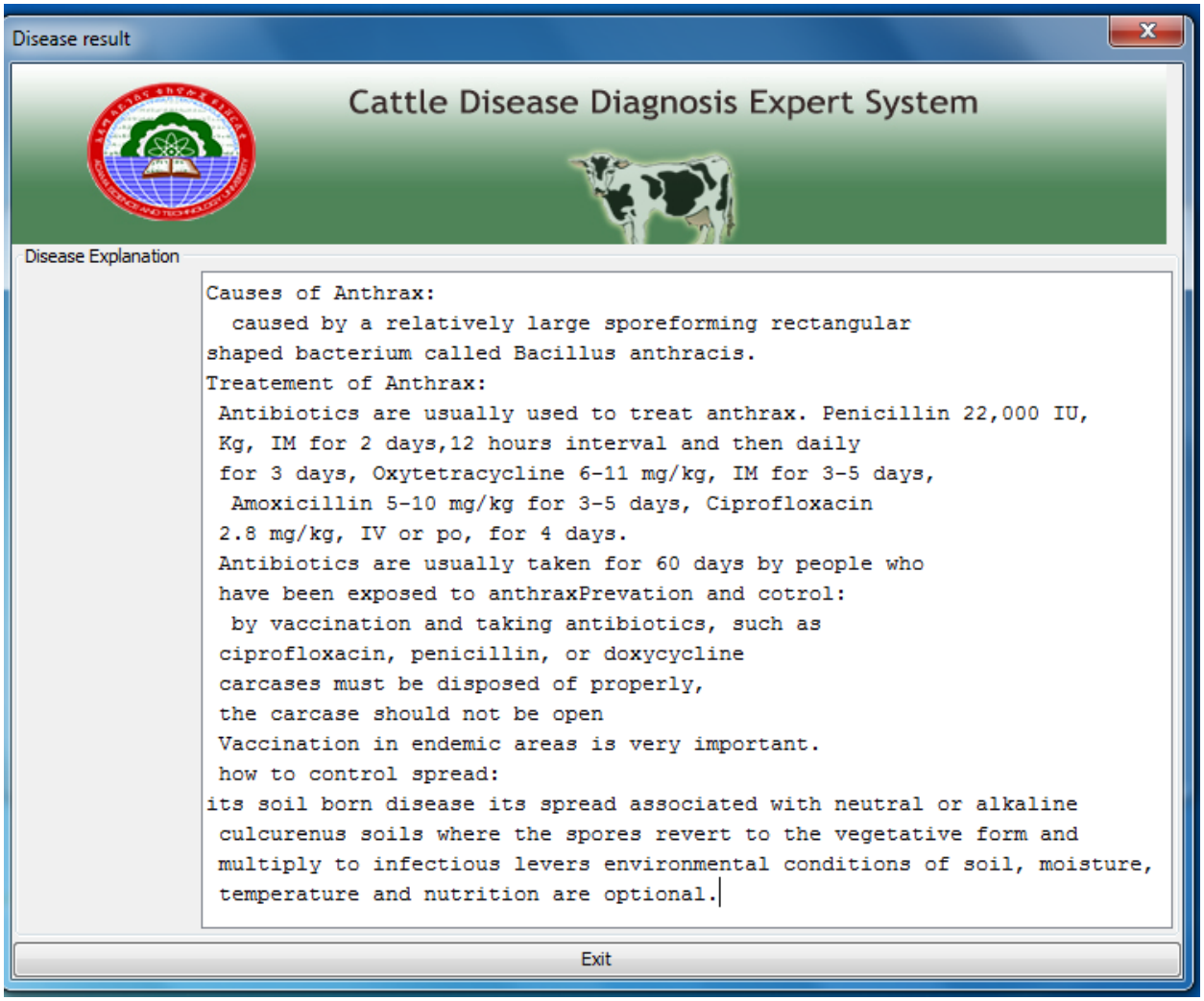


**Figure 4. 8 Explanation of Diagnosed Disease**

The above figure shows that, after the disease diagnosed or identified, if the user wants to know the explanation about the diagnosed disease such as, its causes, and drug treatment, how the disease spread, prevention and control of the disease.

# CHAPTER FIVE

# SYSTEM TESTING AND EVALUATION

## 5.1. Introduction

The objective of this chapter is to test and evaluate how the prototype of KBSCDD fits with the objectives of this research study. This is done by two major techniques which help for knowledge Engineer to test and evaluate after the system was implemented. These two techniques are system performance and user acceptance testing. The system performance testing helps to know how the system is properly works to achieve the real activities of domain problems. On other hand, the user acceptance testing is helps to know how the system easily interacts with end users.

## 5.2. User Acceptance Evaluation

The User acceptance testing is the basic issue for the application of successful and effective knowledge based system. To address the issue of user acceptance testing, the researcher uses visual interaction along with open ended and close ended questionnaires. For the purpose of user acceptance evaluation process ten domain experts were selected. Among these five experts were selected from East Shoa Agricultural Office and five experts from Addis Ababa University Veterinary Institute were selected.

Those domain experts were selected purposely based on their experience, job position and educational level. The first step before evaluation process was started, the researcher identify the domain experts which are directly involved during research writing process and experts which have no idea with research done, after identifying domain experts the next steps is giving some demonstration to domain experts about the purpose of evaluation and how evaluation can be done. This helps them to properly evaluate the prototype of cattle disease diagnosis system.

This testing method used to test how visualizes the system, while direct interaction with the end users of the system. This measurement was mainly done by domain experts through prepared open

and close ended questionnaires. The questionnaires are prepared by Knowledge Engineer to perform user acceptance evaluation. For purpose of this evaluation process, the questionnaires are adopted from research done by (Seblewongel, 2011 and Tagel, 2013) for this study. After evaluators are interacting with the system by using test cases, which have similar parameters with the rules in the prototype, and finally, they give their feedbacks on the questionnaires.

The questionnaires were prepared by using both open and closed ended types. Closed ended questionnaires helped to evaluate the user satisfaction level with the system prototype user interface designed and system performance of problem solving capability. Among the first seven questions, the first three(3) questionnaires were used to evaluate system prototype of its attractiveness, easy to use and time effectiveness of user interface designed while the user interact with the system (Seblewongel, 2011 and Tagel, 2013).

The rest of four (4) questionnaires were used to evaluate the system prototype accuracy, adequacy, problem solving ability and the importance of developed knowledge based system for Diagnosis of cattle diseases.

Based on selected close ended questionnaires, the domain experts put the value of their satisfactory level as Excellent, Very Good, Good, Fair and Poor of evaluation criteria. For their satisfactory level, the researcher puts the value as; 1 for Poor, 2 for fair, 3 for Good, 4 for Very Good and 5 for excellent values. After user acceptance evaluation was done by domain expert, the next step was done by knowledge Engineer about the analysis results that are given by domain experts about visual interaction of the proposed system and finally, give its description about the analysis results of proposed system prototype user acceptance evaluation.

**Table 5. 1** KBSCDD Prototype Evaluation

| ***No*** | ***Questions*** | ***poor*** | ***Fair*** | ***Good*** | ***Very Good*** | ***Excellent*** | ***Average*** | ***Total average performance (%)*** |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | | |
| 1 | Is the prototype easy to use and interact with it? | 0 | 0 | 1 | 5 | 4 | 4.3 | 86% |
| 2 | How do you rate the attractiveness of KBSCDD? | 0 | 0 | 1 | 5 | 4 | 4.3 | 86% |
| 3 | Is KBSCDD more efficient in time? | 0 | 0 | 0 | 6 | 4 | 4.4 | 88% |
| 4 | How accurately does the KBCDDS reach a decision to diagnose Cattle diseases? | 0 | 1 | 2 | 3 | 4 | 4 | 80% |
| 5 | Does the system incorporate sufficient and practical knowledge to diagnose Cattle diseases? | 0 | 2 | 3 | 1 | 4 | 3.7 | 74% |
| 6 | Can the system give right description and treatment for identified cattle Disease? | 0 | 2 | 1 | 2 | 5 | 4 | 80% |
| 7 | How do you rate the significance of the system in the domain area? | 0 | 1 | 2 | 2 | 5 | 4.1 | 82% |
| | **Total Average** | | | | | | 4.11 | 82.28% |

The above table 5.1, shows that for the question number one of the system prototype evaluation about use and inter-activeness of the proposed system prototype the respondents respond their satisfactory level as 10% of the respondents respond good, 50% of the respondents respond Very good, and the rest 40% of the respondents respond Excellent.

At the same time for the question number two about the attractiveness of system prototype the respondents respond as 10% of the respondents respond Good, 50% of the respondents respond Very Good and the rest 40% of the respondents respond Excellent.

Similarly, for the question number three of the system prototype evaluation about system efficient in time. The respondent's respond for this question as 60% of the respondents respond Very Good and the rest of the 40% respondents respond Excellent. And also, for the question number four of the system prototype evaluation about accuracy of the prototype in decision making, The respondent's respond for this question as 10% of the respondents respond fair, 20% of the respondents respond good, 30% of the respondents respond Very Good and the rest of the 40% respondents respond Excellent.

On other hand, for the question number five of the system prototype evaluation about system sufficiency and practical knowledge of the system. The respondent's respond for this question as 20% of the respondents respond fair, 30% of the respondents respond Good, 10% of the respondents respond Very Good and the remaining 40% respondents respond Excellent. In the same way, for the question number six of the system prototype evaluation about system right description and treatment. The respondent's respond for this question as 20% of the respondents respond fair, 10% of the respondents respond good, 20% of the respondents respond Very Good and the rest of 40% respondents respond Excellent.

Finally, for the question number seven of the system prototype evaluation about system prototype significance for domain area, the respondent's respond for this question as 10% of the respondents respond fair, 20% of the respondents respond good, 20% of the respondents respond Very Good and the rest of 50% respondents respond Excellent. To summarize the above table the total Average performance of the user acceptance evaluation for all questions become 82.28% of the proposed system prototype.

On other hand, the open ended questionnaires are consist of eight questions among these questions the first question deals about, how implemented prototype knowledge based system better than currently working human expert cattle disease diagnosis system with their similarity and difference exists between them.

Similarly, for the open ended questionaries' the respondents respond different opinion as feedback of system prototype. Most of the respondents agreed with KBSCDD prototype can handle cattle disease diagnosis. However, some of the respondents would not be agreed with KBSCDD prototype would not handle cattle disease diagnosis. This is because of the prototype would not cover all disease. On other hand, all of the respondents agreed with KBSCDD help to support Veterinary experts particularly, animal health assistant and Veterinary laboratory Technician workers in the domain area. As the Respondents opinion the system prototype different from existing human experts these are summarized as follows.

- In human expert, the patient's history directly taken from the animal owners complains but in case of proposed system prototype complain filled by experts.
- In the system prototype, the Reagents and lab equipment's that used for clinical experts cannot be included.
- In the system prototype, if there are correct symptoms then the disease would be diagnosed, but in human expert there should be some cases needed for laboratory result expected for the conformation.
- Sometimes, in human experts there are some confusion are happened, but in the system prototype the right decision would make with correct result.
- In the new system there is a need of few costs for training, to understand the symptoms with proper disease diagnosis rather than human experts.
- In case human expert every disease visual observed either diagnosed the disease or sent to laboratory conformation to see the accurate result, but in case this system prototype there is no need to be sent to the laboratory testing, the disease automatically diagnosed the disease.

More or less, According to respondents some of the strength system prototype is listed below

- The system easily understandable by the user
- Pictorial diagnosis of the disease would increase the user acceptance
- Reduce time consuming to diagnosis the disease
- Sufficient treatment and support after disease diagnosed
- Increase user satisfaction
- Easy to use
- Good demonstration of disease control and prevention
- No need of veterinary doctor to diagnosis the disease any experts can use the system.
- The system prototype helps for the experts who has no experience and fresh experts as well as for novice experts.
- It minimizes the experts confusion to diagnosed the disease
- Using a few number of expert the system can assist a lot of cattle owners
- system cover all common symptom of to be disease diagnose

According to respondents some of the limitation system prototype are listed below

- The new system prototype would not support local language to diagnose the disease.
- The new system prototype is not flexible to diagnose the disease only search prior store knowledge.
- The system prototype serves only for cattle species.
- All of the cattle would not be covered only diagnose for a few number of disease.
- It needs some basic Computer knowledge to be familiar with the system prototype.
- It is not 100% accurate it might give less reliable than laboratory result.
- It only doing by identifies the correct symptoms of the diseases that makes the system is not flexible with the disease.
- The system would not guess any other related disease after incorrectly entered by the user.
- The system would not identify any other cattle symptom to diagnose such as toxin or poison.

## 5.3. System performance Using Test Cases

In this section deals about system performance evaluation using sample case testing mechanism in order to check the accuracy and correctness of the system prototype performance. System performance testing is the process of determining whether the prototype system is correct, that is whether it meets the level of accuracy as required. It confirms whether the right prototype system has been built. The correct and incorrect outcomes are identified by comparing decisions made by domain experts on the sample cattle case and with the conclusions of the system prototype.

This evaluation strategy is used to validate the achievement level of the system and to measure the accuracy of the system. To address the issue of validation, thirteen (13) test cases are selected that have similar parameter with the system prototype they are selected purposely from East Shoa Agricultural Office and Addis Ababa University Veterinary Institute. These test cases are categorized in to four, based on knowledge structured for the disease categories of the proposed system. These categories are infectious, noninfectious, respiratory and reproductive system disease cases. The system evaluator select cases from any categories of tested cases.

On other hand, the system performance evaluation in this study done by, evaluating how the collection of rules or cases that are written by JESS integrate with java user interface script and also evaluate the correctness of input facts that are selected by the users with jess working memory and java interface. In addition to this how the system fired each case with correct input facts as well as with incorrect input facts. This helps to know whether the system correctly diagnoses with the given facts or not.

During the system performance evaluation process the developed system prototype can check all rules or cases that are exists in knowledge base with known facts but when system evaluator check any rule weather the system response proper solution or not. After evaluator insert new rules into developed system prototype then the system response as unknown case or rule. This shows that the system could not create any rule by itself or there no mechanism to make similar measurement from the nearest case or rule. So, to overcome this limitation the proposed system should be integrated with case base or fuzz logic reasoning techniques.

In the process of testing the performance of the proposed system prototype, the domain experts classify correctly and incorrectly diagnosed disease cases by comparing the judgments reached by the prototype system with that of the domain experts. Performance of this prototype system is

usually evaluated using confusion matrix. The following table shows the confusion matrix for a cattle diseases class classifier.

**Table 5. 2** KBSCDD Accuracy Testing

| ***No*** | ***Cattle disease category*** | ***Total number of cases selected*** | ***Correctly diagnosed disease*** | ***Incorrect diagnosed disease*** | ***Accuracy of the prototype (100%)*** |
|---|---|---|---|---|---|
| 1 | Infectious Disease | 4 | 3 | 1 | 75% |
| 2 | Non-Infectious Disease | 3 | 3 | 0 | 100.% |
| 3 | Respiratory System Disease | 3 | 2 | 1 | 66.66% |
| 4 | Reproductive System Disease | 3 | 2 | 1 | 66.66% |
| Total | | 13 | 10 | 3 | 76.92% |

The above table shows, out of 13 cattle disease cases, ten were diagnosed correctly from all disease categories cases, 3 were diagnosed incorrectly from all selected disease categories. Among these, correctly diagnosed cases are from Infectious diseases category cases like Anthrax, Foot and Mouth and Lumpy Skin diseases are correctly diagnosed the disease symptoms. Whereas from non-infectious diseases category cases like Bloat and Hypocalcemia are correctly diagnosed the disease symptoms. Similarly, from Respiratory system diseases category all cases were correctly diagnosed the disease symptoms. Finally, from reproductive system diseases category cases of Metritis and Brucellosis are were correctly diagnosed the disease symptoms. However, the other cases like Black leg, Urolithiasis and Mastitis from diseases category of infectious, non-infectious

and reproductive disease respectively are incorrectly diagnosed the diseases, this is because of some of the disease symptoms were not be inserted correctly as domain expert symptom diagnosis. During the testing procedure, the expert evaluators identify correctly and incorrectly diagnosed cases by comparing the decisions made by the system with that of the experts' decision on those cases.

**Accuracy =** TP+TN/N

= 10+0/13

= 10/13

= 0.769 (76.92%)

The above result shows, the system has an accuracy of 76.92% and the remaining 23.08% is the variation between the system and the human experts. The proposed system prototype 76.92 % were correctly diagnosed cattle diseases were as, 23.08% the proposed system prototype incorrectly diagnosed with the system prototype.

## 5.4. Results and Discussion

The proposed system prototype user acceptance evaluation was evaluated by domain experts using close and open ended questionnaires, how the system prototype interacts with the domain area and importance of the proposed system for the domain area. In addition to this, the domain expert's forward their feedback and constructive suggestion in open ended questionnaire about the strength and limitation of proposed system prototype. The following table shows the total number of respondents evaluates for each scale values and average performance of proposed prototype visual interaction with the end user.

**Table 5. 3 Total KBSCDD Prototype Evaluation**

| ***Total no of respondent respond for a given scale values*** | ***Poor(1)*** | ***Fair(2)*** | ***Good(3)*** | ***Very Good(4)*** | ***Excellent(5)*** | ***Average performance*** |
|---|---|---|---|---|---|---|
| **Total no scale values** | 0 | 6 | 10 | 24 | 30 | 4.11 |
| **Out of 100%** | 0 | 9% | 14% | 34% | 43% | 82.28% |

The above table demonstrates about the evaluation results that are obtained from user acceptance testing using closed ended questions. According to respondents evaluation for each scale values along with prepared evaluation questions it is summarized as, no one responds for poor scale value, and also for fair scale value respondents respond six(6) times this result (9%) of respondents respond. similarly, for good scale value respondents respond ten(10) times this result (14%) of respondents respond .On the other , for very good scale value respondents respond twenty four(24) times this result (34%) of respondents respond hand. Finally, for excellent scale value respondents respond thirty (30) times this result (43%) of respondents respond for a given scale values.

Moreover, as shown in the above table 5.2 overall average user acceptance evaluation of knowledge base system prototype results about 82.28% evaluated by the domain experts evaluators. This shows that approximately about 80% of the respondents are satisfied with system prototype of evaluation criteria's such as, attractiveness, significance, time usage, accuracy and capability to solve a given problem of the proposed system prototype. This indicated that how the system is important to diagnose the cattle diseases of the domain area.

Beside to this, for the open ended questions the domain experts forward their feedback for the proposed knowledge based system prototype of its strength and limitation as they are compare with the existing disease diagnosis process. As most of the respondents raised as major limitation of the prototype are; it is not incorporate all cattle disease, it is only identify the disease that are caused by the agents, it is flexible human experts when the disease incorrect inserted or missed symptom as human experts and it need more expert knowledge with basic computer skill.

Similarly, as most of the respondents opinion regarding with the strength of the proposed system prototype are; it consume a lot of time to diagnosis the common disease, it has better description and treatment after diseases were diagnosed ,it reduce cost for train novice experts.

In general, the domain experts for the following constructive opinion for the limitation of the proposed knowledge based system for cattle disease diagnosis.

- The system should have to be incorporating all cattle diseases.
- It better to diagnose other born cattle disease such as poison/toxin and parasites.
- It should be acts as human experts judgment during the decision making process.
- The system should be flexible as human when the symptom missed and forgotten.
- The system should use in local language to be familiarly for all expert users.

# CHAPTER SIX

# CONCLUSION AND RECOMMENDATION

## 6.1. Conclusion

There are different constraints that hinder livestock production in Ethiopia among these the major constraints are endemic diseases, shortage of animal feed both in terms of quality and quantity and low production of the local stock. Livestock diseases are the main cause for livestock mortalities and socio-economic hardship to the Pastoral communities and farmers as well as countries economy.

In developing countries like Ethiopia, the impact of cattle disease on lives and livelihoods of society make very difficult. The result of such diseases can also make difference between sufficient food stocks and food insecurity, between having a secure income to the loss of key household assets. To address those problems this study has an effort to develop knowledge based system for cattle disease diagnosis and treatment.

To develop the KBSCDD system prototype, the knowledge acquired using both structured and unstructured interview from the domain experts. The acquired knowledge is represented using decision tree structure that represents the conceptual knowledge of domain area and the knowledge structured by IF-THEN rules. The system prototype implementation developed by rule based java Expert System Shell (JESS) and Eclipse IDE tools for graphical user interface development.

The system testing and evaluation is done by visual interaction of user acceptance testing and using case testing method. The user acceptance testing done by prepared questionnaires which evaluated by the domain experts evaluator by using open and close ended questions, After each questions was evaluated by the respondents, the analysis was done by collecting each respondents evaluation points. Finally, calculating the average performance of the user acceptance testing for KBSCDD Prototype were done. The system performance testing was done by using test cases and its accuracy measured by confusion matrix.

Based on the result obtained from respondent' evaluation points, the proposed prototype for KBSCDD the total average performance of the user acceptance evaluation is about 82.28% of the proposed system prototype satisfied by domain experts. Similarly, the total system performance testing using test cases were obtained about 76.92% of proposed system prototype was accuracy tested. This results shows how the domain experts satisfied with proposed KBSCDD and they hope the developed prototype helps to solve domain problems.

Generally, the evaluators of the KBSCDD prototype provide their opinion for system prototype as a major limitation are; inability to be flexible as human judgments, inability of the system for using local language and being new technology transfer to the domain area for changing the existing working environment. These all comments and feedback help the improvement of prototype KBSCDD by future researchers considering the feedbacks obtained in the system evaluation phase of this research work.

## 6.2. Recommendation

Due to time and other constraints, the following points were not covered in this research work. The researcher would thus suggest these areas for the future researchers to be implemented in a better way in veterinary domain and to be conducted on untouched point in the domain. So, the researcher forwards the following domain area for future works.

- There are so many languages spoken in Ethiopia. It is thus to make the system more efficient and more better problem solving, it is better to use local language that would be easily fit with domain areas.
- Due to time constraints the researcher could not coverer all the cattle disease categories so, the future researchers should include the rest of categories with their agents and born factors.
- It is better to integrate with other KBS techniques such as Bayesian network, fuzz logic and neuron network and like.
- The developed cattle disease diagnosis system would not have any update feature, so to be the system more suited with the human expert, it is better to add update feature to the system this enabled the system learn from the experience and self-learning as human brain. So, to do this the future researcher will use some machine learning techniques to make the system self-learning and update by themselves.
- To make the system more effective and powerful, the future research should change it into the hybrid approach by using either case base system approach.

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# APPENDIXES

## Appendix I

**Sample code for Anthrax disease diagnosis**

```
public Infectious_Disease_Dialog() {
        engine.watchAll();
        configureFrame();

    }

    /** Returns an ImageIcon, or null if the path was invalid. */
    protected ImageIcon createImageIcon(String path, String description) {
        java.net.URL imgURL = getClass().getResource(path);
        if (imgURL != null) {
            return new ImageIcon(imgURL, description);
        } else {
            System.err.println("Couldn't find file: " + path);
            return null;
        }
    }

    class ColorChanger implements ActionListener {
        ColorChanger() {
        }

        public void actionPerformed(ActionEvent e) {
            @SuppressWarnings("unchecked")
            JCheckBox jc = (JCheckBox) e.getSource();
            if (jc.isSelected()) {
                jc.setBackground(Color.green);
            } else {
                jc.setBackground(Color.white);
            }
        }
    }

    private void configureFrame() {
        try {


    UIManager.setLookAndFeel(UIManager.getSystemLookAndFeelClassName());

            this.setTitle("Check know symptoms of Infectious disease");
```

```
                image = new JLabel();
                ImageIcon icon = createImageIcon("Images/systemlogo.jpg", "blahblah");
                image.setIcon(icon);
                this.getContentPane().setLayout(new BorderLayout());
                this.getContentPane().add(image, BorderLayout.NORTH);

                /*********************************************************/
                JPanel symptoms = new JPanel();
                symptoms.setBorder(BorderFactory.createTitledBorder("Symptoms"));
                symptoms.setLayout(new SpringLayout());

                symptoms.add(Difficulty_Breathing = new JCheckBox("Cattle Has
Difficulty for Breathing"));

                Difficulty_Breathing.addActionListener(new ColorChanger());
                symptoms.add(Not_Stiffen = new JCheckBox("The body not stiffen after
death"));
                Not_Stiffen.addActionListener(new ColorChanger());

                symptoms.add(High_Fever = new JCheckBox("High Fever"));
                High_Fever.addActionListener(new ColorChanger());

                symptoms.add(Muscle_Tremors = new JCheckBox("Cattle Has Muscle
Tremors"));
                Muscle_Tremors.addActionListener(new ColorChanger());

                symptoms.add(Lameness = new JCheckBox("Cattle Has

                symptoms.add(Unclotted_Blood = new JCheckBox("Cattle Has Unclotted
Blood Execude"));
                Unclotted_Blood.addActionListener(new ColorChanger());


(set-reset-globals FALSE)

(defrule infrule1

   (Difficulty_Breathing True)

        (Unclotted_Blood True )

        (Not_Stiffen True)

        (High_Fever True)

        (Muscle_Tremors True)
```

```
        (Lameness False)
        (Limb_Swelling False)
        (Myonecrosis False)
        (Severe_Toxemia False)
        (High_Fatality_Rate False)
        (Very_Depressed False)
        (Loss_of_Apetite False)
    (Severe_Dejection False)
   (Anorexia False)
(Vesicles_Bullae False)
(Abundant_Salivation False)
(Smacking_Lips False)
        (Chews_Carefully False)
        (Painfull_Stomatits False)
   (Nasal_Discharge False)
        (Noduler_Lesions_Skin False)
        (Noduler_Lesions_Mucous_Membranes False)

  =>
   (assert (disease Anthrax))
)
```

# Appendix II

## Interview Questions

The importance of this interview questions is to extract tacit knowledge from domain experts of veterinary Medicine that will support for the development of a knowledge based system for diagnosis and treatment of cattle diseases. The interviewer stores the answerers‟ reply using pen, paper, and voice recorder of mobile phone as well. I would like to thank for your cooperation and valuable information.

1. Which diseases attack cattle in Ethiopia?
2. What are the different types of cattle diseases? Which types of cattle mostly affected by diseases
3. Which parts of the cattle mainly attacked?
4. How do you identify similar symptom for different diseases? How identify the unique characteristics of each disease?
5. Does a disease have common behaviors due to different factors? if your answer is yes, what are they?
6. What considerations do you use to identify particular cattle diseases? What steps (procedures) do you follow to diagnosis them?
7. Do you use standardized guidelines/manuals to diagnose cattle diseases?
8. If your answer for question number 7 is yes, to what extent do you follow the guideline? After diagnosis of these diseases, what are the recommendation and treatments you provided?
9. What are the main challenges encountered during diagnosis of cattle diseases?
10. What are proper management under taken to overcome cattle diseases in the sectors?
11. What are common and Zoonotic cattle disease?

# Appendix III

**ADAMA SCIENCE AND TECHNOLOGY UNIVERSITY**

**School of Electrical and Computing**

**Department of Computing**

**Dear Participant**,

I' am currently writing my research thesis on the area of knowledge based system to finalize this research study that I've been attending at Adama Science and Technology University, I need to have some survey question to be answer by domain experts.

My research title is knowledge based system for Cattle Disease Diagnosis; this survey questionnaire helps to evaluate the developed system prototype its performance testing as well as user acceptance testing by the domain experts. So that you have to give your opinion and feedback and the assessment of knowledge base system for Cattle Disease Diagnosis would be developed as a solution. You have every right to withdraw from this survey at any point, if you are not comfortable. Thank you very much for spending time to read and answer these short questionnaires!

**Thank you very much again for your support!**

Adola, Haile

Adama Science and Technology University,

Adama.

August 30, 2016

**Questionnaires for KBSCDD (knowledge based system for Cattle Disease Diagnosis) System Prototype Evaluation**

Please, read and answer all questions according to the instruction given below.

**I. Please circle the options for each of the following questions given below**.

1. Is the prototype easy to use and interact with it?

   1. Poor 2. Fair 3. Good 4. Very good 5. Excellent

2. How do you rate the attractiveness of KBSCDD?

   1. Poor 2. Fair 3. Good 4. Very good 5. Excellent

3. Is KBSCDD more efficient in time?

   1. Poor 2. Fair 3. Good 4. Very good 5. Excellent

4. How accurately does the KBCDDS reach a decision to diagnose Cattle diseases?

   1. Poor 2. Fair 3. Good 4. Very good 5. Excellent

5. Does the system incorporate sufficient and practical knowledge to diagnose Cattle diseases?

   1. Poor 2. Fair 3. Good 4. Very good 5. Excellent

6. Can the system give right description and treatment for identified cattle Disease?

   1. Poor 2. Fair 3. Good 4. Very good 5. Excellent

7. How do you rate the significance of the system in the domain area?

   1. Poor 2. Fair 3. Good 4. Very good 5. Excellent

**II. Please state your opinions and suggestions regarding the performance and applicability of the KBSCDD in the domain area.**

8. How is KBSCDD different from diagnosing the cattle disease from the human experts?

_____

_____

9. What issues are covered by the KBSCDD Advisory system?

_____

10. Please state your suggestion if you think that there are uncovered issues by prototype KBSCDD?

_____

11. Do you believe that, KBSCDD prototype handle cattle disease Diagnosing tasks?

_____

12. Do you think that, KBSCDD contribute in diagnosing and treatment of cattle disease can support Veterinary experts particularly, Animal Health Assistant and Veterinary laboratory Technician workers in the domain area? How?

_____

13. What are the limitations of KBSCDD as you see its performance when you are interacting?

With it?

_____

14. What are the strengths of the KBSCDD in solving problems in the domain areas?

## Appendix IV

## Selected for Testing Cases

**Case: 1**

If the cattle has difficulty for breathing

And cattle has unclotted 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 will be diagnosed

**Case: 2**

If the Cattle has Lameness and Pronounced swelling of upper limb in many,

And the Cattle has Myonecrosis of skeletal or cardiac muscles,

And the Cattle has patients severe toxemia and a high case fatality rate,

And the Cattle has very depressed,

And the Cattle has loss of appetite,

And the Cattle has high temperature,

Then Black-leg will be diagnosed.

**Case: 3**

If the Cattle has severe dejection and anorexia,

And the Cattle has high fever,

And the Cattle has severe toxemia and a high case fatality rate,

And the Cattle has Vesicles and bullae (1-2 cm in diameter) appear on the buccal mucosa, dental pad and tongue,

And the Cattle has abundant salivation,

And the Cattle smacking of the lips,

And the has Cattle anirnal chews carefully,

And the Cattle has painful stomatitis,

Then Foot and Mouth will be diagnosed.

**Case: 4**

If the Cattle has nasal discharge,

And Cattle has high fever,

And the Cattle has salivation,

And the Cattle has lameness,

And the Cattle Nodular lesions on the skin and mucous membranes,

Then LSD will be diagnosed.

**Case: 7**

If Cattle has Distension of the left flank,

And Cattle has protrusion and enlarged abdomen,

And Cattle has dispnea and granting,

And the has Cattle mouth breathing,

And the Cattle has protrusion of the tongue and extension of the head,

And the Cattle has vomiting,

Then Bloat will be diagnosed.

**Case: 8**

If the Cattle has reduction in the intensity of the heart sounds and occasionally an arrhythmia,

And Cattle has decrease in the frequency, amplitude of rumen contractions,

And the Cattle has anorexia,

And the Cattle mild tachycardia,

Then Hypocalcemia will be diagnosed.

**Case: 9**

If the Cattle has dribble blood-tinged urine,

And Cattle has decrease in the frequency, amplitude of rumen contractions,

And the Cattle has pain on urination & on complete obstruction tenesmus,

And the Cattle has tail twitching,

And the Cattle has weight shifting

And the Cattle has Inappetence,

And the Cattle has depression, and rectal prolapse

Then Urolithiasis will be diagnosed.

**Case: 10**

If the Cattle has Dyspnea,

And Cattle has difficulty breathing,

And the Cattle has grunt at expiration,

And the Cattle has high fever,

And the Cattle has cough when forced to move

And the Cattle has Pain on chest percussion,

And the Cattle has Anorexia,

And the Cattle has Pleuritic friction rubs early and moist crackles

Then CBPP will be diagnosed.

**Case: 11**

If the Cattle has Depression,

And Cattle has toxemia,

And the Cattle has pyrexia,

And the Cattle has serous to mucopurulent nasal discharge,

And the Cattle has moist cough

And the Cattle has shallow respiratory rate,

And the Cattle has increased bronchial sounds,

Then Pasteurellosis will be diagnosed.

**Case: 12**

If the Cattle has increase in respiratory rate

And Cattle has cough,

And the Cattle has abnormal breath sounds on auscultation,

And the Cattle has toxemia,

And the Cattle has painful cough,

And the Cattle has hacking coughs,

And the Cattle has nasal discharge, Then Pneumonia will be diagnosed.

**Case: 13**

If the Cattle has udder are swelling, heat, hardness, redness or pain. Milk takes on a watery appearance, flakes, clots or pus is often present,

And Cattle has Milk quality reduced,

And Cattle has reduction in milk yields,

And Cattle has increases in body temperature,

And Cattle has lack of appetite,

And Cattle has Reduction in mobility due to the pain of a swollen udder,

Then Mastitis will be diagnosed**.**

**Case: 14**

If the Cattle has within 24 to 48 hours becomes greatly distressed,

And Cattle has temperature is usually high,

And Cattle has Greyish blood-flecked discharge escapes from the vagina,

And Cattle has refuses food,

And Cattle has tucked up in her abdomen and stands with her back arched,

Then Metritis will be diagnosed**.**

**Case: 15**

If the Cattle has slowly collects in the cavity of the uterus,

And Cattle has little or nothing being seen at the vulva, and

And Cattle has discharged periodically large amounts at a time

And Cattle has continuous reddish-brown or brownish-grey discharge follows

And Cattle has unexpected abortion occurred,

Then Brucellosis will be diagnosed**.**