JIMMA UNIVERSITY

JIMMA INSTITUTE OF TECHNOLOGY

FACULTY OF COMPUTING AND INFORMATICS

DEPARTMENT OF INFORMATION SCIENCE

MSC. IN INFORMATION SCIENCE (IN INFORMATION AND KNOWLEDGE MANAGEMET) (IKM)

DEVELOPING KNOWLEDGE BASED SYSTEM FOR PREDOMINANT CHICKEN DISEASES DIAGNOSIS, PREVENTION AND MANAGEMENT

BY

DIRIBA GIRMA

October, 2019

Jimma, Ethiopia

JIMMA UNIVERSITY

JIMMA INSTITUTE OF TECHNOLOGY

FACULTY OF COMPUTING AND INFORMATICS

DEPARTMENT OF INFORMATION SCIENCE

MSC. IN INFORMATION AND KNOWLEDGE MANAGEMENT (IKM)

DEVELOPING KNOWLEDGE BASED SYSTEM FOR PREDOMINANT CHICKEN DISEASES DIAGNOSIS, PREVENTION AND MANAGEMENT

A Thesis Submitted to Faculty of Computing and Informatics of Jimma University in Partial Fulfillment of the Requirements for the Degree of Master of Science in Information Science (Information and Knowledge Management)

BY

DIRIBA GIRMA

Principal Advisor: Worku Jimma (PhD.)

Co-Advisor: Chala Diriba (Assis. Prof)

October, 2019

Jimma, Ethiopia

JIMMA UNIVERSITY

JIMMA INSTITUTE OF TECHNOLOGY

FACULTY OF COMPUTING AND INFORMATICS

DEPARTMENT OF INFORMATION SCIENCE

MSC. IN INFORMATION AND KNOWLEDGE MANAGEMET

(IKM)

DEVELOPING KNOWLEDGE BASED SYSTEM FOR PREDOMINANT CHICKEN DISEASES DIAGNOSIS, PREVENTION AND MANAGEMENT

As members of the board of examining of the MSc thesis open defense examination of the above title, we members of the board (listed below), read and evaluated the thesis and examined the candidate.

BY

DIRIBA GIRMA

Name	Title	Signature	Date
Elsabet Wedajo	Chair Person		
Worku Jimma	Principal Advisor		
Chala Diriba	Co. Advisor		
	External Examiner		
Workineh Tessema	Internal Examiner		

DECLARATION

I declare that this thesis is my original work and it has not been presented for a degree in any other universities. All the material sources used in this work are duly acknowledged.

____

DIRIBA GIRMA

October, 2019

This thesis has been submitted to the department for examination with our approval as university advisors:

Principal Advisor: Worku Jimma (PhD) … …………………………

Co-Advisor: Chala Diriba (Assis. Prof) …………………………...

DEDICATION

I would like to dedicate my thesis to my family and to all my best friends who gives me their support to achieve my dream.

Acknowledgement

First and foremost, I would like to thank the almighty God, for giving me the strength, ability and opportunity to undertake this study. Without His blessings, this achievement would not have been possible.

Next, I would like to express my heart-full gratitude and thanks to my advisors Dr. Worku Jimma and Mr. Chala Diriba, for their invaluable support, meticulous guidance, patience, encouragement, kind approach and invaluable comments which I found very important and brought up to its present status.

I am also indebted to give special thanks to all staff members of Jimma University College of Agriculture and Veterinary Medicine and Kito Furdisa Poultry Farm for their cooperation during the knowledge acquisition process, testing and evaluation of the prototype system. I also appreciate Wollega University for giving me a chance to pursue my post graduate study and paying the salary during my study.

It is my pleasure also to express my thanks to all my beloved family members for their encouragement and love. Especially, I would like to express my gratitude to my beloved brothers Bikila Girma and Segni Reta for their patience, love and support which was instrumental for accomplishing this research work.

Table of Contents

List of Figures

List of Tables

List of Acronyms/ Abbreviations

AI : Artificial Intelligence

CSA: Central Statistical Agency

DE: Domain Expert

ES: Expert Systems

GDP: Gross Domestic product

ICT: Information and Communication Technology

IE: Inference Engine

KA: Knowledge Acquisition

KBS: Knowledge Based System

KE: Knowledge Engineer

KR: Knowledge Representation

NCD: Newcastle Disease

PROLOG: Programming in Logic

RBS: Rule Based System

UI: User Interface

Abstract

Poultry diseases remain one of the major threats to poultry production. The diseases of chickens need to be observed intensively because of its impact on the health and quality of chicken production. Chicken disease becomes one of the problems that are very detrimental to chicken farmers. Accurate information about handling chicken disease is still difficult to obtain. Expert knowledge (including agricultural and medical experts), which is valuable to control and/or treat such diseases are limited in developing countries in general and in Ethiopia in particular. In attempt to solve this problem, knowledge based system is identified as a powerful tool with extensive potential in alleviating agricultural and medical problems. Therefore, it is necessary to design a knowledge base system application in detecting diseases that are experienced by chickens based on the symptoms shown and how to handle them. This study aims at developing knowledge base system for diagnosing, prevention and management of predominant chicken diseases. The predominant chicken diseases selected for the purpose of this study include: Newcastle disease, marek's disease, infectious coryza, fowl cholera, chicken mite, coccidiosis, aspergillosis and favus. Design Science research method was used to develop the prototype system. To select domain experts for knowledge acquisition, purposive sampling technique was used. The domain experts were selected from Jimma University College of Agriculture and Veterinary Medicine and from Kito Furdisa Poultry Farm. The knowledge was acquired using both structured and unstructured interviews from domain experts and relevant document analysis method was also followed to capture explicit knowledge. The acquired knowledge was modeled using decision tree that represents concepts and procedures involved in diagnosis, prevention and management of predominant chicken disease and production rules (If-Then-Action) were used to represent the domain knowledge and Knowledge-based system was developed using SWI Prolog editor tool. Backward chaining algorithm was used in this study. At the end performance of the system was evaluated and produced a result of 83%. Moreover, user acceptance of the developed system was done by visual interaction method, namely, by showing the system to the domain experts and it was found to produce 83.4%. Thus, the average performance of the prototype system is 83.2%. The prototype system achieves a very good performance and meets the objectives of the study. Lastly, it is recommended that the stake holders should have to take part in deploying the developed system.

Keywords: Knowledge-Based System, Self-learning, Chicken Disease

CHAPTER ONE

INTRODUCTION

1.1.Background of the Study

Agriculture is the back bone of Ethiopian economy where the sector contributes about 42.3% to the total Gross Domestic product (GDP), (World Bank, 2014). Livestock sector as integral part of agriculture contributes about 40% of agricultural GDP and about a quarter (26.4%) of national GDP (ILRI, 2016) of Ethiopia .In terms of number, Ethiopia has the largest livestock population in Africa and it is home to 56.71 million cattle, 29.33million sheep, 29.11 million goats, 2.03million horses, 7.43 million donkeys, 0.4 million mules, 1.16 million camels and 56.87 million poultry (CSA, 2015).

It can be stated that within Africa, the demand for the livestock and poultry product is increasing. Africa experiences the fastest population growth. The main components of the poultry sector, in Africa, are the family and rural sectors which make around 80% of poultry stocks in many African countries. The smallholder production is mainly free range systems (Faridk, et al, 2003).

Agriculture is the corner stone of the development policy of the Government of Ethiopia. Agriculture remains by far the most important sector in the Ethiopian economy for the following reasons: (i) It directly supports about 85% of the population in terms of employment and livelihood; (ii) It contributes about 50% of the country's gross domestic product (GDP); (iii) It generates about 90% of the export earnings. Agriculture is also the major source of food for the population and hence the prime contributing sector to food security (ICARDA, 2010).

The total chicken population in Ethiopia is estimated to be 56.5 million with native chicken representing 96.9%, hybrid chicken 0.54% and exotic breeds 2.56% (CSA, 2017). However, the number of chicken flocks per household in most Ethiopian rural communities is small; constituting an average of 7–10 mature chicken, 2–4 adult hens, a cock male bird and a number of growers of various ages (Tadelle and Ogle 2001).

The poultry sector in Ethiopia can be characterized into village or backyard, small scale and commercial poultry production system (Dawit *et al.*, 2008). Backyard poultry production is the predominant system in Ethiopia which accounts for nearly 99% of the poultry population consisting mainly of local chicken breeds under individual farm household management. It is also common to find a few exotic breeds distributed through the agricultural extension programs in the backyard production system. The small scale intensive poultry production system comprises a flock size ranging from 50 to 500 exotic breeds' operation commercial bases and outdoor with a low bio-security level. Commercial poultry production system is highly intensive production system that involves greater than 10,000 chickens kept under indoor and heavily depends on imported breeds (Dawit et al., 2008).

In Ethiopia chickens are the most widespread and almost every rural family owns chickens, which provide a valuable source of family protein and income generation (Tadelle et al., 2003). The country has diverse agro-climatic conditions favoring production of many different kinds of crops, providing a wide range of ingredients and alternative feedstuffs suitable for poultry feeding. Making use of these resources to complement the scavenging resource base promises a considerable potential for success (Dessie and Ogle, 2001).

According to Ethiopian green economy development strategic plan (FDRE, 2011). The current chicken meat consumption of 15% will be increased to 30% by 2030 indicating the huge emphasis given to poultry production sector in Ethiopia.

One of the important reasons for failure in the poultry industry is disease, especially when there is an outbreak that kills almost the entire poultry population when it occurs. Various types of poultry diseases can cause serious loss in the poultry farming business. Diseases occur due to lack of proper care and management (Singla and Gupta, 2012). The diseases of chickens need to be observed intensively because of its impact on the health and quality of chickens as poor monitoring system will reduce the productivity and increase its mortality rate (Bawa, 2010).

Knowledge Base System (KBS) is a branch of Artificial Intelligence that helps to represent expert's knowledge in artificial way. It is a computer program that replicates the problem solving abilities of human beings and developed to overcome difficulties in solving complex problems. Currently, KBS are receiving attention in many fields. With availability of advanced computing facilities and other resources, attention is now turning to more and more demanding tasks, which might require intelligence (Eds and Akerkar, 2010).

KBS is one of the major family members of the AI group. The society and industry are becoming knowledge oriented and rely on different experts' decision-making ability. KBS can act as an expert on demand without wasting time; can be used at anytime and anywhere. KBS can save money by leveraging expert, allowing users to function at a higher level and promoting consistency. One may consider the KBS as a productivity tool, having knowledge of more than one expert for a long period of time. In fact, a KBS is a computer based system, which uses and generates knowledge from data, information and knowledge. These systems are capable of understanding the information under process and can take decision based on the residing information/knowledge in the system; whereas the traditional computer systems do not know or understand the data/information they process (Sajja & Akerkar, 2010).

According to Pandey and Mishra (2009) KBSs use reasoning techniques like fuzzy logic, case based reasoning and rule based reasoning to provide significant performance in the area of diagnosis. A rule-based system is handling problems from a well-defined knowledge base that contains facts and rules. It is evident that rule based technique of AI is appropriate methodology for medical domains and tasks. Therefore, the main aim of this study was to develop knowledge based system for predominant chicken diseases diagnosis, prevention and management.

1.2.Statement of the Problem

Poultry diseases have highly destructive effects around the world and these diseases have affected both human and chickens (Bawa, 2010). In Ethiopia, the poultry sector has been adversely affected by a variety of constraints; of these poultry diseases continues to play the major role hampering its development. Poultry mortalities due to diseases are estimated to range from 20 to 50%, but it may rise as high as 80% during epidemics (Tadelle and Ogle, 2001). In Ethiopia and different developing countries constant presence of disease can lead not only to illness and death but also reduce productivity of chickens (Tadiose et al., 2017).

Controlling and prevention of chicken diseases from the beginning is important for the success of poultry farm. Once they got sick, the success in healing them is quite low. The reason is that most chicken diseases are caused by virus, especially the outbreak ones and so far it is not possible to treat most viral diseases. The ability to treat the chickens as early as possible is important in today's commercial production systems because the chickens grow very fast. However, prevention was the major mechanisms for controlling the disease. The immediate measures of sick chickens are isolation (culling), vaccination, biosecurity and treating them until recovery is very important (Mobley and Kahan, 2007).

One of the major challenges in “poultry keeping” is the complexity of how to diagnose different types of poultry diseases in the farm. Additionally the similarity of sign /symptoms and failurity to differentiate from its differential diagnosis is a major problem during diagnosing chicken disease. Animal farmers and various poultry keepers run their businesses at loss especially when there is outbreak of poultry diseases which claims the life of millions of chickens. Unfortunately, enough efforts have not been made in terms of research and also there is lack of experts, using Artificial Intelligence (AI) approach to solve or minimize this problem. This research work therefore makes an attempt to develop a knowledge base system to diagnose, prevent and manage predominant chicken diseases based on their symptom.

In the management of poultry, probably one of the most difficult phases is the management of the chickens. Diseases can be transmitted via humans, other birds, newly introduced chickens, or contaminated equipment. Managing diseases from the beginning is important for the success of improving their health (Mobley and Kahan, 2007).

Chicken is one source of protein favored by the community. One of the benefits we can take on chicken is meat and eggs. Chicken was chosen because its importance should not be compromised. But chicken disease becomes one of the problems that are very detrimental to chicken farmers. This was assessed because of the lack of knowledge of farmers in handling conditions that occur in chicken. Accurate information about handling chicken disease among farmers is still difficult to obtain. Some of the things that make chickens affected by the disease include negligence in giving vaccines, lack of nutritional intake, and also the lack of maintaining the cleanliness of the chicken coop and the rapid spread of the virus. Farmers sometimes do not know that their chickens are attacked by disease, but cannot know what type of disease is attacking the chicken. One of the last options for farmers, if they cannot cure the chicken, the farmer will meet directly with the veterinarian. To find out what type of disease is experienced by the chicken. However, the limited number of veterinarians has become an obstacle for farmers (Yanto, 2017).

By looking at the sources of the above problems, a knowledge system was developed because of its application in various fields of science, business and health which proved to be very helpful in making decisions to deal with the identification of predominant chicken diseases based on symptoms, which were expected to provide information fast about the disease suffered and how to overcome it. Knowledge base systems are branches of artificial intelligence or artificial intelligence used to take and apply knowledge from experts. By applying knowledge derived from experts, expert systems can help solve problems in the real world at a relatively low cost. Therefore, this study aims at developing a KBS that provides the necessary advice for experts so as to enable them make the necessary diagnosis, prevention and management of predominant chicken diseases. To the end, this study attempt to explore and answer the following research questions.

- Which knowledge is required to develop knowledge based system for diagnosing, prevention and management of predominant chicken diseases?
- How to identify and diagnose chicken disease using knowledge base system?
- How to design a self-learning knowledge-based system that automatically updates its knowledge?
- To what extent is the proposed system is acceptable by professionals?

1.3. Objectives of the Study

1.3.1. General Objectives

The general objective of this study was to develop knowledge based system for predominant chicken disease diagnosis, prevention and management.

1.3.2. Specific Objectives

- ➢ To extract knowledge from experts and poultry disease manuals, journal articles and books on how to provide diagnosis, prevention and management for predominant chicken disease.
- ➢ To model and represent the acquired knowledge using knowledge representation technique.

- To develop knowledge based system that can learn by memorization (self-learning) and assist experts during chicken disease diagnosis, prevention and management.
- To test and evaluate the performance of the prototype system with the help of professional experts in the field.

1.4.Scope and Limitation of the Study

The aim of this research was to develop Knowledge Base System for predominant chicken disease diagnosis, prevention and management. Rule based reasoning approach was followed in this research. The researcher acquired domain knowledge from Jimma University College of Agriculture and Veterinary Medicine (JUCAVM) and Kito Furdisa Poultry Farm (KFPF) which is under the Jimma University's Development Enterprise. The reason why these two farms are selected is that the domain experts were found in both areas. Additionally JUCAVM is used as both educational center and research center. Kito Furdisa Poultry Farm is used as an income Generation. Generally both of them were used as the study areas to diagnose, prevent and manage predominant chicken disease and thus the study sites are limited to these two farms. The types of knowledge used for this study were, explicit knowledge sourced from, documents and manuals and tacit knowledge from domain experts.

There are different types of chicken diseases in Ethiopia. But the study made reference to eight diseases, selected for inclusion on the basis of those identified and prioritized by experts at Jimma University College of Agriculture and Veterinary Medicine (JUCAVM) and Kito Furdisa Poultry Farm (KFPF). The diseases were Newcastle Disease, Fowl Cholera, Infectious Coryza, Marek‟s Disease, Coccidiosis, Aspergillosis, Chicken Mite and Favus. Almost all of the major constraints identified were covered. These were supported by the symptoms they induce on chickens.

The researcher acquired information about domain experts (educational qualification, area, role, and year of experience) from head department of veterinary medicine and animal science. Based on this information the researcher purposively selected the domain experts from JUCAVM and KFPF for knowledge acquisition. So the researcher has interviewed Veterinary Doctors and Experts who have enough knowledge on the chicken disease.

The immediate beneficiaries of this study are researchers or experts and farm managers in such a way that they can easily and timely diagnose, prevent and manage chicken diseases from knowledge base which stores the facts and rules that experts can use to solve problems that might be encountered.

For the purpose of this study, the type of disease were limited to viral diseases (Newcastle disease, marek's disease), bacterial diseases (infectious coryza, fowl cholera) , parasitic diseases (chicken mite, coccidiosis) and fungal disease(aspergillosis, favus)which were identified to be predominant chicken diseases.

1.5.Significance of the study

Knowledge-based systems are artificial intelligent tools functioning in a specific domain to provide advice and consultation in decision making. With the proper utilization of knowledge, the knowledge-based systems increase productivity, and enhance problem solving capacity in a flexible manner. Such systems can also document knowledge for future use and training. This leads to have increased quality in problem solving process.

The proposed KBS assists the experts to identify the type of disease based on the symptom observed on the chickens. This study is significant in providing a system based help for identifying predominant chicken disease based on their symptoms by using different techniques.

The immediate beneficiaries of this study are researchers or experts and farm managers in such a way that they can easily and timely diagnose, prevent and manage chicken diseases from knowledge base which stores the facts and rules that experts can use to solve problems that might be encountered.

In this study, KBS for predominant chicken diseases diagnosis, prevention and management was designed and presented. The usefulness of a KBS in diagnosing, preventing and managing chicken diseases is really required for chicken production.

Knowledge base system professionals can use the system as a base to conduct further research in the agricultural and veterinary area. Agriculture is the back-bone on which Ethiopia's economy depends. Loss of yield means a lot to a country as it can cause a huge crises. But as a matter of fact significant yield loss occurs due to chicken diseases and lack of knowledge by farmers on effective ways to combat the diseases. Hence information science researchers can use this system as a reference to build similar works on other diseases. Thus researchers can benefit from this research by gaining hands on experience in knowledge base system development.

1.6. Research Methodology

1.6.1. Research Design

Design science research is a "lens" or set of synthetic and analytical techniques and perspectives (complementing positivist, interpretive, and critical perspectives) for performing research in IS. Design science research typically involves the creation of an artifact and/or design theory as a means to improve the current state of practice as well as existing research knowledge (Baskerville, et al. 2018).

Additionally, this research has chosen Design Science Research (DSR) method because of the following reasons. It is centered towards practical problem solving, includes prescriptive or solution-oriented knowledge where the result from scientific justification (predicting, understanding or explaining phenomena) can be used in designing solutions to complex and relevant field problems.

The first important characteristic of Design Science Research Method is that it is motivated by problem-solving and the second distinguishing characteristic is the prescriptive nature of the outcome of a research program. Based on Lukka (2003), Design Science Research Method:

- Focuses on real-world problems felt relevant to be solved in practice
- Produces an innovative construction meant to solve the initial real-world problem
- Implies a very close involvement and co-operation between the researcher and practitioners in a team-like manner, in which experiential learning is expected to take place
- Is explicitly linked to prior knowledge

Design science refers to an explicitly organized, rational and wholly systematic approach to design; not just the utilization of scientific knowledge of artifacts, but design being in some sense a scientific activity itself (Cross, 2007).

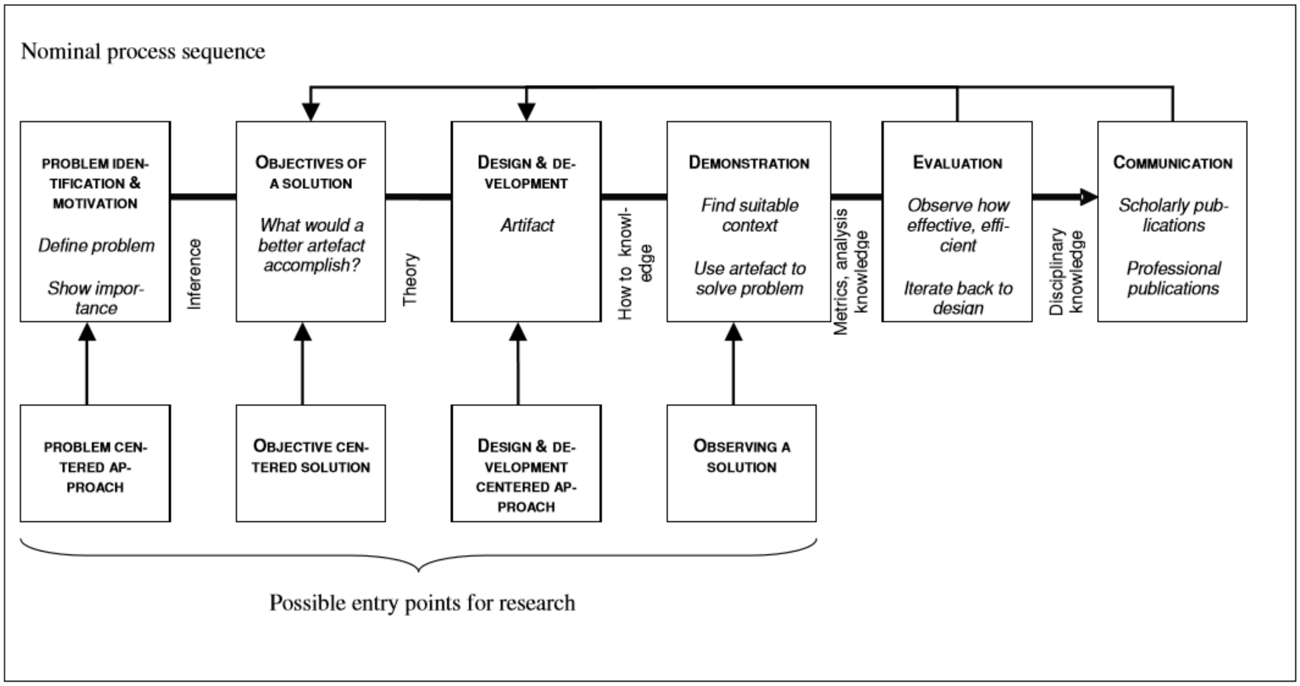


Figure1.1. Design Science Research Process Model (Pefferset al, 2007)

1.6.1.1. Identify Problem and Motivate

Problem definition will be used to develop an effective artifactual solution; it may be useful to atomize the problem conceptually so that the solution can capture the problem's complexity. Justifying the value of a solution accomplishes two things: it motivates the researcher and the audience of the research to pursue the solution and to accept the results and it helps to understand the reasoning associated with the researcher's understanding of the problem. Resources required for this activity include knowledge of the state of the problem and the importance of its solution.

Problem identification contains the following steps: "identify problem", "literature research", "expert interviews" and "pre-evaluate relevance". It specifies a research question and verifies its practical relevance. As a result of this phase, an IS research question is defined. Its relevance is validated by experts. The state of the art in research in the observed area is analyzed. Thus, this phase offers a solid and important foundation for the further research process

The aim of this research was to develop Knowledge Base System for predominant chicken disease diagnosis, prevention and management. Rule based reasoning approach was followed in this research. The researcher acquired domain knowledge from Jimma University College of

Agriculture and Veterinary Medicine (JUCAVM) and Kito Furdisa Poultry Farm (KFPF) which is under the Jimma University's Development Enterprise. Purposive sampling was used for this study because it is one of the most common sampling techniques in which participants are decided to take part based on pre-selected criteria relevant to a particular research question. In this study, to acquire the needed knowledge, both primary (tacit knowledge) and secondary sources of knowledge were used. Based on this information the researcher gets to sampled experts to have knowledge for the system. Primary knowledge gathered from experts in the domain area. Due to this, the researcher purposely selected 1 professor, 3 senior doctors from JUCAVM according to their seniority, exposure, specialization and year of experience they have on chicken disease as suggested by the head and staff members. Additionally, the researcher selected 2 experts from animal science department according to their seniority, exposure and experience they have on chicken disease as suggested by manager of the farm and staff members. These two experts additionally work in the Kito Furdisa Poultry Farm.

1.6.1.2. Define Objectives of Solution

The knowledge has been extracted from its sources i.e. tacit knowledge from experts and explicit knowledge through document analysis. In this study, after the knowledge was extracted from codified and non-codified sources, it was modeled using decision tree and represented using a rule-based knowledge representation techniques, the next step is coding the represented knowledge using prolog programming language into a suitable format that is understandable by the inference engine. For this study, SWI-Prolog editor tool is used to construct the prototype system. Besides, architecture design is done.

1.6.1.3. Design and Development

Knowledge modeling is a cross disciplinary approach to capture and model knowledge into a reusable format for the purpose of preserving, improving, sharing, aggregating and processing knowledge to simulate intelligence (Aronson and Turban, 2007).

During the knowledge modeling phase, the specialist's knowledge (elicited by various techniques) is represented in a knowledge model. A knowledge model is a structured representation of knowledge using symbols to represent pieces of knowledge and the relationships between them.

Knowledge Representation is the area of Artificial Intelligence (AI) concerned with how knowledge can be represented symbolically and manipulated in an automated way by reasoning programs (Brachman, 2003).

Create the artifactual solution. Such artifacts are potentially, with each defined broadly, constructs, models, methods, or instantiations (Hevner et al. 2004). This activity includes determining the artifact's desired functionality and its architecture and then creating the actual artifact. Resources required moving from objectives to design and development include knowledge of theory that can be brought to bear as a solution.

After the knowledge is acquired, it is represented using rule based knowledge representation method. For this research, the knowledge representation method, rule based is chosen; because, it clearly demonstrates the domain knowledge. In a rule based system, much of the knowledge is represented as rules, that is, as conditional sentences relating statements of facts with one another. As a result, rule based representation method is more appropriate to represent and demonstrate the real domain knowledge .

To develop the knowledge-based system, Prolog programming language is used. Specifically, SWI-Prolog editor has been chosen for this study. SWI-Prolog editor has debugging tool and flexible help system. Moreover, the code is readable and easier to update and maintain. It offers backward reasoning capability, which is found to be suitable for medical diagnostic and management problems.

1.6.1.4. Demonstration

The acceptability of a knowledge based system depends on the quality of the user interface. The user interface is used as the means of interaction between a user and the knowledge based system. To use the system there are different steps. At the beginning the system asks the user to insert his/her name. After the user insert name the system recognize that name and proceed to provide general information about predominant chicken disease. Next to this the system asks for explanation by using what and why to clarify how to use the system and understand what to do. After this the system asks a question to diagnose the disease. If the end-user clearly understands the question, the end-user might insert „y‟ or „n‟ to the user interface of the prototype system. When the user response satisfied all the conditions of the given rule, then the system provides a conclusion. After the system identifies type of the disease based on the symptoms that the end user inserts, it provides diagnosis, prevention and management of the disease of predominant chicken.

1.6.1.5. Evaluation

Observe and measure how well the artifact supports a solution to the problem. This activity involves comparing the objectives of a solution to actual observed results from use of the artifact in the demonstration. To meet the established objectives of this study, the prototype system is extensively tested and evaluated including both performance of the prototype system and issues of user's acceptance. Twelve chicken test cases are selected by applying purposive sampling technique from JUCAVM and KFPF for testing performance of the prototype system.

1.6.1.6. Communication

For mean time this research submitted to Faculty of Computing and Informatics of Jimma University in Partial Fulfillment of the Requirements for the Degree of Master of Science in Information Science (Information and Knowledge Management). For the future this research will be sent for publications.

1.6.2. Study Sites

The researcher acquired domain knowledge from Jimma University. The study sites for this study were College of Agriculture and Veterinary Medicine (JUCAVM) and Kito Furdisa Poultry Farm (KFPF). These two areas were selected due to the fact that large numbers of highly qualified experts are available. Moreover, the prevalence of predominant chicken disease is high in the study area.

1.6.2.1. Sampling Techniques and Sample Size

Purposive sampling was used for this study because it is one of the most common sampling techniques in which participants are decided to take part based on pre-selected criteria relevant to a particular research question. It helps the researcher to use different characteristics to select the subject of the study (Mack et al, 2005).

Purposive sampling assists to select sample which can help to acquire the required knowledge from the domain experts. Domain experts were selected based on their educational qualification, area, role and year of experience they have on chicken disease. Thus, the researcher selected domain experts for the knowledge acquisition by purposive sampling process.

1.6.3. Knowledge Acquisition

In this study explicit and tacit knowledge was acquired from both codified (documented) sources and non-codified (non-documented) sources respectively. Non-codified sources of knowledge are acquired from Veterinary doctors who work in the JUCAVM and KFPF by using interview and critique knowledge elicitation methods to filter the acquired knowledge. Similarly, codified sources of knowledge such as poultry disease manuals, journal articles and books were acquired by using document analysis technique.

1.6.4. Knowledge Modeling and Representation Methods

In this study, after the knowledge was extracted from codified and non-codified sources, it was modeled using decision tree. For this research, the knowledge representation method, rule based was chosen; because, it clearly demonstrates the domain knowledge. In a rule based system, much of the knowledge is represented as rules, that is, as conditional sentences relating statements of facts with one another. As a result, rule based representation method is more appropriate to represent and demonstrate the real domain knowledge. Decision trees models by constructing a tree based on training instances with leaves having class labels is used. These are easy to interpret (can be represented as if–then-else rules). Production rules are easy for a human expert to read, understand and maintain. Production rules contain simple syntax that is flexible and easy to understand and are reasonably efficient in diagnosing problems of the form: IF (condition), THEN (conclusion).

1.6.5. Implementation tools

SWI prolog (PROgramming in LOGic) programming language was used as a tool to develop KBS. It is the most popular logic programming language within the realm of Artificial Intelligence (AI). Prolog is a logic programming general purpose fifth generation (AI) language. It has a purely logical subset, called pure Prolog, as well as a numbers of extra logical features. Prolog is a programming language developed especially to enable the implementation of logic-based systems.

Prolog is used to write the code in design phase, prolog is a high level, programming language that is specifically designed for applications in AI. It is often used to develop automated proof systems and automated problem solvers. Prolog, by the nature of being logical, can be very powerful. It is flexible, especially compared to shells, and because it includes a control strategy there is no need to write an inference mechanism. Therefore, in this study Prolog programming language was used to develop predominant chicken diseases diagnosis, prevention and management knowledge base system.

1.6.6. Testing and Evaluation of the System

Once the prototype was developed, the functionality and user acceptance of the system should be tested. So that the evaluation processes focus on systems user acceptance of the prototype and the performance of the system. Accordingly, the system was evaluated by user acceptance testing with the use of a prepared questionnaire (Puet al, 2011).

To meet the established objectives of this study, the prototype system was tested and evaluated including both performance of the prototype system and issues of user's acceptance. The performance comparison parameters such as precision, recall and F-measure were used to measure the accuracy of the prototype system. Issues of user's acceptance testing were also done to see the quality of advice and to access to what extent the KBS satisfies the domain experts.

In this research, system performance testing confusion matrix techniques was used and the performance of the system was calculated using recall, precision and F measure were used to measure effectiveness. The confusion matrix has four categories: True positive, false positive, false negative and True negative.

Table 1.1: Confusion matrix

	Actual Positive	**Actual Negative**
Predicted Positive	**TP**	**FP**
Predicted Negative	**FN**	**TN**

- The precision (P) is the proportion of the classified information which is relevant, as calculated using the equation:

  $$P = TP/(TP + FP)$$

- The recall (R) is the proportion of the classified relevant information versus all relevant information, as calculated using the equation:

  $$R = TP/(TP + FN)$$

- The F-measure is the harmonic mean of precision and recall, as calculated using the equation:

  $$F = 2 * P * R/(P + R)$$

- The accuracy (AC) is the fraction of the total number of predictions that were correct, as calculated using the equation:

  $$AC = (TP + TN)/(TP + FP + TN + FN)$$

In the process of testing the performance of the prototype system, the domain experts classify correct and incorrect decisions by comparing the decision reached by the prototype system with that of the domain expert's decision reached on the same disease.

1.7. Ethical consideration

The proposed study findings should benefit and cause no harm to the participants and society. Privacy and confidentiality will be maintained at all times, all findings will be portrayed in a confidential manner no personal or identifiable information will be recorded or printed in the study. No names will be recorded during the interviewing process. The data will not be transferred to any third part.

1.8. Operational definition of terms

Bio-security level: is a set of bio containment precautions required to isolate dangerous biological agents in enclosed laboratory facilities.

Culling: refers to the identification and removal of the infected chickens from a flock

Domain Expert: is a person who expertise in his/her domain area. In addition, a network administrator who manages and administers a given network is a domain expert in his domain.

Isolation: refers to the separation of chickens with specific contagious (infectious) illness from those which are healthy and the restriction of their movement to stop the spread of a given disease.

Knowledge Engineer: is one who gathers knowledge from experts and represent knowledge.

Quarantine: refers to the separation and restriction of chickens, while not ill, has been exposed to an infectious agent and therefore may become infectious.

Vaccination: is an effective means to prevent or reduce the adverse effects of specific diseases that can cause problems in a poultry flock.

1.9. Organization of the study

This study is organized in to six chapters. The first chapter deals with the background of the study, statement of the problem, research question, objective of the study, scope and limitation of the study, significance of the study, research methodology and ethical consideration.

The second chapter presents review of related literature. Moreover, this chapter contains detail discussion about knowledge base and its components, architecture and application of knowledge base system. Additionally, poultry production system, chicken disease prevention and management were described in this chapter. Specific research works were reviewed regarding predominant chicken disease diagnosis, prevention and management (review of related works).

Chapter three contains the methodologies used in knowledge acquisition, tacit and explicit knowledge elicitation. In addition, knowledge representation and knowledge modeling for predominant chicken disease diagnosis, prevention and management was done in this chapter.

The fourth chapter presents implementation of the knowledge-based system. It also presents architecture of the prototype system.

Chapter five discusses about Testing and evaluation of the proposed systems. This chapter presents the testing process and discusses the evaluation result on the performance of the prototype system. In addition, discussion was made to show the significance of the proposed approach with previous researches.

Finally, chapter six focuses on the conclusion and recommendation based on the results of the research finding for further research work in the domain area.

CHAPTER TWO

LITERATURE REVIEW

2. 1. Introduction

The diseases of chickens need to be observed intensively because of its impact on the health and quality of chickens as poor monitoring system will reduce the productivity and increase its mortality rate (Bawa, 2010). Hence, there should be a way to minimize such a problem by using some technological approach, like developing a knowledge-based system.

KBS provides high qualities of experience, domain specific knowledge, applying heuristic, forward or backward reasoning, uncertainty and explanation capability. KBS are designed to emulate an expert in a specialized knowledge domain such as medicine or any other area of knowledge where there is a shortage of expert knowledge (Tripathi, 2011).

Knowledge-based systems are one of the specialized branches of artificial intelligence functioning in a specific domain to offer wise decisions with reasoning. Tacit and explicit knowledge can be acquired, modeled, and represented using several knowledge representation techniques such as logic, production rules, semantic nets, frames and cases. The main benefits provided by such system are wise decisions, learning from experience, explanation and/or reasoning, and solving problems (Kock, 2003). Therefore, this study aims at developing a KBS that provides the necessary advice for experts so as to enable them make the necessary diagnosis, prevention and management of predominant chicken diseases.

2.2. Concepts of Artificial Intelligence

The term Artificial Intelligence (AI) refers to the activity of building intelligent systems. It is a technology of making computers to simulate human being's intelligence (Raza, 2009). An intelligent system is a system that exhibits and possesses some basic attributes such as performing some actions, reasoning about a particular domain, making decision and goal oriented problem solving capability. A system or an agent can be said to be intelligent when the agent's performance cannot be distinguished from that of a human performing the same task (Honavar, 2006).

Intelligent program (AI) has interdisciplinary approach of various disciplines like computer science, cognitive science, hardware field, etc. In the medical applications areas such as diagnostic techniques in ultrasonography, x-ray, computerized tomography scans, nuclear magnetic resonance imaging etc. The other areas can be clinical laboratories, pathological investigations and computer assisted decision-making. Therefore, the field is potentially relevant to any sphere of human intellectual activity. AI started with a goal to replicate human level of intelligence in machine learning (Shah, 2010). The prime goal of AI research is to increase human beings understanding in all aspects like in human being's perceptual, reasoning, learning, and creative processes (Honavar, 2006).

Development of an intelligent system by itself is a challenge in terms of knowledge acquisition, knowledge representation and knowledge inference because there are differences between one individual to other. Expert may be able to communicate the knowledge needed to knowledge engineer. Knowledge engineer may not be able to structure knowledge for entries into knowledge base are some of challenge during knowledge acquisition process. The size of knowledge base we are dealing with is also one challenge in managing knowledge base since representing that knowledge in a computer readable format is also a challenge. The need of constantly updating knowledge base system because of frequent changes in the real world is also a challenge in the area (Sharma, 2010).

2.3. Knowledge Based Systems

Now days, some of the behaviors such as problem solving, learning and understanding are handled by computer programs. Knowledge base system is a computer program that can solve and simplify the problems that is encountered in human expert by using knowledge about the application domain and problem solving techniques. Human experts use their knowledge about the domain and techniques that lead how to use the knowledge to solve problems. Computer knowledge base systems handle problems in the same way as humans do. The system represents knowledge about a specific application domain and uses one or more techniques that guide to use knowledge to solve problems (Mayer, 2004).

Knowledge based systems are a branch of artificial intelligence, which is a computer program that attempts to replicate the reasoning processes of a human expert and it can make decisions and recommendations and perform tasks based on user input. The expert`s knowledge is available when the human expert might not be and so that the knowledge can be available at all times and in many places, as necessary. Expert systems derive their input for decision making from prompts at the user interface, or from data files stored on the computer (Mahamana et al., 2003; Prasad and Vinaya, 2006 and Abu-Naser et al., 2008).

Knowledge based system makes extensive use of specialized knowledge to solve real world problems which normally would require a specialized human expert. KBS system is an intelligent computer program that uses knowledge and reasoning procedures. Designing and constructing knowledge based system involves extracting the relevant knowledge of practical problem domain during knowledge acquisition (Tomas, 2004).

According to Kesarwani & Misra (2013), a knowledge base is the collection of relevant knowledge that is stored in the computer and is organized in such a manner that it can be used for inferences, which is the reasoning process of Artificial Intelligence that takes place in the brain of an Artificial Intelligence process. It is one of the major family members of the AI group. With the availability of advanced computing facilities and other resources, attention is now turning to more and more demanding tasks, which might require intelligence (Kesarwani & Misra, 2013).

KBS consists of a Knowledge Base and a search program called Inference Engine (IE). The IE is a software program, which infers the knowledge available in the knowledge base. The knowledge base can be used as a repository of knowledge in various forms. This may include an empty Workspace to store temporary results and information/knowledge pieces/chunks. As an expert's power lies in his explanation and reasoning capabilities, the expert system's credibility also depends on the explanation and reasoning of the decision made/suggested by the system. Also, human beings have an ability to learn new things and forget the unused knowledge from their minds. Simulation of such learning is an essential component of KBS. The life of KBS may vary according to the degree of such simulation. KBS may be either manually updated (manual update) or automatically updated by machine (machine learning). Ideally, the basic frame of a KBS rarely needs to be modified. In addition to all these, there should be an appropriate User Interface, which may have the Natural Language Processing facility (Sajja & Akerkar, 2010).

Knowledge Base contains domain-specific and high-quality knowledge. Knowledge is required to exhibit intelligence. The success of any Expert System (ES) mainly depends upon the collection of highly accurate and precise knowledge. The data is collection of facts. Knowledge base is a collection of a particular field of knowledge at the level of experts in a particular format (Hartati, 2008).

Categories of knowledge

Knowledge is a set of facts designed for a special activity, procedures, and decision commonly articulated as rules. According to Jay et al. (2007) knowledge is categorized as declarative knowledge, procedural knowledge and Meta knowledge.

Declarative knowledge is a descriptive representation of knowledge. It tells about facts and is expressed in a factual statement. It is considered shallow or surface level, information that experts cab verbalize. Declarative knowledge is important in the initial stage of knowledge representation.

Procedural knowledge deals with the manner in which things work under different situations. It includes step-by-step sequences and how to types of instructions and may also include explanations. It involves automatic responses to stimuli and also tells us how to use declarative knowledge and how to make inferences. Declarative knowledge relates to a specific object. It includes information about the meaning, roles, environment, resources, activities, associations and outcomes of the object. Whereas procedural knowledge relates to the procedures used in problem-solving process for example, information about problem definition, data gathering, the solution process, evaluation criteria.

Meta knowledge is knowledge about knowledge. It is knowledge about the operation of the knowledge based system i.e. about their reasoning capabilities.

2.4. Knowledge Based System Architecture

Architecture is a blue print that helps to represent the structure of system. System architecture is a conceptual model that defines the structure and guidelines of the system. It also helps to describe set of convections, rules, tools and standards that should be incorporated in the corresponding systems. According to Sajja and Akerkar (2010), every KBS have at least five main components. These components are depicted schematically in figure 2.1 and are explained below.

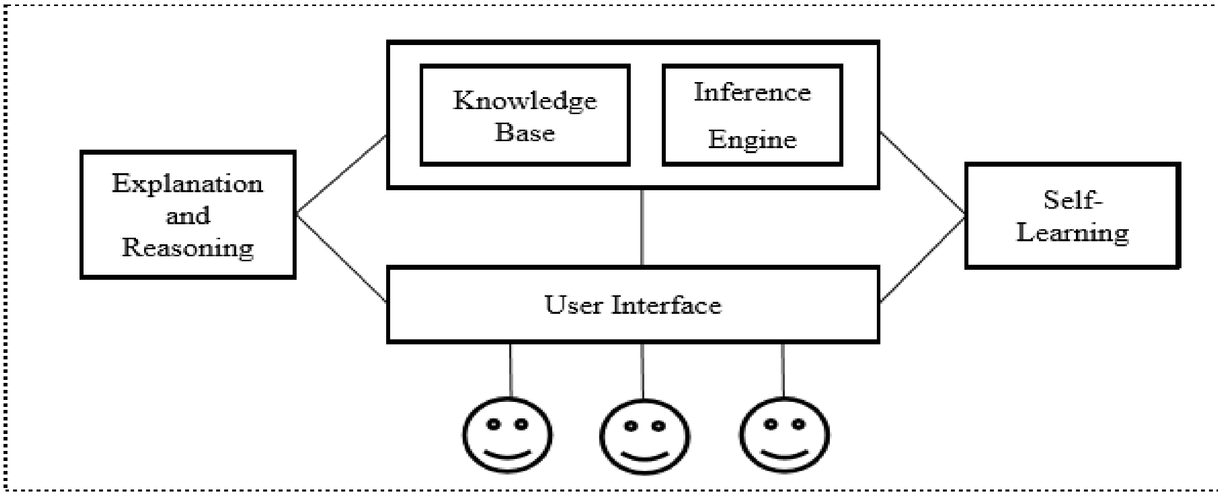


Figure 2.1: Knowledge Based System Architecture (taken from Sajja and Akerkar, 2010)

2.4.1. Knowledge Base

Knowledge base is a collection of facts, rules, and procedures organized into schemas. It is the assembly of all the information and knowledge about a specific field of interest. Knowledge base is the permanent knowledge of an expert system is stored in a knowledge base. It contains the information that the expert system uses to take decisions. This information represents expertise gained from top experts in the field. The knowledge base generally holds the knowledge which is useful for understanding, formulating and for solving problems. It is a warehouse of the domain-specific knowledge captured from the human expert during knowledge acquisition (Tripathi, 2011) and (Turban, Sharda, and Delen, 2010).

The knowledge base is the heart of knowledge based systems, which contains the problem solving knowledge of a particular application. The knowledge base stores all relevant information, data, "domain knowledge", rules of inference, cases and related factual information. It combines the knowledge of multiple human experts (Abraham, 2005) and contains the domain-specific knowledge required to solve a particular problem (Krishnamoorthy & Rajeev, 2010).

The knowledge base represents the repository of knowledge for specific and narrow domain. Usually in any knowledge base there are many facts, rules, and Meta knowledge (Owaied et al., 2010).

The knowledge base comprises specific knowledge on a certain domain that makes human an accurate expert on the specific domain. This knowledge is extracted from human expert and encoded in the knowledge base using different knowledge representation techniques. In a knowledge-based system, one of the main techniques used for representing the knowledge is rule. A rule has an IF/THEN type structure which links a certain identified information in the IF part with the concluded information in the THEN part.

2.4.2. Inference Engine

Refers to the part of knowledge based system that specifies the logical process by which new facts and belief are derived from known facts and beliefs. It also contains the control strategy that orders the search for an inferential solution. Inference engine is a generic control mechanism that applies the axiomatic knowledge in the knowledge base to the task specific data to arrive at some solution or conclusion (Azevedo & Santos, 2008).

The inference engine is the component that provides a methodology for reasoning and formulating conclusions. The inference engine provides directions about how to use the system's knowledge to solve problems. The purpose of the inference engine is to seek information and relationships from the knowledge base and to provide answers, predictions, and suggestions in the way a human expert would (Ayman Al Ahmar, 2010).

Inference is the process of chaining multiple rules together based on available data in the knowledge base. The inference engines are applicable in answering and solving complex queries in order to infer possible answers. The purpose of the inference engine is to seek information and form relationships from the knowledge base and provide answers. It matches the facts in the working memory against rules in the rule base, and it determines which rules are applicable according to the reasoning method adopted by the engine (Turban, et al., 2007).

2.4.3. Explanations/Reasoning Facility

Knowledge based system typically able to provide explanation regarding to the conclusion it makes. It is essential in all nontrivial domains to provide explanations to users to understand how the system works and determining whether its reasoning is correct or not. The explanation facility allows a user to understand how the expert system arrived at certain results (Abraham, 2005).

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 (Abraham, 2005). 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 (Krishnamoorthy & Rajeev, 2010).

2.4.4. Self-Learning

Self-learning is one of the elements of KBS which tries to imitate the learning capability of human beings. It is possible to update the knowledge base of the KBS either manually or automatically using machine learning algorithms (Sajja and Akerkar, 2010).

According to Akerkar and Sajja (2010), "Self-learning is a scientific task that enables the knowledge-based system to learn automatically from the inference process, cases executed, and environment. To carry out such tasks, one needs to have a control mechanism that discovers general conjectures and knowledge from specific data and experience, based on sound statistical and computational principles". This study develops knowledge based system that can carry out different activities such as storing or memorizing knowledge, and learn from the facts base to diagnose, prevent and manage predominant chicken disease.

2.4.5. User Interface

User interface is a component that facilitates interaction between the user and the knowledge base system. But is not considered as a part of the main knowledge base system, however, it is now widely accepted that the user interface can make a critical difference in the perceived utility of a system regardless of the system's performance (Cassandra, et al., 2007).

The user interface simulates the communications with the environment unit of the functional model of human system, which means an interaction between the users of the knowledge based system and the system itself (Owaied et al., 2010). User interface is allowing the user to input information in response to questions generated by the system. It will also be able to give advice and (very importantly) explain why it is giving that advice (Bethune, 2007).

2.5. Knowledge Based Systems Development

The development process of a KBS is similar to the development of any other software system; phases such as requirements elicitation, system analysis, system design, system development and implementation are common activities. The stages in KBS development are: business modeling, conceptual modeling, knowledge acquisition, knowledge system design and KBS implementation (Speel et al, 2001).

Mostly knowledge engineering, the process of building an expert system, involves some basic steps. The main phases of a knowledge based system development processes are planning, knowledge acquisition, knowledge representation and evaluation (Sajja & Akerkar, 2010).The knowledge of the expert(s) is stored in his mind in a very abstract way. Also every expert may not be familiar with knowledge-based systems terminology and the way to develop an intelligent system. The Knowledge Engineer (KE) is responsible person to acquire, transfer and represent the expert's knowledge in the form of computer system (Sajja & Akerkar, 2010).

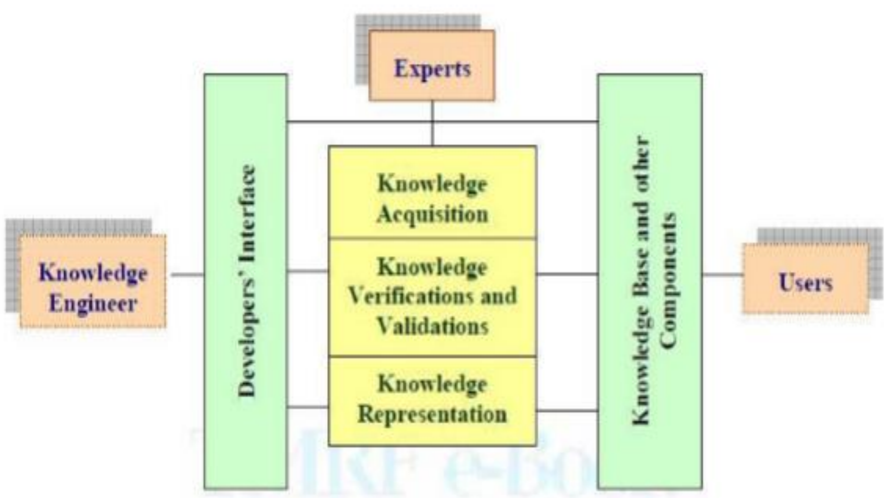


Figure 2.2: Development of a Knowledge-Based System (Sajja & Akerkar, 2010)

2.5.1. Knowledge Acquisition

Knowledge acquisition is major obstacle and time consuming when constructing knowledge based systems. It is one of the most difficult and error prone tasks that knowledge engineer does while building a knowledge based system (Rhem, 2001).

In building knowledge based system, the knowledge acquisition process incorporates typical fact finding methods like interviews, questionnaires, record reviews and observation to acquire factual and explicit knowledge. Moreover, to extract tacit knowledge which is stored in subconscious mind of experts and reflected in the mental models, insights, values, and actions of the experts techniques like concept sorting, concept mapping, and protocol analysis are being used. These are important techniques for extracting or obtaining useful knowledge from experts for developing knowledge based systems (Okafor & Osuagwu, 2006).

The extraction and formulation of knowledge derived from various sources, especially from experts and other sources of knowledge. Knowledge acquisition in knowledge based systems development involves elicitation and representation of the appropriate knowledge from its sources such as human experts, textbooks, multimedia documents, databases, different research papers and from the web in general. This is a process by which KBS developers use it to determine where in the organization the knowledge exists, how to capture and use it in the prototyping phase. Approaches of capturing knowledge takes many forms and are evolving over time. New facts and rules can be added to the knowledge base by using the knowledge acquisition sub-system (Rhem, 2002).

Knowledge acquisition includes the elicitation, collection, analysis, modeling and validation of knowledge. Some of the most important issues in knowledge acquisition are; most knowledge is in the heads of experts that experts have vast amounts of knowledge in the form of tacit knowledge; hence they do not know all that they know and use that is because tacit knowledge is hard and impossible to fully describe. Moreover, experts are very busy and valuable people, because of such reasons design and implementation of KBS is require in certain domain areas (Rusel and Norvig, 2003).

Knowledge acquiring from experts is difficult task. Some of the factors that made it difficult are listed below.

- Experts may not know how to articulate their knowledge or even may not able to do so.
- Experts may not be willing or have time scarcity
- System builders tend to gather knowledge from one source, but the relevant knowledge is distributed across several sources.
- The knowledge collected may not be complete due to builder‘s attempt to collect from documented knowledge
- Experts may not show consistent behavior when they are observed or interviewed.

2.5.1.1. Knowledge acquisition Methods

Knowledge acquisition methods can be classified into manual and computer-based. Computer can support to acquire knowledge using semi-automatic or fully-automatic means (Mohammed et al., 2010).

2.5.1.1.1. Manual Knowledge Acquisition Methods

Interview

The most frequently used form of knowledge acquisition is interviewing. This is an unambiguous technique that comes out in numerous inconsistencies. It encompasses a direct exchange of ideas between the human expert and the knowledge engineer. Information is gathered with the help of instruments such as tape recorders, questionnaires, and so on and is consequently translated, analyzed, and coded. During the interview, the expert is presented with an imitated case or, preferably, with a real problem that the KBS will be anticipated to find the solution. The expert is inquired to talk the knowledge engineer via the solution of the problem (Mohammed et al., 2010).

One variant of the interview approach starts with no information at all being given to the expert. Whatever facts the expert needs should be inquired for openly. This variant makes the expert’s path via the domain more manifest, mainly in terms of defining the input a KBS would expect. The interview process can be boring. It lays great demands on the domain expert. The expert should be able to exhibit expertise and express it. On the contrary, it needs little equipment and can generate a huge amount of information (Mohammed et al., 2010).

Observations

According to Mohammed et al (2010) observations can be seen as a special case of protocols are of two types: motor movements and eye movements. With observations of motor movements, the expert's physical performance of the task (e.g., walking, reaching, talking) is documented. With observations of eye movements, a record is made of where the expert fixes his/her stare. Observations are used mainly as a way of assisting verbal protocols. They are largely expensive and time-consuming.

Document Analysis: The final form of knowledge acquisition method is concerned with a detailed analysis of the existing document. This technique is used to collect relevant knowledge from the existed documents of different format. These documents include professional literature, manuals, guidelines, protocol medical, reports, course texts, and other relevant materials (Osuagwu, 2006).

Protocols: 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. For this method, the knowledge engineer interrupts the expert at critical points in the task to ask questions about why they performed a particular action. Therefore, in this study the researcher uses interview, document analysis, observation and protocol analysis to gather relevant information and knowledge.

2.5.1.1.2. Computer-Based Knowledge Acquisition Methods

Acquiring knowledge from experts can be supported using computer-based tools. These tools offer surroundings for knowledge engineers to identify knowledge via an interactive process (Mohammed et al., 2010).

2.5.2. Knowledge Modeling

Knowledge modeling is a cross disciplinary approach to capture and model knowledge into a reusable format for the purpose of preserving, improving, sharing, aggregating and processing knowledge to simulate intelligence (Aronson and Turban, 2007).

During the knowledge modeling phase, the specialist's knowledge (elicited by various techniques) is represented in a knowledge model. A knowledge model is a structured representation of knowledge using symbols to represent pieces of knowledge and the relationships between them. Knowledge models include symbolic character based languages such as logic, diagrammatic representations such as networks and ladders, tabular representation such as matrices and structured text such as hypertext. 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 project 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 (Emberey et al., 2007).

Decision tree are modeling tools that are used in a variety of different settings to organize and break down clusters of data decision tree is schematic tree shaped diagram used to determine a course of action and models the possible consequences of a series decisions in some situations (Lidtke and Sato, 2003).

In this work a decision tree were used to model the acquired knowledge because this modeling tool helps to select the best of several alternatives courses of action and to clarify and find an answer to a complex problem. The structure allows users to take a problem with multiple possible solutions and displays it in a simple, easy to understand format that shows the relation between different decisions (Lau & Chan, 2004 and Podgorelec et al., 2002).

2.5.3. Knowledge Representation

Knowledge Representation is the area of Artificial Intelligence (AI) concerned with how knowledge can be represented symbolically and manipulated in an automated way by reasoning programs (Brachman, 2003). It is an idea to enable an individual to determine consequences by thinking rather than acting, i.e., by reasoning about the world rather than taking action in it (Tanwar et. al., 2010).

Knowledge representation deals with formalizing and organizing the knowledge. Several knowledge representational models have been used to construct knowledge-based systems, including symbolic methods, such as simple decision trees, statistical and/or probabilistic methods, and rule-based and frame or descriptive logic based expert systems (Lifschitz, Morgenstern, and Plaisted, 2007).

2.5.3.1. Frame based Representation

A frame is a node with additional structure that facilitates differentiated relationships between objects and properties of objects. Sometimes it is called as "slot-and-filler" representation. Frames overcome the limitation of semantic network that differentiates relationships and properties of objects. Each frame represents a class (set) or an instance (an element of a class). Frames are application of object-oriented programming for expert systems. The concept of a frame is defined by a collection of slots. Each slot describes a particular attribute or operation of the frame. Slots are used to store values. A slot may contain, a default value or a pointer to another frame, a set of rules or procedure by which the slot value is obtained (Sharma & Kelkar, 2012).

Production rules: - are the most popular methods of knowledge representation. Production rules represent knowledge in the form of condition/ action pairs. A Rule is a structure which has an IF component and THEN component.

IF <condition> THEN <action>

IF condition (premise or antecedent) occurs, THEN some action (conclusion or consequence) will occur. Rules can be viewed as a simulation of the cognitive behavior of human experts.

2.5.3.2. Decision trees

Decision trees are related to decision tables and are popular in many places. They are composed of nodes representing goals and links representing decisions. The major advantage of decision trees is that they can simplify the knowledge acquisition process. Knowledge diagramming is often more natural to experts than formal representation methods (Vadera, 2005). Decision trees can easily be converted to rules. The conversion can be performed automatically by a computer program. In fact, machine learning methods are capable of extracting decision trees automatically from textual sources and converting them to rule bases. It is responsibility of the knowledge engineer to select appropriate knowledge presentation scheme that is natural, efficient, transparent, and developer friendly and the degree of familiarity of the knowledge engineer with a technique. One may think for hybrid knowledge representation strategies (Sajja and Akerkar, 2010).

According to (Rajeswari, 2012), decision trees (DTs) are modeling tools that are used in a variety of different settings to organize and break down clusters of data. Similarly, decision tree have been widely used in practical applications area, due to its interpretability and ease of use. Currently, decision trees are used in many disciplines such as medical diagnosis, cognitive science, law and computer diagnosis. Decision tree structures are the bases for the development of prototype knowledge based system.

According to Richard et al., (1999), one of the most extensively applied methods of conceptual modeling is called decision tree. Decision tree commonly acts a key role in a knowledge modeling process. Decision tree is used for the search space of a certain problem and presented by a graph. A node in the tree denotes a decision to be attained when finding a solution of a certain problem, and the branches extended from the node show the potential values of the decision. To find the solution of a certain problem, anyone then traces by way of its tree using data of a certain problem to select a branch at every node.

2.5.3.3. Semantic Networks

Semantic networks focus on the relationships between different concepts. They are graphical depictions of knowledge composed of nodes and links that show hierarchical relationships between objects (Russell and Norvig, 2002).

Semantic representation consists of 4 parts. Part one is Lexical. It tells which symbols are allowed in the representation's vocabulary. Nodes denote objects, links denote relations between objects, and link-labels denote particular relations. The second part is Structural that describes constraints on how the symbols can be arranged. Nodes are connected to each other by links. The third is Procedural which specifies the access procedures (to create, modify, answer questions). Procedures are constructor procedure, reader procedure, writer procedure and erasure procedure. The last part is Semantic that establishes the way of associating the meaning. Nodes and links denote application specific entities (Sharma & Kelkar, 2012).

2.5.3.4. Case-Based Representation

Case-Based Representation is a computer technique which combines the knowledge based support philosophy with a simulation of human reasoning when past experience is used, i.e. mentally searching for similar situations happened in the past and reusing the experience gained in those situations (Kesarwani&Misra, 2013).

According to Pal & Shiu (2004), CBR means reasoning from experiences or old cases in an effort to solve problems, critique solutions, and explaining inconsistent situations. Instead of modeling a complete domain theory, for example, by using rules, CBR exploits single situation-specific knowledge chunks called cases, which are easier available than generalized knowledge about the domain.

2.5.3.5. Rule Based Representation

Rule based representation is one of the most popular knowledge representation and reasoning methods in knowledge based systems. Their popularity stems mainly from their naturalness, which facilitates comprehension of the represented knowledge (Kerber, 2004). The basic form of a rule can be represented as follows:

if < conditions > then < conclusion > where <conditions> represents the conditions of a rule, whereas <conclusion > represents its conclusion.

In rule based knowledge representation, the knowledge is represented by symbolic rules and inference in the system is performed by a process of chaining through rules recursively, either by reverse or forward reasoning (Mohamed and Julie, 2009).

2.5.3.5.1. Rule Based Reasoning Techniques

Forward chaining

During forward chaining, the inference engines first predetermine the criterion and the next steps are to add the criterion one at a time, until the entire chain has been trained. With data driven control, facts in the system are represented in a working memory which is continually updated. Rules in the system represent possible actions to take when specified conditions hold items in the working memory. The conditions are usually patterns that must match with the items in the working memory. In forward chaining, actions usually involve adding or deleting items from the working memory. Interpreter of the inference engine controls the application of the rules, given the working memory. The system will first checks to find all the rules whose condition holds true (Nalepa, 2015). Both data driven and goal driven chaining method follows the same procedures. However, the difference lies on the inference process. The system keeps track of the current state of problem solution and looks for rules. This cycle will be repeated until no rules fire or the specified goal state is satisfied (Rajeswari, 2012). Forward chaining is a data-driven search in rule-based KBS. If the premise clauses match the situation, then the process attempts to assert the conclusion (Turban, et al, 2010). Forward chaining is data-driven approach. It starts from available information or from a basic idea, and then it tries to draw conclusions (Aronson and Turban, 2004).

Forward-chaining systems are commonly used to solve more open-ended problems of a design or planning nature such as, establishing the configuration of a complex product. It works by adding the conclusion the knowledge base until query is found and it is time taken, because it may do various works which are irrelevant to the goal.

Backward Chaining

This strategy focuses its effort by only considering rules that are applicable to the particular goal. It is similar with forward chaining the difference is it receives the problem description as a set of conclusions instead of conditions and tries to find the premises that cause the conclusion. Given a goal state and then the system try to prove if the goal matches with the initial facts. When a match is found goal is succeeded. But, if it doesn't then the inference engine start to check the next rules whose conclusions (previously referred to as actions) match with the given fact. A backward chaining system does not need to update a working memory instead it keeps track of what goal is needed to prove its main hypothesis. Goal driven control is commonly known as top-down or backward chaining (Nalepa, 2015).

This strategy focuses its effort by only considering rules that are applicable to the particular goal. It is similar with forward chaining the difference is it receives the problem description as a set of conclusions instead of conditions and tries to find the premises that cause the conclusion. Given a goal state and then the system try to prove if the goal matches with the initial facts. When a match is found goal is succeeded. But, if it doesn't then the inference engine start to check the next rules whose conclusions (previously referred to as actions) match with the given fact. Note that a backward chaining system does not need to update a working memory instead it keeps track of what goal is needed to prove its main hypothesis. Goal driven control is commonly known as top-down or backward chaining (Nalepa, 2015).

Backward chaining is a Goal-driven reasoning in which it starts from an expectation of what is going to happen (hypothesis) and then seek evidence that support your expectation (Aronson and Turban, 2004).

The choice from backward chaining and forward chaining depends on how domain experts solve the problems. If the domain experts solves a problem by first collecting data and infer a solution from this data, then it is forward chaining. But if the domain expert starts hypothetical solution and then attempts to find facts to prove the hypothesis, then it is a backward chaining (Turban, et al., 2010). Therefore in this study Backward Chaining was used.

Table 2.1: Comparison between forward and backward chaining in Rule based system (Smith, 1985)

Forward Chaining	Backward Chaining
It starts with new data	It starts with some goal or hypothesis
It asks few questions	It asks many questions
It examines all rules	It examines some rules
Slow approach	Fast approach
Gather larger information from small amount of data	It produce small amount of information from available data
It is primarily data driven	It is Goal Driven
It uses its input. It searches rules for answers	It proves the considered hypothesis
It is a form of Top - Down reasoning	It is a form of Bottom - Up reasoning
Works forward to find conclusion from facts	Works backward to find facts that support the hypothesis
It tends to breath – first	It tends to depth – first
It is suitable for problems that start from data collection	It is suitable for problems that start from hypothesis
This type of chaining is non - focused because it infers all conclusion may answer unrelated question	This type of chaining is focused to prove as only the part of knowledge base that is related to the problem
Explanation is not facilitated in Forward Chaining	Explanation is facilitated in Backward Chaining
All data is available	Data must be acquired interactively(i.e. on demand)
It deals with less number of initial states and many results	It deals with less starting goals and many facts
Forming a goal is difficult in case of Forward Chaining	Forming a goal is easy in case of Backward Chaining

Approaches to evaluate the performance of rule based reasoning system

System performance evaluation procedure tends to assess not only the technical aspects of knowledge based system but also user's satisfaction. The evaluation criteria depend up on the purposes of designed knowledge based system in the domain area. Therefore, system's evaluation process tries to evaluate whether a set of rule achieved the expected goal or not (Lech, 2000).

Knowledge based system evaluation process is vital in order to determine the suitability and desirability of the prototype (Mak, 2010). Effective knowledge based system evaluation process incorporates both technical and non-technical aspects. The technical aspects include exploring of the code, examining the correctness of reasoning techniques, checking the efficiency and performance of the system and debugging errors in the early age of a system development. The non-technical aspect includes system compatible with users' satisfaction, the easiness of the system, the quality of the user interface and the acceptability of the system in the real world environments (Seblewongel, 2011).

2.5.4. Knowledge Based System Development Tools

In the 1980s and early 1990s, when commercial interest in knowledge based system was reach at its peak, approximately there are more than 200 commercially available knowledge base system tools (Sajja & Akerkar, 2010).Many are still available but no longer described as KBS tools for marketing reasons. A knowledge base system tool is a set of computer software that manipulates programs and other information in order to design and assist the development of knowledge based systems (Kesarwani & Misra, 2013).

There are many knowledge based system tools. According to Kingston (2008) different author classified KBS development tools based on their functionality. The simplistic nature and additional feature it provides is used as parameters to select KBS development tools. Expert systems are typically written in special programming languages. The use of languages like LISP and PROLOG in the development of an expert system simplifies the coding process. The major advantage of these languages, as compared to conventional programming languages, is the simplicity of the addition, elimination, or substitution of new rules and memory management capabilities.

Prolog (programming in logic) is one of the most widely used programming languages in artificial intelligence research. As opposed to imperative languages such as C or Java (which also happens to be object-oriented) prolog is a declarative programming language. When implementing the solution to a problem we specify what the situation (rules and facts) and the goal (query) then let Prolog interpreter derive the solution. Prolog is very useful in some problem areas, such as artificial intelligence, natural language processing and databases. But it is pretty useless in others domain such as graphics or numerical algorithms (Endriss, 2007).

2.6. Advantages of Knowledge Based System

Knowledge-based systems have several advantages over human experts or natural intelligent systems. To mention some of the major advantages; knowledge-based systems provide efficient documentation of the important knowledge in a secured and reliable way. Moreover, Knowledge-based systems solve unstructured, large and complex problems in a quick and intelligent fashion and provide justification for the decision suggested and KBS offers more than one type of expert knowledge in an integrated fashion. Furthermore, knowledge-based systems are able to infer or create new knowledge and learn from cases or data instead of just referring the stored content, especially in the case of a case based reasoning (Cassandra, et al., 2007).

Knowledge based systems is more useful in many situations than the traditional computer based information systems. Abdullah et al. (2006) highlighted the following advantages of knowledge based system:

- **Time saving:** the amount of time spent on doing the work manually is reduced.
- **Quality improvement:** the quality of decision made increases because there are fewer errors than if the decision performed manually.
- **Practical knowledge made available:** knowledge based systems can assist experts in decision making even if they have that knowledge at hand; this improves the accuracy and timelines of the decision made.
- **Infallible and complete:** unless there are implementation errors, knowledge based systems will always produce the desired result as they will not leave out any rule (consideration) in the reasoning processes.

- **Replication:** human experts are scarce resources. They are physically bound to their geographical locations and can only be available at one place at a time but knowledge based system can be replicated and in effect to be transferred to any other locations to perform other task
- **Updating knowledge:** Knowledge based system can be updated easily by editing the rules base; but human expert take to retrain

2.7. Limitations of Knowledge-Based System

According to Sajja and Akerkar (2010) the following are some of the major drawbacks of using the KBS are as follows:-

Weak support of methods and heuristics: Knowledge-based systems cannot operate with their full capacity if there is no response given or the problem is out of the system's knowledge. When the heuristics is applied to look for a solution from the search space, the success of the systems relies on the quality of the heuristics. Thus, the responsibility depends on the knowledge engineer to develop the heuristics.

Development methodology: System development is not only an art but also a science. For example, in the development of information systems there is no one common accepted methodology. There are common guidelines and lifecycle models that help to develop all types of computer-based information systems. However, there is no common development model that helps knowledge engineers to develop a KBS.

Knowledge acquisition: It is a transfer of knowledge from its source into an appropriate format that can be used by the knowledge-based system. Knowledge is basically personal in nature and is therefore very challenging to extract the embedded knowledge from human mind.

Creativity and innovation: It is not possible for computer-machines to show a certain behavior as creative as humans do. Domain experts can answer back in a creative manner to new conditions though knowledge-based systems as a maximum can deal with the five basic sense organs. KBSs do not have any methodology to deal with invention, the ability to create and common sense organs. If we use AI methods in KBS, humanlike five basic sense organs can be partly applied. The vision, listening, smell, taste, and touch tasks are implemented so that they cannot totally assist activities associated to perception, emotion, and enjoyment. This is because knowledge-based systems are now reliant on symbolic input though human beings have a varied of sensory experience.

Partial self-learning: The knowledge-based systems can explain when they made a decision and learn from experience by updating its knowledge. However, the represented knowledge may not be completely known so that the knowledge-based system can learn partially from experience. Besides, domain experts can conform automatically to new conditions though KBSs should explicitly update their knowledge.

2.8. Application of Knowledge Based Systems

There are several KBS applications; broadly knowledge-based system applications can be divided into two major categories. These are, pure and applied knowledge-based systems application. Pure application includes researches contributing in knowledge-based systems and AI development techniques such as knowledge acquisition, knowledge representation, models of automated knowledge-based systems development such as knowledge engineering approaches, models and computer-aided software Engineering (CASE) tools for KBS, knowledge discovery and knowledge management types of tools (Priti and Rajendra, 2010).

The role of knowledge based system in agriculture and health sector was studied by the Bristol group identified that Knowledge Based Systems (KBS) will play greater role in health care. In particular, it seeks to identify the key clinical areas that will require computerized decision support, and examines the way in which KBS technology may prove to be the key enabling technology. There is a long tradition now in developing clinical support systems that focus on diagnostic assistance for clinicians. Faced with growing evidence both that diagnosis is only one of many problems in clinical medicine, as well as the manifest failure in the adoption of diagnostic systems into routine practice (Abdulkerim, 2013).

Now days the use of computer technology in the fields of medicine area diagnosis, treatment of illnesses and patient pursuit has highly increased. Despite the fact that these fields, in which the computers are used, have very high complexity and uncertainty and the use of intelligent systems or technology and algorithms to develop KBS such as rule based reasoning, case based reasoning fuzzy logic, artificial neural network and genetic algorithm have been developed.

Currently, KBS in medicine have received much attention, mainly because of the potential benefits that can be gained from using them. They may facilitate in increasing productivity in a medical environment, support the making of diagnoses and other types of medical decisions, assist in the training of medical professionals, and can even handle some routine tasks in a medical environment. However, some critical problems in this field have also been identified. For example, research indicated that some problems can be solved partially, but not completely, with existing artificial intelligence techniques. Another problem is that many of the existing medical information systems do not support the integration of KBS in a natural way. Furthermore, the routine use of a medical KBS is complicated by legal issues. These and other problems contribute to what we experience today: a large proportion of the medical KB applications that are developed are never actually used in practice.

Knowledge based system is essential in medical information technology for emulation of human reasoning process and human expert problem solving skills. Starting from early times, there are many medical technologies that were applied in health institution (Sasikumar et al., 2007).

Siew et al. (2005) mentioned the various tasks of the medicine domain, in which KBSs can be applied. These are generating alerts and reminders, diagnostic assistance, therapy critiquing and planning, agents for information retrieval and image recognition and interpretation.

According to Sajja and Akerkar (2010), knowledge-based systems can be used in a number of applications. The common applications are:

Advisory systems: Knowledge-based systems are preferable than any computer-based information systems for advising purposes. This is because knowledge-based systems are goal directed, have the ability to adapt to different situations, and have the capacity to justify their decisions.

Health care and medical diagnosis systems: The process of finding out the errors in a certain system or identifying the state of sickness in a living organism according to the analysis of noisy or incomplete data is called diagnosis. The interpretation of different medical reports such as dermatology reports and physicians" decisions can be verified in a simple manner with the assistance of knowledge-based systems.

Tutoring systems: The tutoring system wants to communicate with the end-user in a friendly style, recognize their status and offer a means to get the teaching modules in a cost-efficient manner. End-users can communicate with the system in their mother tongue to get the teaching modules based on their desire and request.

Control and monitoring: Monitoring is a continuous interpretation of signals and making important decisions if interference is necessary. For example, such kind of monitoring can be applied to an artificial life support system attached to a person who requires medical care after the surgical process.

Prediction: It is forecasting what will happen in the future according to the models developed on the previous and current status. For example, a knowledge-based system can forecast about the volatile market.

Planning: A plan is a program of activities that can be done to realize objectives. Such kind of a plan assists in using limited resources effectively by preparing a series of activities to be done. Activities associated with the development of software needs preparation of preparing a plan and monitoring stages. However, the knowledge-based system permits a slight change from the plan. The extent of such change without troubling the total goal is identified by the knowledge-based system.

Searching larger databases and data warehouses: It is not a simple task to look for and retrieve relevant information from huge databases. For example, specifically in the Internet the sources of information in the databases are dispersing widely. Therefore, by using the knowledge based systems the end-user can retrieve the needed information in an efficient manner.

2.9. Methods of Evaluation

According to Thomas (2014) knowledge based systems evaluation method can be split into verification, validation, assessment of human factors and assessment of correctness. These evaluation methods are discussed as follow:-

Verification: is an evaluation process that should be implemented during system design and development to answer the question "Did we build the system correctly?" Verification can be defined as the process that involves checking for compliance with the system specifications, checking for syntactic and semantic errors in the knowledge based system. Specification assessment includes user interface, explanation facility, real time performance and security provisions specified in the system design. To verify a knowledge based system, it is possible to use either a program proof or a test strategy.

Validation: The concept of validation refers to determining the correctness of the system with respect to users 'needs. Validation criteria include comparisons with known results (e.g. past cases or solved problem), comparison against expert performance, and comparison against theoretical possibilities.

Evaluation of human factors: is the process of determining the acceptability and usability of the knowledge based system. Usefulness of a system is often measured by examining user satisfaction. User satisfaction can be measured from different point of views such as content satisfaction, interface satisfaction and institutional objective. Personal aspect such as individual's dislike of computer is also taken into consideration.

Evaluation of explanations: is used to evaluate the explanation ability of knowledge based system. An explanation facility must have the ability to accept feedback from the user and provide response for the given feedback. An explanation facility must be able to offer brief description in more than one way. An explanation module should be able to answer a range of questions that a user's 'wishes to ask and not limited to those questions predicted by developers. An explication module should take into account the user's goals, the problem domain and the previous explanatory dialogue (Stranieri, 2000).

According to Stranieri (2000) explanation facility was measured based on the following criteria which used to judge the user interaction with the system:

- **Naturalness-** Explanations should be natural to the end user. Explanations that are not structured according to standard patterns of human dialogue create ambiguous information.
- **Responsiveness-** An explanation facility must have the ability to accept feedback from the user and provide response for the given feedback.
- **Flexibility-** An explanation facility must be able to offer brief description in more than one way.

- **Sensitivity-**An explication module should take into account the user's goals, the problem domain and the previous explanatory dialogue.
- **Fidelity/accuracy-** An explication system must accurately reflect the system's knowledge and reasoning.

2.10. Poultry production systems

The poultry sector in Ethiopia can be characterized into three major production systems based on some selected parameters such as breed, flock size, housing, feeding, health, technology and bio-security. These are large scale commercial poultry production system, small scale commercial poultry production system and village or backyard poultry production system (Bush, 2006).

The large-scale commercial production system is highly intensive production system which involves an average of greater or equal to 10,000 chickens kept under indoor conditions with a medium to high bio-security level. This system heavily depends on imported exotic breeds that require intensive inputs such as feed, housing, health, and modern management systems. It is estimated that this sector accounts for nearly 2% of the national poultry population. This system is characterized by higher level of productivity where poultry production is entirely market oriented to meet the large poultry demand in major cities. The existence of somehow better biosecurity practices has reduced chick mortality rates to merely 5% (Bush, 2006).

Small-scale intensive production system is characterized by medium level of feed, water and veterinary service inputs and minimal to low bio-security. Most small-scale poultry farms obtain their feed and foundation stock from large-scale commercial farms (Nzietchueng, 2008).

Village/indigenous production system is characterized by little or no inputs for housing, feeding (scavenging is the only source of diet) and health care with minimal level of bio-security, high off take rates and high level of mortality. As such, it does not involve investment beyond the cost of the foundation stock, a few handfuls of local grains and possibly simple night shades, mostly night time in the family dwellings. Mostly, indigenous chickens are kept although some hybrids and exotic breeds may be kept under this system (Dawit et al., 2008).

Poultry production will assist in poverty alleviation and the improvement of food security. The increased availability of village chickens and eggs should result in an improved intake of protein by the population and increased access to cash and other sources. They are active in pest control, provide manure, are required for special festivals and to meet social obligations, they are essential for many traditional ceremonies and traditional treatment of illness (Robyn and Spreadbrow, 2001).

2.11. Chicken Diseases and Their Causes

Chicken disease is a disease that affects chickens and disturbs daily movement/activity of chicken by injuring either internal or external part of their body. It is also any change or impairment of normal body function that affects the chickens' ability to survive, grow or reproduce. An understanding of the cause of a disease and its method of spread (transmission) will assist in controlling it.

Many factors can contribute to diseases of chickens. By being aware of their causes and how they spread. Disease can often lead to reduced performance in areas such as breeding, growth rate, feed conversion and egg production. Although there are many possible causes of disease, it is often a combination of factors that make chickens and chickens sick.

2.11.1. Infectious agents

Infectious agents are living organisms that cause disease or illness and can be spread from chicken to chicken. These include 'germs' (bacteria, viruses, and fungi), external parasites (lice and mites) and internal parasites (worms, coccidiosis, and blackhead). Infectious agents that cause disease are also referred to as pathogens.

2.11. 2. Environmental conditions

Some environmental conditions can also make chickens sick. Unlike infectious agents, the illness is not spread among chickens. When the environment affects the health of chickens it is usually because the animals are unable to adapt to the conditions. Environmental factors that can cause disease include: poisons, injury, nutritional deficiencies, poor air quality, extreme temperature, physical stress and exposure to disease carrying vermin and insects such as rodents and darkling beetles.

2.12. Chicken disease prevention and management

In the management of poultry farms, probably one of the most difficult phases is the management of the newly introduced flock. For the operation to be profitable, a good disease prevention program should be available for the newly introduced chickens to avoid any future losses. Diseases can be transmitted via humans, other birds, newly introduced chickens, or contaminated equipment. Controlling diseases from the beginning is important for the success of the operation (Mobley and Kahan, 2007).

The aim of management is to provide the conditions that ensure optimum performance of the chickens (Bell and Weaver, 2001). These methods include the following:

2.12.1. Vaccination

Vaccination is an effective means to prevent or reduce the adverse effects of specific diseases that can cause problems in a poultry flock. Vaccination involves the administration of a specific antigen to stimulate the immune system to produce homologous antibodies against viral, bacterial, and protozoal diseases. Vaccination programs should be based on the following considerations:

- Diseases prevalent in the area of operation.
- Risk of exposure.
- Immune status of parent-level stock in relation to maternal antibody transfer.
- Cost of acquisition and administration of vaccines.
- Intensity and consequences of adverse vaccine reaction.
- Flock placement programs.
- Availability of specific vaccines.
- Cost to benefit ratio associated with vaccination taking into account the risk of infection and financial losses from disease.

There are three vaccination strategies that may be appropriate in different situations (Marangon et al. 2006):

a. A routine vaccination program which may take place in areas where the disease is endemic. The aim should be to reduce the effects of the disease (including mortality) and may also contribute to eradication campaigns.

b. An emergency vaccination program is an option during introduction of an infection in previously unaffected area. This may be used to reduce the impact of the disease in that area and help prevent spread to other areas.

c. A preventive vaccination program may be applied wherever a high risk of introduction and further spread of a contagious poultry disease has been identified. Prophylactic vaccination should be applied while the risk of infection exists.

2.12.2. Isolation

Isolation is the separation of chickens with specific contagious (infectious) illness from those which are healthy and the restriction of their movement to stop the spread of a given disease.

2.12.3. Quarantine

Quarantine refers to the separation and restriction of chickens, while not ill, has been exposed to an infectious agent and therefore may become infectious. Quarantine may be used when a chicken has been exposed to a highly dangerous and infectious disease. Chicken that are purchased should be quarantined for a minimum of 2 to 3 weeks before being introduced in to the flock. Chicken that develops disease symptoms during this period should remain quarantine until it has been diagnosed and treated and found to be disease free.

2.12.4. Biosecurity

Biosecurity refers to all the management practices aimed at excluding or reducing the potential for the transmission and spread of diseases to animals, humans or an area initially free from the diseases causing agents (Halifa, 2008). It is a term coined from two words: Bio – life, and security protection, with the two main objectives of biosecurity being bio-exclusion and bio-containment (AICP, 2008; USAID, 2009).

Biosecurity is the implementation of measures that reduce the risk of the introduction and spread of disease agents. In this case chickens should be kept in a fully enclosed area, to which entry by other people is physically restricted by having only one point of access. This access point should be enterable only through a footbath containing disinfectant. Biosecurity consists of a set of management practices which, when followed, collectively reduce the potential for the transmission and spread of disease-causing organisms onto and among farms, chickens and humans.

A successful biosecurity program presumes an understanding of the principles of epidemiology and economics and requires teamwork to maximize benefits. Biosecurity programs require a structured approach involving the following sequence:

- Planning and evaluation of programs.
- Locating resources and training of personnel.
- Implementing including erection of facilities.
- Control involving review of results and analytical procedures.

The following procedures won’t stop diseases getting into farms, but they will stop them from spreading and reduce their severity:

• **Ensure all chickens are correctly vaccinated and medicated.** A suitable vaccination regimen for the diseases that occur in the area should be followed. Use and care for vaccines as directed on the label is vital. Preventative medications (for example coccidiostats) may be necessary for some conditions.

• **Have one age of chicken per farm.** Having one age of chicken per farm allows any acquired diseases to be eradicated. Make sure that incoming started pullets and day-old chickens are free of disease and that strict quarantine procedures are in place on the farm. After the batch of chickens is sold, clean the sheds and equipment thoroughly and allow 2 weeks (the depopulation period) before bringing in the next batch.

• **Use all-in all-out sheds.** If it is not practical to have only one age of chicken on the farm, reduce the number of age groups to a minimum. If there are fewer age groups than sheds (for example if a given farm have four sheds and three age groups), it is good to have the same age group in the sheds that are closest together. Egg packers and other workers should preferably be allocated specific sheds to work in. If this is not possible and they have to go into all the sheds, the general direction of movement should be from the youngest chickens to the oldest chickens.

• **Dispose of dead chickens properly.** Dead chickens should be quickly burnt, deeply buried or effectively composted and should never be fed to cats or dogs. Dead chickens left lying around the farm can spread disease to other sheds and neighboring farms via carrion-eating birds, dogs, cats and rats.

• **Recapture escaped chickens**. Recapture escaped chickens quickly. If a chicken has been free for an undetermined length of time and has got out of the shed, it should not be returned to the main flock. The chicken-proofing recommended to stop wild birds getting into the sheds will also stop escaped chickens from getting out.

• **Inspect your farm daily.** Finally, inspect the sheds daily so that any problems can be identified early and rectified quickly. This will minimize the degree of disease challenge.

2.12.5. Culling

Culling chicken refers to the identification and removal of the infected chickens from a flock. It is about removing any chickens which have a permanent genetic or injury-produced deformity such as crossed beak, slipped wing, one or both eyes blind, or any leg deformity that can interfere with the chicken ability to mate or to reach feed, water, or the laying nest. It is most economical to remove these chickens from the flock. Sick or unthrifty chicken will often have short, narrow, emaciated bodies and appear listless or droopy. Small, pale combs and wattles generally indicate chronic poor health. Thus, it is advisable to remove these chickens from the flock as soon as possible to avoid disease problems that may spread to the flock.

2.13. Related Works

There are some related works on knowledge base system (expert system) in the area of diagnosis, prevention and management of poultry diseases.

Thammi and Sudhakar (2006) presented a research work titled "An Information Technology Enabled Poultry Expert System: Perception of Veterinarian and Veterinary Students, University, India". The major aim of the study was not to carry out diagnosis but rather to collect relevant information from students and veterinarians of the institution on the effectiveness of using expert system for diagnosis and management of poultry diseases.

Butcher et al., (2012) identified different types of diseases with their symptoms and also suggested different methods of treating such diseases. Some preventive measures were also mentioned by the authors. This system is not restricted to poultry diseases and it is not an automated system. The new system focuses on chicken and also uses rules to identify the disease type.

Andino and Mahmud (2012) developed poultry disease warning system using Dempster-Shafer theory and web mapping. Obviously, the method used is more of statistics and geographical information system. The principle adopted looks different from that of expert system. It was built to visualize map so as to identify the existence of poultry disease in a region by the district, regencies or municipalities.

Andino and Hassan (2012) present a research work titled “Avian Influenza Expert System using Dempter-Shafer. The system was able to identify Avian Influenza disease and display the result of identification process. The system only made use of basic probability assignments of symptoms and not expert system approach to build the knowledge base. The system was also restricted to Avian Influenza as the only type of disease and other common poultry diseases were not considered. The new system focuses on different disease such as bacterial, viral, fungal and protozoal.

Arowolo, et al., (2012) developed an expert system for management of poultry disease using visual prolog 7.3. The work laid emphasis on management of the poultry disease and it was developed for the use of poultry farmers. The weakness of this system is that it did not actually define enough rules for sufficient diagnosis of the diseases. Additionally, the system does not learn from experience to update its knowledge. The current work is also different from Arowolo, et al., (2012) since it focuses on the diagnosis, prevention and management of predominant chicken diseases and enough rules are used for each disease to identify the diseases. Additionally the current work updates its knowledge and learns from experience.

“Animal knowledge based system” was also developed by Maryam and Alaa (2013). The article present different methodologies of developing knowledge base system and developed an animal knowledge base system. The system was not particular about poultry diseases. The new system focuses on poultry particularly on chickens. Additionally, the new system updates its knowledge and learns from experience.

Puja Putri Abdullah in 2016 has done research on Expert System to Diagnose Chicken Diseases with Certainty Factor Based on Android. This study uses a calculation method called Certainty Factor and the study is limited to diseases caused by bacteria (bacterial disease). But the current work is different from Puja Putri Abdullah (2016) since it uses prolog programming language. The current work dealt specifically on chickens and prevention issues are discussed deeply because of chickens diseases are uncured since they are caused by virus and fungus and also the life span of the chickens are short that's why this study focus on diagnosis, prevention and management of predominant chicken disease. The new system learns from experience and updates its knowledge. Thus, in this study an attempt is made to design a learning KBS that can update its knowledge through experience. Additionally, enough rules are used to identify the type of diseases.

Based on the review of literature, it is clear that each of the existing system have one weakness or the other. This research work is expected to come up with a better system that save the knowledge base, update the knowledge and learns from experience by memorization (self-learning). Again, Most of the existing systems were not evaluated. In the very few ones that were evaluated, experts in the field were not directly involved. The new system comes up with better evaluation method that involves expert from the field. This help to really determine the actual performance of the system by the users. This study also focuses on diagnosis of chicken disease and also prevention and management of predominant chicken diseases were deeply discussed because since chicken diseases are caused by virus /fungus and the life span of chicken is too short. Additionally, most of the existing systems were done on poultry but they were not done specifically on chickens. This study specifically done on chickens and enough rules were used for each disease.

CHAPTER THREE

KNOWLEDGE ACQUISITION, MODELING AND REPRESENTATION

3.1. Knowledge Acquisition

Knowledge Acquisition (KA) is the process of acquiring relevant knowledge from domain experts and other sources of information such as books, databases, guidelines, manuals, journal articles, computer files, etc. KA is the process of eliciting, structuring and representing (formalizing) domain knowledge acquired from different sources. The acquired knowledge can be specific to the problem domain, it can be general or it is meta-knowledge (knowledge about knowledge). Knowledge acquisition is the first step and critical task in the development of KBS (Sagheb, 2009). In this study, the knowledge required to build a KBS acquired from both tacit and explicit sources of knowledge. Tacit knowledge is collected from six experts in the domain area by using structured and unstructured interviews. Domain experts were chosen purposefully for detail discussion using structured and unstructured interviews to understand the domain knowledge. These experts are essentially taking part during the study and asked to verify the rightness of the acquired knowledge. Moreover, explicit source of knowledge is collected from the Internet, manuals, research papers and journal articles

According to (Sajja & Akerkar, 2010), the knowledge acquisition process incorporates typical fact finding methods like interviews, questionnaires, record reviews and observation to acquire facts and explicit knowledge. Tacit knowledge which is stored in the subconscious mind of experts and reflected in the mental models, insights, values, and actions of the experts were extracted by using techniques like protocol analysis (documentation of the expert's stepwise information-processing and decision-making behavior) (Sajja & Akerkar, 2010).

The objective of KA is to gather the required knowledge, interpreting the acquired knowledge, analyzing and validating the knowledge content. Based on the acquired knowledge, the KBS was designed using decision tree model. Therefore, knowledge acquisition process of this thesis was based on domain expert interviewing, observing and reviewing of related documents.

In this study to acquire knowledge unstructured interview technique was used. Unstructured interview is an interview with open-ended questions. It is more flexible than structured one because the interviewer has the chance to change the order of questions according to the context of response. Unstructured interview is a kind of interview that is not pre-determined. It depends on the interaction of the researcher and domain expert. Since one of the main focuses of this research is eliciting relevant tacit knowledge from the domain experts, domain experts were selected from each case teams as per information acquired from the department head of Veterinary Medicine and animal science based on their educational qualification, area, role and year of experience by applying purposive sampling technique.

In this chapter, the knowledge engineer collects chicken disease cases and models it by using decision tree structure. These aid to develop the prototype using rule-based reasoning. The study explores the applicability of rule-based reasoning in health and veterinary medicine particularly for diagnosis, prevention and management of predominant chicken diseases. The knowledge for this study is acquired from domain experts by using interviewing and critiquing knowledge elicitation methods and from relevant documents by using documents analysis technique which has been employed to purify the acquired knowledge.

Interviewing Domain Experts

In this study, to acquire the needed knowledge, both primary (tacit knowledge) and secondary sources of knowledge were used. Based on this information the researcher gets to sampled experts to have knowledge for the system. Primary knowledge gathered from experts in the domain area. Due to this, the researcher purposely selected 1 professor, 3 senior doctors from Veterinary Medicine according to their educational qualification, area, role and year of experience they have on chicken disease. Additionally, the researcher selected 2 experts from animal science department according to their educational qualification, area, role and year of experience they have on chicken disease they have on chicken disease. These two experts additionally work in the Kito Furdisa Poultry Farm.

During the interview phase, the main challenge was willingness of the experts to share their expertise and experience, which is important to acquire the relevant knowledge. The researcher have tried to convince the domain experts on the advantage of the research for the predominant chicken disease diagnosis, prevention and management KBS and on which data that the researcher want to collect. The interview with the experts covered issues such as what are the tasks that are performed in disease identification using symptoms, how the experts identify the disease, what are techniques used to identify the pillar symptoms of the chicken diseases, what are the major identified symptoms of selected diseases, how to identify the degree of the symptoms that have been identified on the diseases and compare them. In this discussion the experts tried to reflect on the questions prepared for them and the researcher tried to acquire the relevant tacit knowledge which is significant to represent the symptoms of the diseases as an input. During face to face communication, the acquired knowledge from domain experts has been recorded manually by using pen and paper sheet.

Table 3.1: Profile of experts interviewed

No	**Educational qualification**	**Area**	**Role**	**Year of Experience**	**Willingness to participate**
1	Professor	Professor	School of Veterinary Medicine Head	20	Yes
2	Doctor of Veterinary Medicine	Doctor of Veterinary Medicine(Dr.)	Lecturer	14	Yes
3	Doctor of Veterinary Medicine	Doctor of Veterinary Medicine(Dr.)	Coordinator	12	Yes
4	Doctor of Veterinary Medicine	Doctor of Veterinary Medicine (Dr.)	Lecturer	9	Yes
5	MSc.	Animal Science	Lecturer (Animal Science)	7	Yes
6	BSc.	Expert in Animal Science	Expert and Coordinator (Animal Science)	4	Yes

3.2. Steps in Knowledge Acquisition

According to Jones (2012), there are two main steps in knowledge acquisition process that are accomplished by the knowledge engineer so as to develop KBS. These are knowledge elicitation and knowledge structuring. Tacit knowledge is collected from six experts in the domain area from JUCAVM and Kito Furdisa Poultry Farm (KFPM). These experts are essentially taking part during the study and asked to verify the rightness of the acquired knowledge. Moreover, explicit source of knowledge has been collected from the poultry disease manuals, books and journal articles.

3.2.1. Knowledge Elicitation

It involves extracting knowledge from human experts, and/or written documents to build a KBS. In this study, the knowledge required to build a KBS was elicited from both tacit and explicit sources of knowledge.

Knowledge elicitation methods can be classified in many ways. Direct and indirect elicitation methods are the most common ways of knowledge elicitation. This shows how the knowledge engineers obtain information and knowledge from domain experts. Direct questioning of the domain experts on how they are doing their job and how they can succeed is called direct elicitation, whereas in the indirect elicitation method the required information from domain expert is not requested directly but can be elicited by analyzing the session to extract the required information (Shadrick et al, 2005).

Prior to the in-depth key informant interview, informal communication and observations has been held with the Veterinary Medicine Doctors and Farm Managers to be familiar with chicken diseases identification. Then in-depth interview has been conducted to acquire knowledge about how chicken diseases are identified and basic characteristics keys or features used for the identification process and checklist of the question raised during interview are attached in Appendix A.

3.2.2. Knowledge Structuring

The knowledge elicited from its source (as a form of tacit or explicit) is structured and modeled in an appropriate manner using appropriate tool. Knowledge structured and modeled using the appropriate structuring method and models is a one step forward for knowledge codification. The knowledge used for building of the KBS in this study focused on knowledge regarding the diagnosis, prevention and management of predominant chicken disease.

3.3. Knowledge on the predominant chicken disease

3.3.1. Newcastle Disease

Newcastle disease (NCD) is a contagious viral disease of poultry caused by a *Paramyxovirus.* For this disease, three strains exist: *the velogenic strains,* which are highly pathogenic and easily transmitted; the mesogenic strains, which show intermediate pathogenicity; and the lentogenic strains, which show low pathogenicity in chickens. The disease was reported in Ethiopia in 1974 from exotic chicken. Since then, NCD has become cosmopolitan.

The domain experts have identified the following symptoms which are shown on chicken which are affected with Newcastle Disease. Moreover, the reviewed document for the purpose confirms the presence of these symptoms. These symptoms are Torticollis (twisting of neck), severe tracheitis, pulmonary congestion, mild conjunctivitis, Rales (abnormal breathing sound), Sneezing, Swollen Eye and Fever.

Diagnosis

Tentative diagnosis of a rapidly spreading, respiratory-nervous disease may be confirmed by isolation of the hemagglutinating virus identified by inhibition with Newcastle disease antiserum. A rise in hemagglutination-inhibition antibodies in paired serum samples is confirmatory.

Prevention/control

Good sanitation and implementation of a comprehensive biosecurity program are necessary to prevent Newcastle Disease. Well-designed vaccination schedules, using low-virulence live vaccines, give very effective immunization results. Inactivated oil-emulsion vaccines administered to the parent flock before onset of egg dropping ensure passive immunity in day-old chicks. Sick chickens should be culled, and carcasses burnt or buried deep enough so that scavenging animals, such as dogs, cannot dig them up. Healthy chickens should be isolated and closely monitored for signs of disease.

Additionally, pest control in flocks, control of access to poultry farms and proper carcass disposal are also used to prevent and control Newcastle Disease.

3.3.2. Fowl Cholera

Fowl cholera, (*Avian Pasteurellosis*or avianhemorrhagic *septicemia)* is a contagious bacterial disease of poultry characterized by septicaemia, sudden onset with high morbidity and mortality; chronic and asymptomatic infections may also occur. It is caused by *Pasteurella multocida* and commonly reporter in commercial flock in Ethiopia. Transmission occurs by secretions from carrier birds, infected droppings, cannibalism of dead birds, and contaminated water, feed, equipment, or clothing. The organism is primarily excreted from mouth, nose, and conjunctiva of diseased birds that contaminate their environment.

Chicken with Fowl cholera may develop the following symptoms as the domain experts have been suggested. This was again cross checked with the explicit knowledge collected from the reviewed documents. The symptoms are Bluish combs and wattles, Abscessed wattles, Swollen joints, Anorexia, Foot pads, Ruffled Feather, Coughing, Fever, Labored breathing and Ocular Discharge.

Prevention and control

Treatment with appropriate antibiotics or chemotherapeutics can be successful in halting mortality and restoring egg production. However chronic carrier chickens have been found in flocks of chickens after treatment. If clinical fowl cholera with mortality reappears in such flocks, one must treat again. Rodent control is also very important to prevent reintroduction of the infection. Vaccines both inactivated bacterins as well as live vaccines are available.

3.3.3. Infectious Coryza

Infectious coryza is an acute respiratory disease of chickens caused by the bacterium *Haemophilus paragallinarum* [gallinarum]. Chronically ill or healthy carrier chickens are the reservoir of infection. Transmission is by direct contact, airborne droplets, and by contamination of drinking water. The disease may be complicated with *Mycoplasma gallisepticum* concurrent infection.

The following symptoms are reflected on the chicken with Infectious Coryza. These are Unilateral or bilateral ocular discharge, chronic sinusitis, Nose with foul-smelling discharges, Conjunctivitis, Wheezing, Mucoid Discharge, Facial Edema, Eye Inflammation and Swollen Wattle.

Diagnosis

History, signs including swelling of the face and wattles and lesion are suggestive; after inoculation of susceptible chickens, typical signs of nasal exudate are diagnostically reliable. Isolation and examination of Gram stained smear from sinus exudates are confirmatory.

Haemophilus paragallinarum can be isolated from sinus swabs in acutely affected chickens. Since the organism is susceptible to desiccation it is recommended that acutely infected live chickens should be submitted to a diagnostic laboratory whenever possible. Alternatively, severed heads packed on ice can be forwarded to a laboratory. Isolation involves semiaerobic culture on a blood agar medium streaked with *Staphylococcus sp.* incubated in a candle jar.

Prevention

Appropriate biosecurity measures will limit the possibility of introducing infection on to breeding and commercial egg production farms. Immature flocks can be partly protected by administration of inactivated multivalent or homologous bacterins in aqueous suspension or oil emulsion. Two doses of inactivated vaccine should be administered by the subcutaneous or intramuscular route at four week intervals during the rearing period.

Good management and sanitation are the best ways to avoid infectious coryza. Most outbreaks occur as a result of mixing flocks. All replacement birds on "coryza-endemic" farms should be vaccinated. The vaccine (Coryza-Vac) is administered subcutaneously on the back of the neck.

3.3.4. Marek's Disease

It is a viral-induced-neoplastic disease of chickens characterized by infiltration of the peripheral nerve, brain, and other organs by lymphoid cells. Young chicken are mainly affected. Transmission occurs by inhalation of virus laden feather follicle or from excretion. Marek's disease affects commercial chicken flocks from approximately 5 to 35 weeks of age in all parts of the world.

Chickens become infected with Marek's Disease by inhaling virus-laden dander. While the virus is easily killed in its purified form, the virus can live for years in the dander. This means that once the disease enters a coop, the environment will most likely be contaminated for a very long time (months to years) even if all chickens are gone.

Chickens which are affected with Marek's Disease have various symptoms. These symptom are Paralysis, Incoordination (kidney, eye, proventriculus, Ovary or other organs may be affected)**,** Emaciation, Weight loss**,** Paleness, Vision Impairment (blindness), Lameness, Skin Change**,** Depression, Greenish, diarrhea.

Diagnosis

The gross appearance of neural lesions is generally diagnostic. Histological examination of nerve and visceral lesions will show characteristic lymphocytic proliferation. The condition should be differentiated from botulism and from "transient paralysis", an emerging condition of unknown etiology, but suspected to be an autoimmune response to vaccination in specific strains of commercial laying hens.

The causal virus may be isolated and identified by submitting tissues to a suitably equipped laboratory using specific tissue culture techniques.

Prevention

There is no treatment for Marek's disease. Preventive strategies include vaccination at hatchery. Affected chickens should be culled to prevent transmission to other chickens. A range of mainly live attenuated vaccines are usually delivered via spray in commercial hatcheries. While the vaccination prevents tumor formation, it does not prevent infection by the virus.

3.3.5. Coccidiosis

Coccidiosis is a disease caused by infection with one or more species of coccidian; with subdivision protozoa and family Eimeridia. Coccidia are intracellular protozoon parasites, which with few exceptions parasitize the intestinal tract of their host. *Eimeridae coccidian* have a number of genera but, five of them are the most economical important group of protozoan in domestic animals. From these the great majority of the parasites known as coccidian belong to the genus *Eimeria* (Conway and McKenzie, 2007).

It is one of the economical important groups of protozoan in domestic animals. Chickens are the natural host of nine Eimeria. Among which six species namely *Eimeria tenella*, *Eimeria acervulina, Eimeria necatrix*, *Eimeria maxima*, *Eimeria mivati*, *Eimeria brunette* produces moderate to severe intestinal or cecal lesions. *Eimeria mitis Eimeria hangani* and *Eimeria praecox* do not cause significant lesions (Gari *et al.*, 2008).

The domain experts identified the following symptoms which are shown on chicken infected by Coccidiosis**.** These symptoms are Bloody droppings**,** Pale comb, and Pin point hemorrhage in serosal surface of caecum, ruffled plumage**,** Shriveled comb**,** Listless and Unthriftiness.

Prevention

The disease can be prevented by regular and careful cleaning of troughs and chicken houses. And by not keeping too many chickens together; avoid different age groups of chickens in the same house as the disease may spread from adults to young chicks. Cleaning of drinkers and feeders with soap, prevent moist conditions in and around the chicken house and their daily shelter.

3.3.6. Aspergillosis

Aspergillosis is a Mycotic disease affecting many species of chickens. It is caused by several species of the genus *Aspergillus spp. Aspergillus fumigatus* is the most important and frequent one implicated in cases of aspergillosis in poultry (Charlton et al., 2008). Alike most of fungal species, it is an opportunistic pathogen, causing disease in immune compromised chickens or in chickens exposed to overwhelming numbers of fungal spores (Arné et al., 2011 ; Umar et al., 2015; Copetti et al., 2015).

Aspergillosis is a non-contagious fungal disease of avian species comprising of chickens. It usually is a disease of lower respiratory system occurring in immuno compromised birds or when they are exposed to large number of spores and stress being one of the main predisposing factors responsible for development of disease (Saif, et al., 1999).

Chicken with Aspergillosis may develop the following symptoms as the domain experts suggested. The identified symptoms are Labored breathing (Gasping), Yellow to green nodules are observed in the lungs and air sacs and occasionally in other organs including the brain and eye, Yellow-white pin head, Bluish-purple discoloration of face , Paralysis (disinclined to move, incoordination and coarse muscle tremors), Dyspnea, hyperpnea, anorexia and Emaciation.

Prevention

There is no treatment for aspergillosis. Affected chickens should be removed and destroyed. Strict hygiene in breeder and hatchery management is necessary. Choice of litter material is important so that no spore-bearing wood shavings are used.

It is important to thoroughly clean and disinfect the brooding area between broods. Using clean litter and preferably soft wood shavings are very important. Do not use sawdust, litter high in bark content, or shavings that have been wet. Move feeders and waterers periodically.

Improving nest-box hygiene, increasing the frequency of collection of eggs to four times daily and where possible, substituting plastic nest pads for litter will reduce the prevalence of aspergillosis. Decontamination of eggs by formalin fumigation or phenolic disinfectants is advised, but eggs should not be washed by immersion. Decontamination of setters, hatchers, and air ducts is recommended including the use of aerosol generators and medicated "candles." The efficacy of cleaning procedures can be monitored, using an appropriate microbiological detection procedure such as an air sampler or exposed petri-plate.

3.3.7. Favus

Favus is caused by a fungus *(Lo- phophyton gallinae) (Achorion gallinae)* that attacks especially the wattles and comb, but may spread to other portions of the body. When the crusts are removed the skin appears irritated and some- what raw. If the feathered portions become affected the feathers become dry, erect, and brittle and finally break off or fall out, leaving a disk-shaped scale with a depression at the bottom where the feather was located. The affected parts appear white, as though covered with powder. The disease often spreads rapidly.

Favus arises through the invasion of the skin by the fungi. Lesions first develop on the comb and then often spread to produce white spots, giving the appearance of sprinkled flour. As the disease spreads concentrically, the white spots begin to scale off to give an appearance of a wrinkled crust. The fungus may spread to the feathered regions. When this happens, the feathers fall out in patches and thickened, crusty skin develops around the feather follicles. This can develop as depressions and are often referred to as “fvus cups”. Bradley and colleagues describe the appearance of white plaques on the comb, face, and/or ear lobes followed by feather loss starting at the caudal base of the comb and progressing down the neck in chickens infected with *M. gallinae* (Bradley et al., 1998).

Chickens which are affected with favus show the following Symptom. These are fall of feather, Anemia, Cachexia, Icterus and Depression.

Prevention

Biosecurity precautions should be implemented to avoid introducing infected chickens to the flock. Transport crates and other equipment should be thoroughly decontaminated and disinfected to prevent lateral transmission of the agent.

After removing as much of the scale as possible with warm water or glycerine and gently scraping with some blunt instrument, apply tincture of iodine. Early stages of the disease often respond favor- ably to an application of lard or oil, or to a salve made by mixing about equal parts of lard and sulphur.

The condition normally only affects individuals within a flock, and spreads very slowly, by physical contact. Contamination of housing can occur, and so disinfection and the removal of infected individuals are important control measures. Avoid predisposing factor and care should be noticed.

3.3.8. Chicken Mite (Red Mite)

Blood sucking mite “*Dermanyssus gallinae*” is a disease that parasitizes chickens, Red mites are obligatory but temporary nocturnal blood feeders, they visit their hosts at night and after engorging blood for 30 to 60 minutes return to their hiding places.

The domain experts identified the following symptoms which are shown on chicken infected by Chicken Mite**.** These symptoms include Blood loss leading to anemia**,** Irritation and stress due to disturbed sleep**,** Sabs on legs and feet, Blood spots on eggs resulting in egg downgrading**,** Higher infestations lead to lowered egg production, Dark spot in the cage near streams and Hens are agitated.

Prevention and Control

Chicken mite diseases have been controlled by using different methods. These methods are, Poultry house hygiene, whole flock replacement rather than partial culling, Cleaning thoroughly after removing previous flock, Avoid bringing in new mites: via egg cases, egg trays, egg containers, transport equipment, passive transmission by people, vaccination crew, rodents or wild birds, Accurate identification is the key to control this parasite**,** Contact an entomologist for help in identifying them and Use pesticides to control chicken mite as wettable powder or an emulsion spray.

3.4. Knowledge Representation

Knowledge representation is the method used to encode knowledge in an intelligent system's knowledge base. The objective of knowledge representation is to express knowledge in computer tractable form, such that it can be used to help intelligent system perform well. The function of any representation scheme is to capture essential features of a problem domain and make that information available to a problem solving procedure.

After the knowledge is acquired, it is represented using rule based knowledge representation method. For this research, the knowledge representation method, rule based is chosen; because, it clearly demonstrates the domain knowledge. In a rule based system, much of the knowledge is represented as rules, that is, as conditional sentences relating statements of facts with one another. As a result, rule based representation method is more appropriate to represent and demonstrate the real domain knowledge .

The reason why rule based reasoning is chosen is that this method is common one and it can be satisfyingly powerful from the perspective of building useful applications. Moreover, the experience and knowledge of domain experts are captured in the form of IF-THEN rules (Siew et al., 2005).

General Chicken Disease Diagnosis Steps

- History Taking
  - Past History
  - Immediate History (Present History)
  - Environmental and management History
- Identifying Clinical Sign and
- Differential Diagnosis
- Post mortem finding
- Confirmatory Diagnosis
- Treatment

Rules for Chicken disease diagnosis system

Rule 1:

IF

Chicken have torticollis (twisting of neck),

AND severe tracheitis,

AND pulmonary congestion,

AND Mild conjunctivitis,

AND Rales (abnormal breathing sound),

AND Nervous Sign,

AND Sneezing,

AND Swollen Eye

AND Fever.

THEN

The disease is Newcastle Disease.

Rule 2:

IF

Chicken have bluish combs and wattles,

AND abscessed wattles,

AND Swollen joints,

AND Anorexia.

AND Foot pads,

AND Ruffled Feather,

AND Coughing, Fever,

AND labored breathing,

AND Ocular Discharge.

THEN

The disease is Fowl Cholera.

Rule 3:

IF

Chicken have unilateral or bilateral ocular discharge,

AND chronic sinusitis,

AND nose with foul-smelling discharges,

AND conjunctivitis,

AND wheezing

AND Mucoid Discharge,

AND Facial Edema,

AND Eye Inflammation,

AND Swollen Wattle

AND Reduced Feed.

THEN

The disease is Infectious Coryza.

Rule 4:

IF

Chicken have paralysis,

AND Incoordination (kidney, eye, proventriculus, Ovary or other organs may be affected),

AND Emaciation,

AND weight loss,

AND Paleness,

Vision Impairment (blindness),

AND Lameness,

AND Depression,

AND Greenish diarrhea.

THEN

The disease is Marek's Disease.

Rule 5:

IF

Chicken have bloody droppings,

AND pale comb,

AND pin point hemorrhage in serosal surface of caecum, AND ruffled plumage,

AND shriveled comb,

AND listless,

AND unthriftiness.

THEN

The disease is Coccidiosis.

Rule 6:

IF

Chicken have labored breathing (Gasping),

AND yellow to green nodules are observed in the lungs and air sacs and occasionally in other organs including the brain and eye,

AND Yellow-white pin head,

AND Bluish-purple discoloration of face,

AND Paralysis (disinclined to move, incoordination and coarse muscle tremors),

AND Dyspnea, hyperpnea, anorexia,

AND emaciation.

THEN

The disease is Aspergillosis

Rule 7:

IF

Chicken have anaemia,

AND Scabs on legs and feet

AND Agitation

AND Loss of appetite,

AND Stress,

AND Higher infestations

THEN

The disease is Chicken Mite.

Rule 8:

IF

Chicken have Cachexia

AND Skin Change

AND Icterus

AND Emaciation

AND Depression

THEN

The disease is Favus.

Rule 9:

IF

Chicken have no torticollis

AND bluish combs and wattles,

AND abscessed wattles,

AND Swollen joints,

AND Anorexia.

AND Foot pads,

AND Ruffled Feather,

AND Coughing, Fever,

AND labored breathing,

AND Ocular Discharge.

THEN

The disease is Fowl Cholera.

Rule 10:

IF

Chicken have no bluish combs and wattles

AND unilateral or bilateral ocular discharge,

AND chronic sinusitis,

AND nose with foul-smelling discharges,

AND conjunctivitis,

AND wheezing

AND Mucoid Discharge,

AND Facial Edema,

AND Eye Inflammation,

AND Swollen Wattle.

THEN

The disease is Infectious Coryza.

Rule 11:

IF

Chicken have no ocular discharge

AND paralysis,

AND Incoordination (kidney, eye, proventriculus, Ovary or other organs may be affected), AND Emaciation,

AND Paleness,

AND Vision Impairment (blindness),

AND Lameness,

AND Skin Change,

AND Depression,

AND Greenish diarrhea.

THEN

The disease is Marek’s Disease.

Rule 12:

IF

Chicken have no paralysis

AND bloody droppings,

AND pale comb,

AND pin point hemorrhage in serosal surface of caecum,

AND ruffled plumage,

AND shriveled comb,

AND listless,

AND unthriftiness.

THEN

The disease is Coccidiosis.

Rule 13:

IF

Chicken have no bloody droppings

AND labored breathing (Gasping),

AND yellow to green nodules are observed in the lungs and air sacs and occasionally in other organs including the brain and eye,

AND Yellow-white pin head,

AND Bluish-purple discoloration of face,

AND Paralysis (disinclined to move, incoordination and coarse muscle tremors),

AND Dyspnea, hyperpnea, anorexia,

AND Emaciation.

THEN

The disease is Aspergillosis

Rule 14:

IF

Chicken have no labored breathing (Gasping),

AND Anaemia
AND Scabs on legs and feet
AND Agitation

AND Loss of appetite,

AND Stress

AND Higher infestations

THEN

The disease is Chicken Mite.

Rule 15:

IF

Chicken have no Anaemia

AND Cachexia

AND Skin Change

AND Icterus

AND Emaciation

AND Depression

THEN

The disease is Favus.

ELSE

Sorry we may not be able to diagnosis the disease.

3.5. Knowledge Modeling

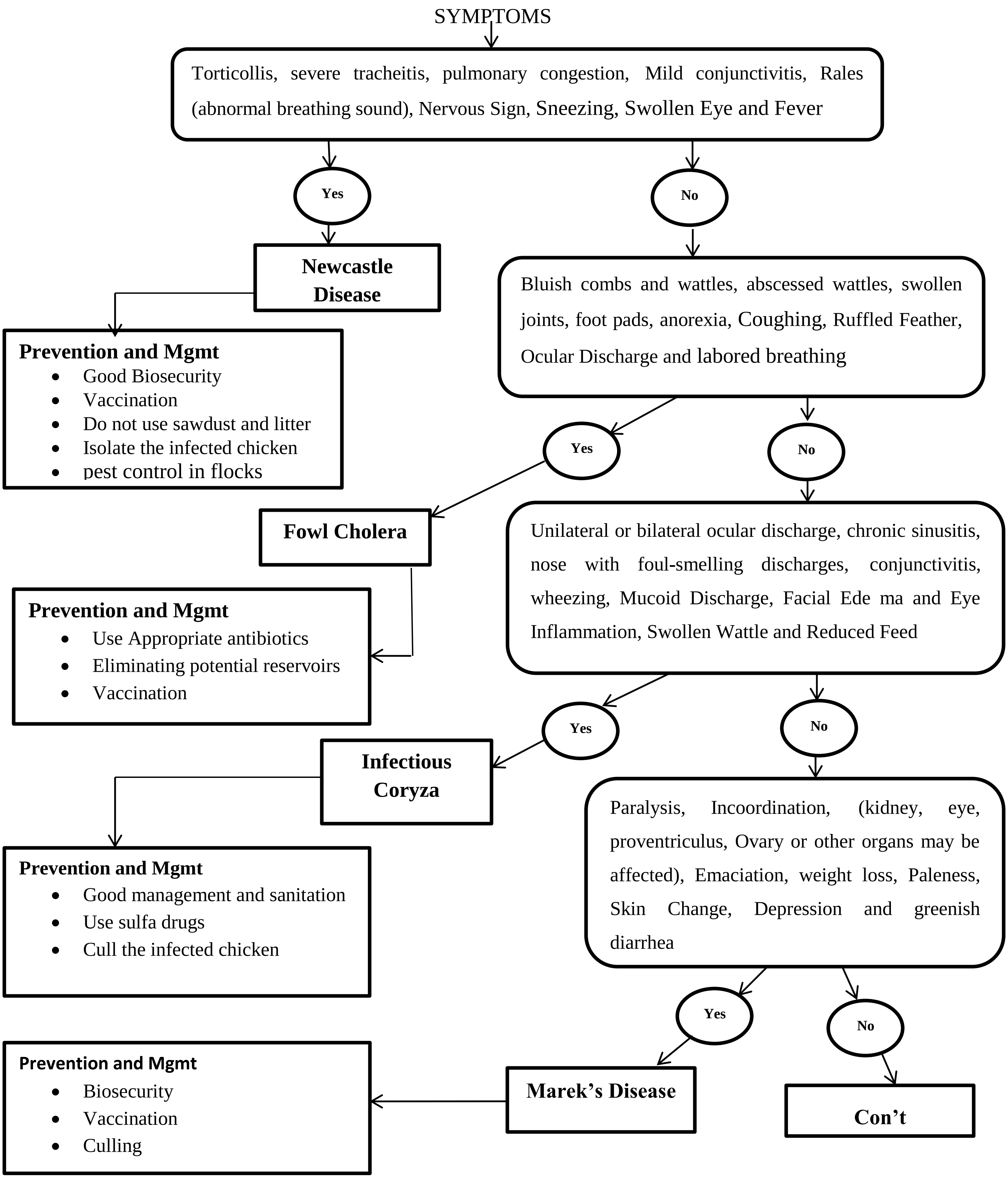
Knowledge modeling is a cross disciplinary approach to capture and model knowledge into a reusable format for the purpose of preserving, improving, sharing, aggregating and processing knowledge to simulate intelligence (Aronson and Turban, 2007).

During the knowledge modeling phase, the specialist's knowledge (elicited by various techniques) is represented in a knowledge model. A knowledge model is a structured representation of knowledge using symbols to represent pieces of knowledge and the relationships between them. Knowledge models include symbolic character-based languages such as logic, diagrammatic representations such as networks and ladders, tabular representation such as matrices and structured text such as hypertext. 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 project 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 (Emberey et al., 2007).

A decision tree was used for conceptual modeling of the acquired knowledge in this research. A conceptual model is a representation of a system that uses concepts and ideas. This involves concept, control mechanism and constraints. Here the concept of symptoms checking system was used. According to those symptoms it is possible to know the disease and the disease will be displayed on the system.

The general structure of creating knowledge modeling contains input, knowledge model and output as shown below (Makfi, 2011).

Figure 3.1: Knowledge modeling (Makfi, 2011).



SYMPTOMS
Torticollis, severe tracheitis, pulmonary congestion, Mild conjunctivitis, Rales (abnormal breathing sound), Nervous Sign, Sneezing, Swollen Eye and Fever
Yes
No
Newcastle Disease
Prevention and Mgmt
Good Biosecurity
Vaccination
Do not use sawdust and litter
Isolate the infected chicken
pest control in flocks
Bluish combs and wattles, abscessed wattles, swollen joints, foot pads, anorexia, Coughing, Ruffled Feather, Ocular Discharge and labored breathing
Yes
No
Fowl Cholera
Prevention and Mgmt
Use Appropriate antibiotics
Eliminating potential reservoirs
Vaccination
Unilateral or bilateral ocular discharge, chronic sinusitis, nose with foul-smelling discharges, conjunctivitis, wheezing, Mucoid Discharge, Facial Ede ma and Eye Inflammation, Swollen Wattle and Reduced Feed
Yes
No
Infectious Coryza
Prevention and Mgmt
Good management and sanitation
Use sulfa drugs
Cull the infected chicken
Paralysis, Incoordination, (kidney, eye, proventriculus, Ovary or other organs may be affected), Emaciation, weight loss, Paleness, Skin Change, Depression and greenish diarrhea
Yes
No
Marek's Disease
Con't
Prevention and Mgmt
Biosecurity
Vaccination
Culling

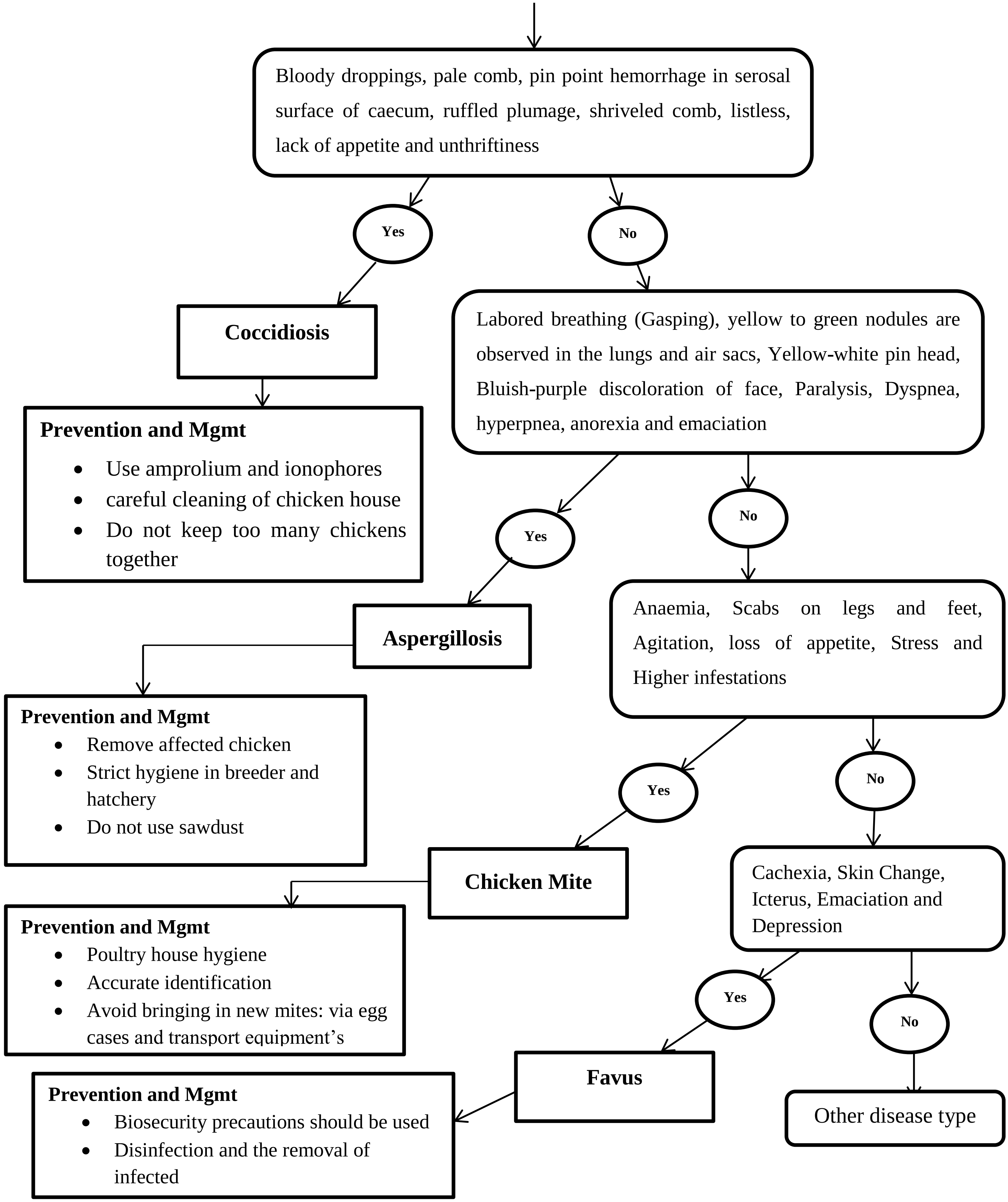


Figure 3.2: Decision trees for diagnosis, prevention and management of predominant chicken disease

As shown in the above figure 3.2, the decision tree structure shows the flow of knowledge in the diagnosis, prevention and management of predominant chicken disease. First it checks the appearance of the basic symptoms of predominant chicken disease and identifies the type of disease based on the symptoms. After the system identifies the type of disease it provide description about the identified disease. Lastly, the system provides how to prevent and manage predominant chicken diseases.

In general, the necessary knowledge was extracted from domain experts and relevant documents analysis was made for building the decision tree model of concepts in the diagnosis, prevention and management of predominant chicken disease. This is used for building the knowledge-based system that can provide advice for experts.

CHAPTER FOUR

IMPLEMENTATION AND EXPERIMENTATION OF THE PROTOTYPE SYSTEM

4.1. Introduction

In this chapter, the implementation includes the real construction of the prototype system for diagnosis, prevention and management of predominant chicken diseases. The knowledge has been extracted from its sources i.e. tacit knowledge from experts and explicit knowledge through document analysis. After the necessary knowledge is represented using a rule-based knowledge representation technique, the next step is coding the represented knowledge using prolog programming language into a suitable format that is understandable by the inference engine. For this study, SWI-Prolog editor tool is used to construct the prototype system. Besides, architecture design is done in this chapter as well, which incorporates the knowledge base (facts and rules), explanation facility, inference mechanism and the user interface are discussed in this chapter.

4.2. Architecture of the Prototype System

Architecture is a blueprint showing how the components of the prototype self-learning knowledge-based system interacts and interrelates. Figure 4.1 illustrates the architecture of the prototype system.

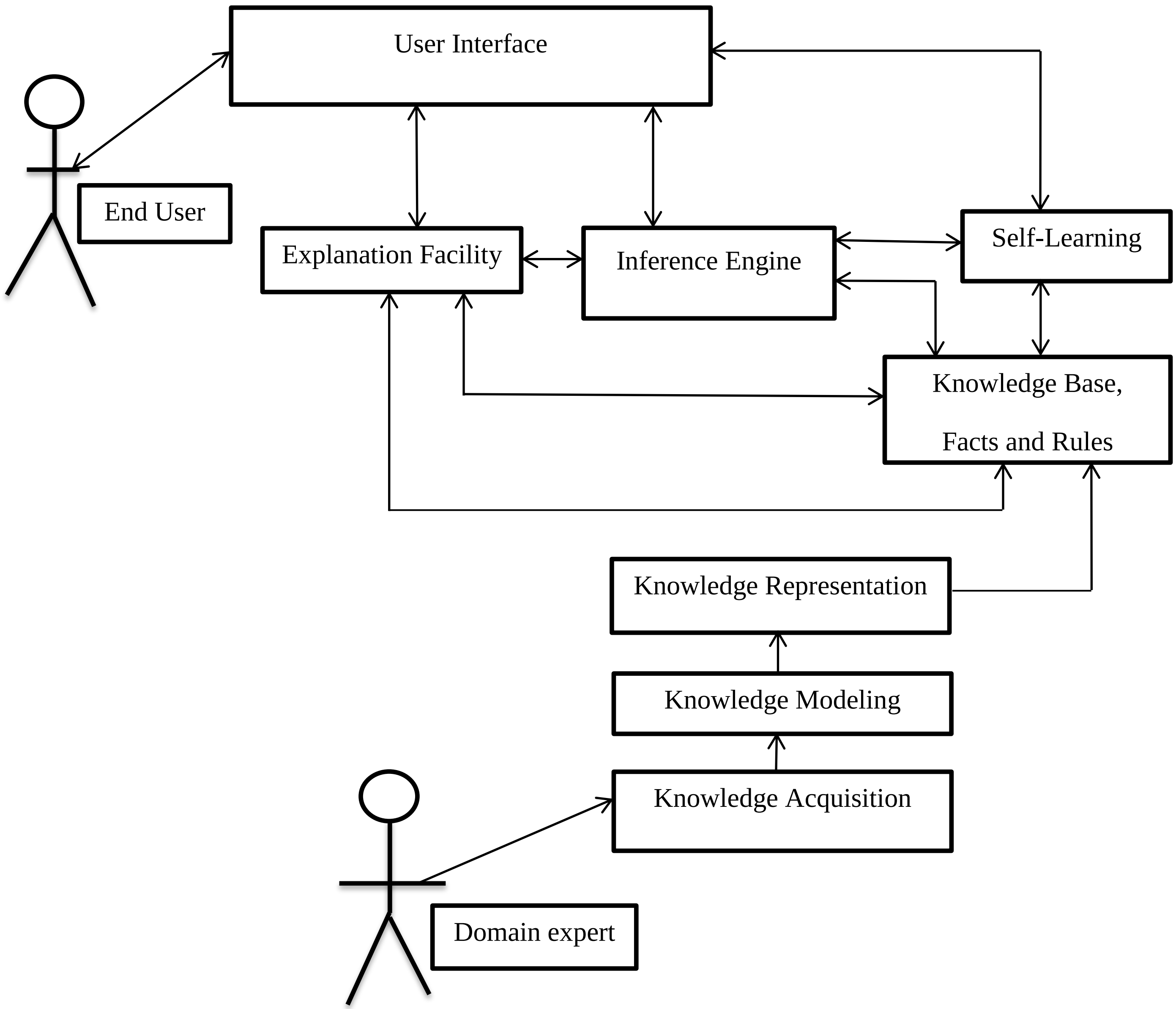


Figure 4.1: Architecture of the prototype self-learning knowledge-based system

4.2.1. Knowledge Base

Knowledge base is a set of rules or the encoded knowledge about diagnosis, prevention and management of predominant chicken disease of the prototype system. It incorporates the relevant knowledge that was acquired from the domain experts. The knowledge base stores all relevant knowledge, fact, rules, and relationships used by the KBS.

The knowledge base of the prototype contains the domain knowledge which is used to identify the types of disease that affected the chickens. The fact base component of knowledge based system includes basic facts of different cases that are handled during chicken disease diagnosis, prevention and management. The number of facts depends on the number of rules incorporated into the knowledge base. Functionally, the facts in the fact base are used to compare against the condition part of rules. In other words, if the given facts satisfy all the conditions which proved to be true, then the inference engine draw a conclusion. This is based on the pattern matching between the facts in fact base and their respective rules in the knowledge base.

4.2.2. The inference engine

The inference engine simulates the domain expert reasoning process. It works from the facts in the working memory (fact base) and stored knowledge in the knowledge base to fire the rule. It achieves the goal by searching through knowledge base to find rules whose premises match with the given facts in working memory. The searching process continues until the inference engine is unable to match any premise with the facts in the working memory. As a result, the proposed system uses backward chaining reasoning mechanism. During the reasoning process, the inference engine starts from the consequents (type of disease) and checks the symptoms of the occurrence of this disease to prove the hypothesis (type of disease). If certain antecedents (symptoms) are evaluated as true, then it logically follows the consequent are proved, and then the type, description, prevention and management of the chicken disease is provided.

4.2.3. The user interface

The acceptability of a knowledge based system depends on the quality of the user interface. The user interface is used as the means of interaction between a user and the knowledge based system. For the proposed knowledge based system, users interact with the system through "yes" or "no" response.

```
1 ?- start.
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
                         JIMMA UNIVERSITY INSTITUTE OF TECHNOLOGY
                         DEPARTMENT OF INFORMATION SCIENCE
                 WELL COME TO PREDOMINANT CHICKEN DISEASE DIAGNOSIS,
                      PREVENTION  AND MANAGEMENT KNOWLEDGE BASE SYSTEM
                              THANK YOU FOR CHOOSING US
                              DEVELOPED BY DIRIBA GIRMA
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%&&&&&

Copyright (C) 2019
No rights reserved, use it as you wish!

To get general information please enter your name ?
|: john.

Hello,john! The following general information is about chicken disease.

chicken disease is a disease that affect chickens and  disturb daily movement/activity
of chicken by injuring either internal or external part of their body.

Are you familiar with chicken disease?(yes/no/what): what.


There are many types of chicken disease and it helps u?(yes/no/why): why.


Because understanding chicken disease and their types is the most important for knowing
the cause of disease and how to prevent and manage it.
```

Figure 4.2: User Interface of the system

4.2.4. Explanation Facility

One of the interesting features of knowledge based systems is the ability to explain itself. The knowledge based system developer uses the explanation facility to have more realistic dialogs with the system user. In addition to offering the end results, the prototype system can explain „"what‟ a request to repeat for clarification before it reached on its conclusions. This ability is usually important since the type of problems to which knowledge-based systems are carried out need an explanation of the result delivered to the end-users. It has also the ability of justifying „"why‟ a certain problem is being questioned. For example, the following figure 4.3 illustrates the „"what‟ and „"why‟ explanation facility that is used to make the results easily understandable by the end-users and build a good communication between the end-users and the system.

```
1 ?- start.
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
                         JIMMA UNIVERSITY INSTITUTE OF TECHNOLOGY
                         DEPARTMENT OF INFORMATION SCIENCE
                 WELL COME TO PREDOMINANT CHICKEN DISEASE DIAGNOSIS,
                      PREVENTION  AND MANAGEMENT KNOWLEDGE BASE SYSTEM
                              THANK YOU FOR CHOOSING US
                              DEVELOPED BY DIRIBA GIRMA
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%&&&&&

Copyright (C) 2019
No rights reserved, use it as you wish!

To get general information please enter your name ?
|: john.

Hello,john! The following general information is about chicken disease.

chicken disease is a disease that affect chickens and  disturb daily movement/activity
of chicken by injuring either internal or external part of their body.

Are you familiar with chicken disease?(yes/no/what): what.


There are many types of chicken disease and it helps u?(yes/no/why): why.


Because understanding chicken disease and their types is the most important for knowing
the cause of disease and how to prevent and manage it.
```

Figure 4.3: Sample „”what‟ and „”why‟ explanation facility

As shown in the above figure 4.3, it is a sample dialogue between the end-user and the prototype system. The prototype system asks a question like “Are you familiar with chicken disease? (yes/no/what):” through the user interface to the end-user. If the end-user clearly understands the question, the end-user might insert „”yes‟ or „”no‟ to the user interface of the prototype system. But if the end-user does not clearly understand the question, the end-user can ask for further clarification by inserting „what‟ question to the user interface of the prototype system. Then the prototype system provides answers by saying “There are many types of chicken diseases and it helps you? (yes/no/why):” Again, if the end-user wants an answer for the reason „”why‟, the prototype system provides the answer to clarify the reason why by saying “Because understanding chicken diseases and their types is the most important for knowing the cause of disease and how to prevent and manage it”. After clarifying „”what‟ and „”why‟ questions, the prototype system requests the end-user to insert „”yes‟ or „”no‟ answers by saying “So, do you want to continue for further diagnosis? (yes/no): ". Next, the end-user may insert to the user interface either „"yes‟ or „"no‟, and then the prototype system continues for another question by saying "Does the infected chicken have torticollis? (yes/no/what):" followed by numbers of other symptoms that is used to diagnose a given disease type.

4.2.5: Knowledge Based System for diagnosis, prevention and management of predominant chicken disease

4.2.5.1. Diagnosis of Newcastle disease using symptoms

The system identifies the type of disease which is Newcastle disease by using the symptom

```
To get general information please enter your name ?
|: john.

Hello,john! The following general information is about chicken disease.

chicken disease is a disease that affect chickens and  disturb daily movement/activity
of chicken by injuring either internal or external part of their body.

Are you familiar with chicken disease?(yes/no/what): yes.


Chicken Disease Diagnosis,Prevention and Management System....

To use it, just answer the questions the systems asks you.


Does the infected chicken has torticollis?(y/n)y.

Does the infected chicken has severe_tracheitis?(y/n)y.

Does the infected chicken has pulmonary_congestion?(y/n)y.

Does the infected chicken has mild_conjunctivitis?(y/n)y.

Does the infected chicken has rales?(y/n)y.

Does the infected chicken has nervous_sign?(y/n)y.

Does the infected chicken has sneezing?(y/n)y.

Does the infected chicken has swollen_eye?(y/n)y.

Does the infected chicken has fever?(y/n)y.

The infected chicken disease could be newcastle_disease
```

Figure 4.4: Sample dialogue that uses symptoms to identify the disease

As shown in the above figure 4.4, it is a sample dialogue between the end-user and the prototype system. The prototype system asks a question like "Does the infected chicken has symptom? (y/n):" through the user interface to the end-user. If the end-user clearly understands the question, the end-user might insert „y‟ or „n‟ to the user interface of the prototype system. When the user response satisfied all the conditions of the given rule, then the system provides a conclusion, diagnosing that the chicken is infected by Newcastle disease.

4.2.5.2. Diagnosis of Coryza disease using symptoms

```
To get general information please enter your name ?
|: sara.

Hello,sara! The following general information is about chicken disease.

chicken disease is a disease that affect chickens and  disturb daily movement/activity
of chicken by injuring either internal or external part of their body.

Are you familiar with chicken disease?(yes/no/what): yes.


Chicken Disease Diagnosis,Prevention and Management System....

To use it, just answer the questions the systems asks you.


Does the infected chicken has torticollis?(y/n)n.

Does the infected chicken has bluish_combs?(y/n)n.

Does the infected chicken has ocular_discharge?(y/n)y.

Does the infected chicken has chronic_sinusitis?(y/n)y.

Does the infected chicken has nose_smelling_discharges?(y/n)y.

Does the infected chicken has conjunctivitis?(y/n)y.

Does the infected chicken has wheezing?(y/n)y.

Does the infected chicken has mucoid_discharge?(y/n)y.

Does the infected chicken has eye_inflammation?(y/n)y.

Does the infected chicken has swollen_wattle?(y/n)y.

Does the infected chicken has reduced_feed?(y/n)y.
```

Figure 4.5: Sample dialogue that uses symptoms to identify the disease

As depicted in the above figure 4.5, the system use symptom to identify the type of disease. The system can diagnose by asking the most common signs and symptoms of chickens and if the rules are satisfied it identifies the disease type and also it provides description, prevention and how to manage the predominant chicken disease.

4.2.5.3. Diagnosis, Prevention and/or management of Newcastle disease after diagnosis

After the disease is diagnosed the system produce description, prevention and management of the identified disease

```
To get general information please enter your name ?
|: john.

Hello,john! The following general information is about chicken disease.

chicken disease is a disease that affect chickens and  disturb daily movement/activity
of chicken by injuring either internal or external part of their body.

Are you familiar with chicken disease?(yes/no/what): yes.


Chicken Disease Diagnosis,Prevention and Management System....

To use it, just answer the questions the systems asks you.


Does the infected chicken has torticollis?(y/n)y.

Does the infected chicken has severe_tracheitis?(y/n)y.

Does the infected chicken has pulmonary_congestion?(y/n)y.

Does the infected chicken has mild_conjunctivitis?(y/n)y.

Does the infected chicken has rales?(y/n)y.

Does the infected chicken has nervous_sign?(y/n)y.

Does the infected chicken has sneezing?(y/n)y.

Does the infected chicken has swollen_eye?(y/n)y.

Does the infected chicken has fever?(y/n)y.

The infected chicken disease could be newcastle_disease

    ========== EXPLANATION ==========

Newcastle disease (NCD) is a contagious viral disease of poultry caused by a Paramyxovirus.

    ====== PREVENTION AND MANAGEMENT =========

a.Good sanitation and implementation of a comprehensive biosecurity program are necessary to prevent Newcastle disease.

b.Well-designed vaccination schedules, using low-virulence live vaccines, give very effective immunization results

c.Do not use sawdust, litter high in bark content, or shavings that have been wet

d.Isolate the infected chicken from others

e.Pest control in flocks

f.Control of access to poultry farms
```

Figure 4.6: sample dialogue that provides diagnosis, prevention and management for ND

4.2.5.4. Diagnosis of Coryza disease using symptoms, Prevention and its Management

```
Hello,sara! The following general information is about chicken disease.

chicken disease is a disease that affect chickens and  disturb daily movement/activity
of chicken by injuring either internal or external part of their body.

Are you familiar with chicken disease?(yes/no/what): yes.


Chicken Disease Diagnosis,Prevention and Management System....

To use it, just answer the questions the systems asks you.


Does the infected chicken has torticollis?(y/n)n.

Does the infected chicken has bluish_combs?(y/n)n.

Does the infected chicken has ocular_discharge?(y/n)y.

Does the infected chicken has chronic_sinusitis?(y/n)y.

Does the infected chicken has nose_smelling_discharges?(y/n)y.

Does the infected chicken has conjunctivitis?(y/n)y.

Does the infected chicken has wheezing?(y/n)y.

Does the infected chicken has mucoid_discharge?(y/n)y.

Does the infected chicken has eye_inflammation?(y/n)y.

Does the infected chicken has swollen_wattle?(y/n)y.

Does the infected chicken has reduced_feed?(y/n)y.

The infected chicken disease could be coryza

    ========== EXPLANATION ==========

coryza is an acute respiratory disease of chickens caused by the bacterium Haemophilus   paragallinarum [gallinarum].
Chronically ill or healthy carrier chickens are the reservoir of infection.
Transmission is by direct contact, airborne droplets, and by contamination of drinking water.

    ========== PREVENTION AND MANAGEMENT ==========

1.Good management and sanitation are the best ways to avoid infectious coryza.

2.Use Antibiotics and sulfa drugs

3.Appropriate biosecurity measures will limit the possibility of introducing infection
  on to breeding and commercial egg production farms

4.Cull the infected chicken
```

Figure 4.7: sample dialogue that provides diagnosis, prevention and management

In the figure above 4.7 after the system identifies type of the disease based on the symptoms that the end user inserts, it provides diagnosis, prevention and management of the disease of predominant chicken.

4.2.5.5. Self-Learning Knowledge Based System for diagnosis, prevention and management of predominant chicken disease

In the present study, the learning prototype system attempts to store the details of a specific chicken symptom and disease. The facts base is stored on a separate file called **“chicken.pl”** and becomes updated whenever the user ends the program. An example of a self-learning case is depicted in figure 4.8.

```
Type names entirely in lower case, followed by period.

This is a program that add new chicken symptom to knowledge base and learn from experience

Type "stop." to quit.
% chicken.pl compiled 0.00 sec, 19 clauses

Please enter new chicken Symptom? gurgling.
I do not know the diseases of this symptom.

Please tell me the disease name for this symptom.

Disease? newcastle_disease.
Thank you.
```

Figure 4.8: Sample dialogue that learns from experience

As shown in the above figure 4.8, it is a sample dialogue between the user and the prototype system. The prototype system asks a question like “please enter a new symptom” If the user inserts a symptom which is new, then the prototype system provides answers by saying “I do not know the diseases of this symptom”, after that the system asks the user to insert a disease name for the new symptom. Again after the end user inserts the disease name, the system adds the new symptom and disease in to the knowledge base. Then after the system asks the end user “please enter new chicken symptom” If the user inserts the new symptom that is added to the knowledge base system it provides the disease name of that symptom by learning from experiences. In figure 4.8, a sample of such a case is depicted followed by the fact base whereby the system is able to learn the newly added symptom (figure 4.9).

```
Type names entirely in lower case, followed by period.

This is a program that add new chicken symptom to knowledge base and learn from experience

Type "stop." to quit.
% chicken.pl compiled 0.02 sec, 20 clauses

Please enter new chicken Symptom? gurgling.
The chicken has newcastle_disease disease.

Please enter new chicken Symptom? stop.
Saving the knowledge base...
Done.
```

Figure 4.9: Sample dialogue that save the knowledge and learn from experience

As shown in the above figure 4.9, the prototype system asks that "please enter new chicken symptom" after this if the end user insert the symptom which is in the knowledge base the system provides the type of disease. And lastly, if the end user types stop the system quits and save the relevant information in to the knowledge base.

```
:- dynamic(chicken_has/2).
:- dynamic chicken_has/2.

chicken_has(gurgling, newcastle_disease).
```

Fig 4.10: Fact Base

As shown in the above figure 4.10 after the knowledge is added to the knowledge base then the learning prototype system attempt to store the details of a specific chicken symptom and disease in the fact base respectively. The fact base is stored in the form of chicken has (symptom, disease) and becomes updated whenever the end-user ends the program.

```
Does the infected chicken has(gurgling)(y/n)y.

Does the infected chicken has torticollis?(y/n)y.

Does the infected chicken has severe_tracheitis?(y/n)y.

Does the infected chicken has pulmonary_congestion?(y/n)y.

Does the infected chicken has mild_conjunctivitis?(y/n)y.

Does the infected chicken has rales?(y/n)y.

Does the infected chicken has nervous_sign?(y/n)y.

Does the infected chicken has sneezing?(y/n)y.

Does the infected chicken has swollen_eye?(y/n)y.

Does the infected chicken has fever?(y/n)y.

The infected chicken disease could be newcastle_disease

    ========== EXPLANATION ==========

Newcastle disease (NCD) is a contagious viral disease of poultry caused by a Paramyxovirus.

    ====== PREVENTION AND MANAGEMENT =========

a.Good sanitation and implementation of a comprehensive biosecurity program are necessary to prevent Newcastle disease.

b.Well-designed vaccination schedules, using low-virulence live vaccines, give very effective immunization results

c.Do not use sawdust, litter high in bark content, or shavings that have been wet

d.Isolate the infected chicken from others

e.Pest control in flocks

f.Control of access to poultry farms
```

Fig 4.11: Sample dialogue that provides description, prevention and management after new symptom is added

As shown in the above figure 4.11 after the new symptom is added to the knowledge base it will be displayed within the rules of the system and at the last the system identifies the type of disease and also it provides description, prevention and management for the identified disease.

4.3 Discussion

As discussed under sections 4.4.1 and 4.4.2, the accuracy of the prototype system is calculated as 83% and the average evaluation result filled by the domain experts in the domain area is 83.4%, respectively. The overall performance of the prototype system is 83.2%.

There are some challenges encountered during the study which limits the prototype system to register a better performance for diagnosis, prevention and management of predominant chicken disease. These are discussed as follows:

Even though tacit knowledge about the diagnosis and treatments of chicken disease is extracted from the domain experts using interviewing method in order to have detail understanding of the domain knowledge, it is challenging to extract the necessary knowledge due to the personal nature of tacit knowledge.

Training was given to the domain experts on how the system functions and on how to use and interact with the system. However, from six evaluators, two of them are not satisfied by the user interface of the prototype system. The two evaluators responded that, they want to insert their queries to the user interface in their local language and also want the decisions provided by the system in their local language so as to understand the decisions made by the system. Due to this reason, two evaluators replied as good rating value for the simplicity to use and interact with the prototype system criteria of evaluation.

During coding the represented knowledge about chicken disease using the SWI-Prolog editor tool, the facts base of the prototype system is able to update its knowledge automatically. However, the researcher encountered a challenge to update the rules of the knowledge base of the prototype system automatically.

The developed system has the capability to update new facts and/or rules if necessary. In other words the proposed knowledge based system makes the right decision and appropriately advice during predominant chicken disease diagnosis, prevention and management. When comparing the performance of knowledge based system for predominant chicken disease diagnosis, prevention and management result 83.2%. (which is the average of user acceptance and system performance result) with other knowledge based system result (expert system to diagnose chicken diseases with certainty factor based on android where the evaluation testing result of the diagnosis of the disease there are several groups of research results show 3 groups with a good preference for the application of expert systems with a range of values of 63% to 82%, said good and very good categories and an information technology enabled poultry expert system: perceptions of veterinarians and veterinary students, the evaluation result was not specified. Hence, from these two knowledge based systems, the performance of knowledge based system for predominant chicken disease diagnosis, prevention and management we developed is better than the previous knowledge based system.

Based on the review of literature, it is clear that each of the existing system have one weakness or the other. This research work is expected to come up with a better system that save the knowledge base and update the knowledge. The new system uses prolog programming language and it learns from experience by memorization (self-learning). Again, Most of the existing systems were not evaluated. In the very few ones that were evaluated, experts in the field were not directly involved. The new system comes up with better evaluation method that involves expert from the field. This help to really determine the actual performance of the system by the users. As stated in the review of related works previous research works were done on poultry but they do not done specifically on chickens and it does not learn from experience to update its knowledge. The current work dealt specifically on chickens and prevention issues are discussed deeply because of chickens diseases are uncured since they are caused by virus and fungus and also the life span of the chickens are short that's why this study focus on diagnosis, prevention and management of predominant chicken disease. The new system learns from experience and updates its knowledge. Thus, in this study an attempt is made to design a learning KBS that can update its knowledge through experience. Additionally, enough rules are used to identify the type of diseases.

The prototype system developed can also be taken as a stepping-stone for conducting research to further come up with other approaches than adopted in this work to design and implement knowledge based system for predominant chicken disease diagnosis, prevention and management.

Generally, all the evaluation and testing results of the prototype show encouraging finding for further research work to fully implement and apply knowledge based systems technology in diagnosis, prevention and management of predominant chicken diseases. The result and finding of this study was encouraging because of many reasons. The first one is that this study was done with higher quality and during the knowledge acquisition relevant information was acquired from domain experts. The second was that the system save knowledge, update the knowledge and learn from experience. The third one was that the system was evaluated thoroughly by the domain experts. The fourth reason was since chicken diseases were caused by fungus and virus mostly and the diseases were not curable the issue of prevention were discussed in this study. Therefore, from the research findings, it is possible to conclude that the research achieve its objectives that were they designed for.

Table 4.1: Comparism of the New System with the Existing Ones

Author	Title	Self Learning	Evaluation
Thammi and Sudhakar (2006)	An Information Technology Enabled Poultry Expert System: Perception of Veterinarian and Veterinary Students, University, India	No	Not specified
Butcher et. al (2012)	A review of expert system in animal health care	No	Not evaluated
Andino and Mahmud (2012)	poultry disease warning system using Dempster-Shafer theory and web mapping.	No	Not well evaluated
Arowolo et. al (2012)	An Expert System for Management of poultry Diseases	No	Not well evaluated
Puja Putri Abdullah (2016)	Expert System to Diagnose Chicken Diseases with Certainty Factor Based on Android	No	Not well evaluated(63 to82%)
New System	Developing knowledge Based System for Predominant Chicken Disease Diagnosis, Prevention and Management	Yes	Thoroughly evaluated(83.2%)

4.4. Testing and Evaluation of the Prototype

Measuring the performance of a given system helps to know the extent to which it has achieved the objective it is developed for or not. For the purpose of this study, KBS is tested and evaluated based on the objective of the system. The user acceptance of the system was carried out during system user interaction.

The KBS user acceptance was measured by using open and close ended questions. It is used to evaluate the performance system of the prototype from the users' point of view. Similarly, the questionnaires helped to assess and evaluate the acceptability and applicability of KBS for predominant chicken disease diagnosis, prevention and management. The system evaluators directly interact with the system to measure its performance from the points of its correctness in providing solutions for different problems. In addition, the validation test was done by comparing solved errors against the system conclusions on the similar issues. By comparing the result obtained from the system conclusion, the evaluators determine the performance of the system.

In testing and evaluation of the prototype system, eight diseases of chickens are selected (from four disease categories means Viral, Fungal, Bacterial and Protozoal) using purposive sampling method in order to test the accuracy of the prototype system. The correct and incorrect results are identified by comparing decisions made by the domain experts on the cases of patients and with the conclusions of the prototype system. And also the process of ensuring that the prototype system satisfies the requirements of its end-users is performed.

4.4.1 System Performance Testing

System performance testing is the process of determining whether the prototype system is good enough, i.e., whether it meets the level of accuracy as required. It confirms whether the right prototype system has been built.

In this study, 1 professor, 3 senior veterinary doctors were selected from veterinary medicine department and two experts were selected from Animal science department for the purpose of testing the prototype system. The criteria for selecting the evaluators were due to the facts that they are expert on chicken diseases diagnosis and prevention since they are from veterinary medicine department. Whereas the experts from animal science department have adequate knowledge on predominant chicken disease management. Twelve chicken diseases test cases were circulated equally to the evaluators that mean two chickens' disease test cases for each evaluator.

In the process of testing the performance of the prototype system, the domain experts classify correctly and incorrectly diagnosed chickens disease cases by comparing the judgments reached by the prototype system with that of the experts' judgments reached on the same chicken's disease test cases. The result was presented by using a confusion matrix in table 4.2.

Table 4.2: Confusion matrix of the prototype system

<table>
<tr><th colspan="3">KBS Suggestion</th><th></th></tr>
<tr><td></td><td>Actual correctly diagnosis cases</td><td>Actual incorrect diagnosis cases</td><td rowspan="4">Experts Suggestion</td></tr>
<tr><td>Predicted correct by the prototype system</td><td>6</td><td>1</td></tr>
<tr><td>Predicted incorrect by the prototype system</td><td>1</td><td>4</td></tr>
<tr><td>Total</td><td>7</td><td>5</td></tr>
</table>

As shown in the above Table 4.2, the correct diagnosis by prototype system is 7 and incorrect diagnosis was 5. This indicated the system performance was 83%. The recall, precision and F measure were calculated depending on the above data in the confusion matrix (table 4.2).

Table 4.3: Accuracy of the prototype system

	TP Rate	**FP Rate**	**Precision**	**Recall**	**F-Measure**
Results	0.83	0.167	0.83	0.83	0.83

As shown in above table 4.3, the value of recall is 0.83 and precision is 0.83. F measure is a derived effectiveness measurement. The resultant value was interpreted as a weighted average of the precision and recall. The best value is 1 and the worst is 0. As it showed in table 4.3 the F measure of the prototype system is 0.83 which indicate that the prototype system has a very good performance. The challenges behind performance evaluation of a prototype system are that some of the cases do not contain enough information of signs and symptoms of chicken disease or at least the commons ones. Moreover, the knowledge variation among the profession on predominant chicken diseases diagnosis, prevention and management is another challenge.

4.4.2. User acceptance Testing

User acceptance testing is usually a crucial factor in the success of a knowledge-based system. Irrespective of how accurate the performance measures are, how complete the system may be, or how trustworthy the knowledge-based system is, all development may be useless if the knowledge-based system is not acceptable by the users.

During testing the users‟ acceptance, the applicability of the prototype is evaluated by potential users of the system. After a prototype KBS was developed, evaluation procedures were conducted to check the performance of the prototype system and acceptability by the users.

During testing experts were requested to rank each parameter from poor to excellent by assigning value for poor=1, fair=2, good=3, very good=4, excellent= 5. The Table below indicates the feedbacks obtained from the domain experts (evaluators) of the prototype system, interaction as calculated based on the given scale. Thus, this method helps the researcher to manually examine the user acceptance based on evaluators’ response. The average performance of user acceptance of the system was presented in table 4.4.

Table 4. 4: Performance evaluation by domain experts

Evaluation Parameters	Performance Value						
	1	2	3	4	5	**Average**	**Percent**
Accuracy of the prototype system in diagnosis , prevention and management of chicken disease	0	0	2	1	3	4.17	83.4%
Attractiveness of the prototype system	0	0	2	2	2	4	80%
Relevance of the prototype system	0	1	2	0	3	3.83	76.6%
Resource adequacy of the prototype system	0	0	2	1	3	4.17	83.4%
Does the prototype system have significance contribution for the domain area?	0	0	0	1	5	4.83	96.6%
Efficiency of the prototype system in time	0	0	0	4	2	4.33	86.6%
Is the system accurate in analyzing facts and decision making?	0	0	1	2	3	4.33	86.6%
The ability of the prototype system in making right conclusions and recommendations	0	1	0	2	3	4.17	83.4%
Simplicity to use and interact with the prototype system	0	0	3	2	1	3.67	73.4%
Average						4.17	83.4%

As shown in the above table 4.4 above, 50% of the evaluators scored the accuracy of the prototype system in diagnosis, prevention and management of chicken disease criteria of evaluation as excellent, 16.67% as very good, 33.33% as good. The second evaluation criterion which was attractiveness of the prototype system showed a greater rate of attractiveness by the evaluators the majority scored 33.33% as excellent, 33.33% as very good, and 33.33% as good. The rates relevance of the prototype system by the evaluators scored 50% as excellent, 33.33% as good and 16.67% as fair. In the resource adequacy of the prototype system is rated as, 50% of the evaluators scored as excellent, 16.67% as very good, and the rest 16.67% as good.

In general, 83.33% of the evaluators gave the prototype system an excellent score with regard to "Does the prototype system have significance contribution for the domain area" whereas, 16.67% as very good. In the efficiency of the prototype system with respect to time criteria of evaluation, 33.33% of the evaluators scored as excellent and 66.67% as very good.

When asked “Is the system accurate in analyzing facts and decision making?”, 50% of the evaluators rated the prototype system as excellent and 33.33% as very good and 16.67% as good. The ability of the prototype system in making right conclusions and recommendations criteria was scored by half of the evaluators as excellent while 33.33% as very good and 16.67 as fair.

To this end, 16.67% of the evaluators scored the simplicity to use and interact with the prototype system criteria of evaluation as excellent, 33.33% as very good and 50% as good. Finally, the average performance of the prototype system according to the evaluation results by the domain experts is 4.17 out of 5 or 83.4% which is above very good.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1. Conclusion

Knowledge based system is widely used in the area of medical fields especially for diagnosis and treatment. In this study Knowledge based system is developed for diagnosis, prevention and management of predominant chicken disease, namely, Newcastle disease, marek's disease, infectious coryza, fowl cholera, chicken mite, coccidiosis, aspergillosis and favus.

Hence, in this study an effort has been made to design and develop a prototype of a self-learning (*i.e.*, learning by memorization) knowledge-based system that can provide advice for experts to facilitate the diagnosis, prevention and management of predominant chicken disease.

In developing the prototype system, knowledge is acquired using both structured and unstructured interviews with domain experts and from relevant documents by using documents analysis method to find the solution of the problem. The acquired knowledge was modeled using decision tree that represents concepts and procedures involved in diagnosis, prevention and management of predominant chicken disease. Then, the validated knowledge is represented using rule-based representation technique and codified using SWI-Prolog editor tool for building the knowledge-based system to provide advice for experts.

To conduct this research the researcher has been used design science research methodology, and the necessary knowledge have been collected from domain experts in JUCAVM and KFPF. The proposed knowledge based system is conceptually modeled using hierarchical structure with logical relationships between the identified symptoms and the respective disease of the chickens. Prevention of disease in chickens should be the priority in order to minimize unnecessary costs related with both loss and treatment. The strong side of the prototype system shows that the facts base of the system is able to update its knowledge from experience automatically.

Accordingly, the following were the major findings of the study. The first finding was Applicability of KBS for predominant chicken disease diagnosis, prevention and management has been proved. And the prototype knowledge based system is promising and applicable in the domain area. The feedback and suggestion of domain expert reveals that the knowledge based system goodly gained user acceptance. But, to fully provide better service KBS should be integrated with local languages to facilitate the interaction between the user and system. The second finding was the system provides explanation, prevention and management automatically on the bases of predominant chicken disease after the disease is diagnosed. Thirdly Knowledge is represented in the form of if then rules generated from the decision tree. But, some challenges are identified during inferring from the given conditions, since, rules need pattern matching. Therefore, it is possible to conclude that other approaches such as case based system which infers from previous solved similar cases to draw a better solution was needed. The fourth finding of the study was in the proposed knowledge based system an attempt is made to dynamically update the fact base in working memory. So that it's possible to conclude that, it is possible to make system to learn from the user response and permanently remember the new knowledge.

Generally, the prototype system achieves a "very good performance" and meets the objectives of the study. However, in order to make the system applicable in the domain area for diagnosis, prevention and management of predominant chicken diseases, some adjustments like automatically updating the rules in the knowledge base of the system, incorporating a well-designed user interface and a mechanism of NLP facilities are needed.

5.2. Recommendation

Currently, KBS are receiving attention in many fields. With availability of advanced computing facilities and other resources, attention is now turning to more and more demanding tasks, which might require intelligence.

It is recommended that, improved extension services and the government should formulate a policy that will improve the level of poultry disease management. And also it is recommended that every individual should have to give attention for environment protection to reduce the morbidity and mortality of chickens. In view of the above, the following recommendations are suggested:

- The scope of the knowledge based system should be extended to include others diseases categories of chicken since this system is limited to only 8 major diseases which are dangerous today.
- It is recommended that the stake holders should have to take part in deploying the developed system.
- Government, researchers and developmental organizations should give attention to poultry sector and its development.
- The system needs to be integrated with other languages like C#, VB, or Java.Net to have a more attractive look (user interface). Therefore, further research should be done to integrate KBS with other programming languages.

References

Abdulkerim M.(2013). "MSc Thesis on Towards Integrating Data Mining with Knowledge Based System: The Case of Network Intrusion detection," Addis Ababa University, Addis Ababa.

Abraham, Ajith (2005). Rule-based Expert Systems. In: Peter, H., Sydenham and Richard T. (eds.) Handbook of Measuring System Design. Oklahoma: John Wiley & Sons, Pp. 909-919.

A.H. Mohammed and N.A.M. Al Saiyd(2010). "A Framework for Expert Knowledge Acquisition", *International Journal of Computer Science and Network Security*, Vol. 10, No. 11, pp. 145-191.

Anumba, C J. and Scott, D. (2001). Performance Evaluation of Knowledge Based System for Subsidence Management: Structural survey. *19.*

Arné P, Thierry S, Wang D, Deville M, Le Loc'h G, Desoutter A, Féménia F, Nieguitsila A, Huang W, Chermette R, Guillot J.(2011). Aspergillus fumigatus in Poultry. Int J Microbiol. 2011: 1–14.

Aronson J.E. and Turban E. (2004). Decision Support Systems and Intelligent Systems, New Delhi: Printice-Hall of India.

Bagust, T. J. (n.d.). Poultry health and disease control in developing countries. *Poultry Development review*.

Baskerville, R., Baiyere, A., Gregor, S., Hevner, A., and Rossi, M. (2018). "Design Science Research Contributions: Finding a Balance between Artifact and Theory." *Journal of the Association for Information Systems 19(5): 358-376.*

Bethune, D., Kelly, T., Liversidge, T. (2007). Scholar Study Guide Higher Information System: Expert Systems. Heriot-Watt University, United Kingdom.

B.F. Yanto, I Werdiningsih, And E Purnawanti(2017). “Aplikasi sistem pakar diagnosa penyakit pada anak bawah lima tahun menggunakan Metode Forward Chaining”, *Journal of Information Systems Engineering and Business Intelligence*, Vol. 3, No. 1.

B.F. Richard, G. Violetta, and O.L. Mieczyslaw(1999). “On Features of Decision Trees as a Technique of Knowledge Modelling”, Proceedings of the Workshop on Computer Science and Information Technologies CSIT‟99, Moscow, Russia.

Cassandra J., Leon S., Krista H., and Christopher H. (2007). Transfusion in the Patient with Sickle Cell Disease: A Critical Review of the Literature and Transfusion Guidelines, Elsevier Inc., Journal of Transfusion Medicine Reviews. 21(2): 118133.

Charlton BR, Chin RP, Barnes HM. (2008). Fungal infections. In: Saif YM, Fadly AM, Glisson JR, McDougald LR, Nolan LK, Swayne DE, editors. Dis Poult. 12th ed. Iwoa: Blackwell Publishing; p. 989–1008.

Conway, D.P. and McKenzie, M.E. (2007). Poultry Coccidiosis. Diagnostic and Testing Procedures, Blackwell, 3rd ed.

Cross, N. (2007). From a Design Science to a Design Discipline: Understanding Designerly Ways of Knowing and Thinking. In Design Research Now, R. Michel Ed. Birkhäuser, Basel, 41-54.

Dawit A, Tamrat D, Stotaw F, Nzietcheung S, Roy D. (2008). Overview and background paper on Ethiopia's poultry sector.

Dessie, T. (2010). Indigenous chicken production and marketing systems in Ethiopia: Characteristics and opportunities for market-oriented development. *International Livestock Research Institute*.

Emberey, C. L., Milton, N. R., Berends, J. P. T. J., van Tooren, M. J. L., van der Elst, S. W. G. and Vermeulen, B. (2007). Application of Knowledge Engineering Methodologies to

Support Engineering Design Application Development in Aerospace. 7th AIAA Aviation Technology, Integration and Operations Conference, Northern Ireland.

E.D. Kock(2003). “Decentralising the Codification of Rules in a Decision Support Expert Knowledge Base”, MSc Thesis, University of Pretoria, Faculty of Engineering, Built Environment and Information Technology, South Africa.

Guesh, D. (2012). Designing aknowledge based system for blood transfusion. MSC thesis. Addis Ababa: Addiss Ababa university.

Halifa M. (2008). Good biosecurity practices in non integrated commercial and in scavenging production systems in Tanzania. FAO Study report. Pp 1-28.

Hamra CF (2010). An Assessment of the Potential Profitability of Poultry Farms: A Broiler Farm Feasibility Case Study. Msc thesis submitted to the Faculty of The University of Tennessee at Martin, South Lebanon. pp. 1-43.

Hevner, A.R., March, S.T., and Park, J.(2004). "Design Research in Information Systems Research," Mis Quarterly (28:1) , pp 75-105.

Horrox, n. (2000.). Countering immunosuppression . *International Poultry Production*, 8–12.

Ihsan Sarita, Sri Hartati & Retantyo Wardoyo. (2013). Development of Knowledge Base in Expert System using Dempster's Rule of Combination. *international Journal of Scientific & Engineering Research, Volume 4,* (Issue 5,), 1173-1177.

Kesarwani, P., &Misra, A. (2013).selecting integrated approche for knowledge representation by comparative study of knowledge representation schemes. International Journal of Scientific and Research Publications, 1-5.

Krishnamoorthy, C.S. and Rajeev, S. (2010). Artificial Intelligence and Expert Systems for Engineers. Available from: EartheWeb Resource.

Lamma, E. (2001). Rule-based Programming for Building Expert Systems: a Comparison in the Microbiological Data Validation and Surveillance Domain. Electronic Notes in Theoretical Computer Science.

Lau, J. and Chan, J. (2004). Model : strategic reasoning: using chart and diagram tutorial.

Lidtke, D. and Sato, S. (2003). Fast base np chunking with decision tree.

Lifschitz V., Morgenstern L., and Plaisted D. (2007). Knowledge Representation and Classical Logic., Chapter 1, Elsevier.

Long, N. V. (2008). Poultry production systems in Viet Nam.

Mantaras, R., Bridge, D., Leake, D., Smyth, B., Craw, S. , Faltings, B., Maher, M., Cox, M., Forbus, K., Keane, M., Aamodt, A. & Watson, I. (2005). Retrieval, reuse, revision, and retention in case-based reasoning: The Knowledge Engineering Review, Cambridge University Press, 00 (0), pp. 1-2.

Makfi, P. (2011). Introduction to knowledge modeling and neural network.

Marangon, S. and Busani, L. (2006). The use of vaccination in poultry production. Rev. Sci.Tech., Off. Int. Epiz., 26(1):265–274..

Mohamed R., and Julie T., (2009). Knowledge Based Expert Systems in Bioinformatics, France.

Melesse, A. (2015). Characterization of village chicken production system under traditional management in Gantaafeshum district of Eastern Tigray.

Mobley R, Kahan T (2007). Practical Management of Health Issues in a Poultry Production System: Symptoms, Sources, and Prevention of Common Diseases, Florida A&M University, Tallahassee, Florida.

Nalepa, G. (2015). Methodologies and Technologies for Rule-Based Systems Design and Implementation Towards Hybrid Knowledge Engineering.AGH University of Science and Technology, Poland.

Okafor, E. and OsuagwuC. (2006.). The Underlying Issues in Knowledge Elicitation. *Interdisciplinary Journal of Information, Knowledge, and Management*, *1*.

Owaied, H. H.A. (2010). Application of Knowledge Based System. *International Journal of Computer Science and Networ Security, 10.*

Pal, S., and Shiu, K. (2004).Foundation of Soft Cased-Based Reasoning.Wilely Series on Intelligent Systems, A John Wiley & Sons, Inc. Publication.

Peffers,K.,Tuunanen, T.,Marcus,A.R., &Samir,C.(2007). ADesign ScienceResearch Methodologyfor Information Systems Research. *Journal of Management Information Systems, 45-78.*

Priti Srinivas Sajja, Rajendra Akerkar. (2010). Knowledge-Based System. *vol-1*, 1-11.

P.S. Sajja and R. Akerkar(2010). “Advanced Knowledge Based Systems: Model, Applications & Research”, Vol. 1, pp. 1 – 11.

Rajeswari, P. V. (2012). Hybrid Systems for Knowledge Representation in Artificial Intelligence. *International Journal of Advanced Research in Artificial Intelligence.*

R.A. Akerkar and P.S. Sajja (2010). “Knowledge-Based Systems”, Jones and Bartlett Publishers, USA.

Sasikumar, M., Ramani, S., Raman, M., Anjaneyulu, K. and Chandrasekar, R. (2007). A Practical Introduction to Rule Based Expert Systems. 2nd ed. New Delhi: Narosa Publishing House.

Shadrick, S.B., Iussier, J.W and Hinkle, R., (2005). Concept Development for Future Domain: A new Method of Knowledge Elicitation. U.S Army Research Institute for the Behavioral and Social Science, Technical reports No 1167.

Sharma, T., & Kelkar, D. (2012). A Tour Towards Knowledge Representation tecniques. *International Journal of Computer Technology and Electronics Engineering*, 131-135.

Seblewongel Esseynew. (2011). prototype knowledge based system for anxiety mental disorder diagnosis. Ethiopia, Addis Ababa: Addis Ababa University.

Shane, S. (2004). Global poultry diseases update avian influenza overshadowing erosive diseases. *World Poultry*, 22–23.

Singh, Y., Bhatia, K. & Sangwan, O. (2007). A Review of Studies in Machine Learning Techniques. International Journal of Computer Science and Security, 1(1), 70-84.

Tadelle D., Million T., Alemu Y. and Peters, K. J. (2003). Village chicken production systems in Ethiopia: 1. Flock characteristics and performance. Liv. Resea. Rur. Dev. 15 (1).

Tadelle Dessie, A. Y. (2004). A Review of The Importance and Control of New castle Disease in Ethiopia. *Ethiopian Veterinary Journal, 8*, 71-79.

Tadiose Habte, Alemayheu Amare,Judy Bettridge,Marisol Collins,Robert Christley,Paul Wigley. (2017). Guide to chicken health. *nternational Livestock Research Institute.*

Tanwar, P., Prasad T. V. and Aswal, M. S . (2010). Comparative Study of Three Declarative Knowledge Representation Techniques. *International Journal on Computer Science.*

Appendix A

Interview Questions to Domain Experts

JIMMA UNIVERSITY

JIMMA INSTITUTE OF TECHNOLOGY

FACULTY OF COMPUTING AND INFORMATICS

DEPARTMENT OF INFORMATION SCIENCE

Checklist for the fulfillment of master's program in Information Science (Information and Knowledge Management)

The main objective of this interview question is to elicit knowledge from experts that would help to domain know how and the development of a knowledge base system for Predominant Chicken Disease Diagnosis, Prevention and Management". The interviewer records the respondents‟ response using pen, pencil and paper. I thank you in advance for your willingness and valuable time.

General Information

1. Sex of the respondent

    a. Male b. Female

2. Age of the respondent _______________

3. Educational level of the respondent

    a. No formal education b. Primary and Secondary education

    c. BSc d. MSc e. PhD

4. Marital status

    a. Married b. Unmarried c. Widows

5. Owners occupation

    a. Business b. civil worker c. Retired

    d. Poultry farmer e. House wife f. Professional/expert

Specific Information: Interview Questions

Part One

General

1. What is chicken disease? In brief
2. What is the total capacity of the farm and what type of chicken species found in the farm?
3. From viral diseases which are the most dangerous disease in your farm? Why
4. From Bacterial disease which are more dangerous? Why?
5. From Fungal disease which are more dangerous? Why?
6. Which months or seasons are the diseases commonly observed in chicken?

Part Two

Diagnosis

1. What are the identification techniques and procedures applied to diagnose the diseases?
2. Do you use standardized guidelines/manuals to diagnose each chicken disease?
3. How can you differentiate the disease if the chicken has relatively similar symptom/sign?
4. What are the simple, medium and difficult challenges that experts face during diagnosing chickens disease?
5. What are the identification techniques and procedures you applied to diagnose the diseases?

Part Three

Prevention

1. What are the mechanisms used to prevent chicken disease?
2. When and how these mechanisms applied?
3. Do people in your community have knowledge about the control of chicken disease?
4. What do you suggest can be done to control chicken diseases?

Part Four

Management

1. If chickens are affected by the diseases what measurement you take?
2. Do your chickens share housing with other birds, animals or humans?
3. What procedures to be followed for management purpose?

Appendix B

User acceptance testing questionnaire

This is an evaluation form to be filled by domain experts in order to evaluate the applicability of the knowledge based system in chicken disease diagnosis, prevention and management user acceptance testing. I thank you in advance for your willingness and valuable time.

Description of the parameter values are as follows.

Performance Value	1	2	3	4	5
Description	Poor	Fair	Good	Very good	Excellent

Instruction: Please, tick on the appropriate value for the corresponding parameter of the knowledge based system in chicken disease diagnosis system user acceptance testing.

Evaluation Parameters	**Performance Value**						
	1	2	3	4	5	**Average**	**Percent**
Accuracy of the prototype system in diagnosis , prevention and management of chicken disease							
Interactivity of the user interface							
Relevance of the system							
Resource adequacy of the system							
Attractiveness of the system							
Does the system have significance contribution for the domain area?							
Efficiency of the system in time							
Is the system accurate in analyzing facts and decision making?							
Is the system‘s easy to use?							
Average							

Appendix C

Sample Code of Developing Knowledge Based System for Predominant Chicken Diseases Diagnosis, Prevention and Management

```
write('%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%'),nl,nl,

write('                    JIMMA UNIVERSITY INSTITUTE OF TECHNOLOGY '),nl,nl,

write('                    DEPARTMENT OF INFORMATION SCIENCE'),nl,nl,

 write('  WELL COME TO PREDOMINANT CHICKEN DISEAS DIAGNOSIS,'),nl,nl,

write('   PREVENTION  AND MANAGEMENT KNOWLEDGE BASE SYSTEM         '),nl,nl,

write('                   THANK YOU FOR CHOOSING US                '),nl,nl,

write('                       DEVELOPED BY DIRIBA GIRMA'),nl,nl,


write('%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%'),nl,nl,

write('Copyright (C) 2019'),nl,

write('No rights reserved, use it as you wish!'),nl,nl,

write('please enter your name? '),nl,

        read(User),nl,

write('Hello,'),write(User),write('! The following general information is about chicken disease.
'),nl,nl,

write('chicken disease is a disease that affect chickens and  disturb daily movement/activity of
chicken by injuring either internal or external part of their body.'),nl,nl,

write('Are you familiar with chicken disease?(yes/no/what): '), read(Dis),nl,((Dis=='what',nl,

write('There are many types of chicken disease and it helps u?(yes/no/why): '),   read(New),nl,
(New=='why',nl,
```

```
  write('Because understanding chicken disease and their types is the most important for knowing
the cause of disease and how to prevent and manage it.

/*Ask rules*/
symptom(P, Val):-ask('Does the infected chicken have',Val).
ask(Obj, Val):-known(Obj, Val, true),!.
ask(Obj, Val):-known(Obj, Val, false),!, fail.
ask(Obj, Val):-nl,write(Obj),write(' '),
write( Val) , write('?(y/n)'), read(Ans), !,
((Ans=y, assert(known(Obj, Val, true)));(assert(known(Obj, Val, false)),fail)).


diagnose:-nl,
write('Chicken Disease Diagnosis System..........'),nl, disease (symptom, Disease) ,!,nl,
write('The infected chicken disease could be '),
write(Disease),nl,((Disease=='newcastle_disease',nl,
write('    ========== DESCRIPTION =========='),nl,nl,
write('Newcastle disease (NCD) is a contagious viral disease of poultry caused by a
Paramyxovirus.'),nl,nl,
write('    ====== PREVENTION AND MANAGEMENT =========   '),nl,nl,
write ('a. Good sanitation and implementation of a comprehensive biosecurity program are
necessary to prevent Newcastle disease.'),nl,nl,
write('b.Well-designed vaccination schedules, using low-virulence live vaccines, give very
effective immunization results'),nl,nl,
```

```
write ('c. Do not use sawdust, litter high in bark content, or shavings that have been wet'),nl,nl,

write('d.Isolate the infected chicken from others')),nl; (Disease=='fowl_cholera',nl,

write('    ========== DESCRIPTION  =========='),nl,nl,

write('Fowl cholera(AvianPasteurellosisor  avianhemorrhagic septicemia)is a contagious bacterial  disease  of poultry characterized by septicaemia, sudden onset with high morbidity and mortality; chronic and asymptomatic infections may also occur. It is caused by Pasteurella multocida and commonly reporter in commercial flock in Ethiopia.'),nl,nl,

write('    ========== PREVENTION AND MANAGEMENT ==========      '),nl,nl,

write('Appropriate antibiotics or chemotherapeutics can be successful in halting mortality and restoring egg production. '),nl,nl,

write('Eliminating potential reservoirs'),write('Vaccination'),write('Proper sanitation of the house and premises ')),nl;

% File pp.pl

% % Program that modifies its own knowledge base

% This program requires file KB.PL.

diagnosess:- nl,

 write('Type names entirely in lower case, followed by period.'), nl,nl,

  write('This is a program that add new chicken symptom to knowledge base and learn from experience'),nl,nl,

    write('Type "stop." to quit.'), nl,

     reconsult('chicken.pl'),

    nl,process_a_query.
```

```
process_a_query :- write('Please enter new chicken Symptom? '),
        read(Symptom),
            answer(Symptom).

% If user typed "stop." then save the knowledge base and quit.

answer(stop) :- write('Saving the knowledge base...'),nl,
          tell('chicken.pl'),
            write(':- dynamic(chicken_has/2).'),nl, % omit if not needed
            listing(chicken_has),
            told,
            write('Done.'),nl.
```