Addis Ababa University (Since 1950)

ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES
SCHOOL OF INFORMATION SCIENCE

DESIGNING A SELF-LEARNING KNOWLEDGE BASED SYSTEM FOR CREDIT EVALUATION OF LOAN APPLICATION: IN THE CASE OF COMMERCIAL BANK OF ETHIOPIA

A Thesis Submitted to the School of Graduate Studies of Addis Ababa University in Partial fulfillment for the Degree of Master of Science in Information Science

BY

WESENU BEKELE

October, 2014

ADDIS ABABA UNIVERSITY

SCHOOL OF GRADUATE STUDIES

SCHOOL OF INFORMATION SCIENCE

DESIGNING A SELF-LEARNING KNOWLEDGE BASED SYSTEM FOR CREDIT EVALUATION OF LOAN APPLICATION: IN THE CASE OF COMMERCIAL BANK OF ETHIOPIA

A Thesis Submitted to the School of Graduate Studies of Addis Ababa University in Partial Fulfillment for the Degree of Master of Science in Information Science

BY

WESENU BEKELE

Name and Signature of Members of the Examining Board

Chair person, Examining Board	Signature
Dr. Solomon T.	08/12/2014
Advisor	Signature
Tibebe Beshah	
Examiner	Signature
Martha Yifiru	Dec. 8, 2014
Examiner	Signature

ACKNOWLEDGEMENT

First and foremost, I would like to thank the almighty God who provides me the strength to accomplish this thesis.

I am gratefully thankful to my advisor Dr. Solomon Teferra, for his unreserved assistance, suggestions, guidance, encouragement and critical comments from the initial to the final level of this research that enable me to finish the thesis work.

I gratefully thank Commercial Bank of Ethiopia domain experts of each credit management especially to Wubalem (portfolio management staff), Melkam Beleta (corporate and business customer relationship manager) who have spared their valuable time for personal interview and consultation session throughout the research and for providing me valuable facilities and resources.

I would like to express my gratitude to all my family members for their continuous support, encouragement and moral support throughout my study. I specially thank my lovely mother for her continuous support.

Finally, I would like to express my thanks to all my friends those who helped me with their valuable support during the entire process of this research work.

TABLE OF CONTENTS

Contents **pages**

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS

PROLOG.....PROgramming in LOGic

LISP.....LISt Processing

CBE.....Commercial Bank of Ethiopia

KBS.....Knowledge Based System

VAT.....Value Add Tax

NBE.....National Bank of Ethiopia

CRM.....Customer Relationship Manager

OD.....Overdraft

ES.....Expert System

AI.....Artificial Intelligent

FOPL.....First Order Predicate Logic

EBG.....Explanation Based-Generation

USD.....United State Dollar

GUI.....Graphical User Interface

LC..... Letter of Credit

ABSTRACT

This study on prototype self-learning knowledge based system is focused on evaluation of loan application (request) and is carried out to overcome the challenges that resulted from lack of domain experts and poor loan evaluations.

The research attempts to design and develop a prototype self-learning knowledge based system that can provide advisory services for any credit customers and assists the domain experts in evaluation of customer's requests for the loan. To develop this prototype system, knowledge was acquired using semi-structured interview from domain experts which are selected using purposive sampling technique from Commercial Bank of Ethiopia and critique the acquired knowledge. Explicit knowledge is acquired by analyzing the secondary source of knowledge by method of document analysis. Then, the acquired knowledge is modeled using decision tree that represents concepts and procedures involved in credit evaluation and production rules are used to represent the domain knowledge. The prototype system is implemented using SWI Prolog editor tool.

To determine the applicability of the prototype system in the domain area, the system has been evaluated and tested by the domain experts. Eighteen (18) test cases were selected purposively. Test cases are equally selected from both ineligible and eligible cases.

The overall total performance of the prototype system is 77.71%. The performance of the prototype system is hopeful and meets the objective of the research.

The study concludes that the major credit production type that advanced to customer is import letter of credit facility, export credit facility, pre-shipment credit facility and merchandise. The eligibility of application is focused on general and specific criteria. Credit customer is classified as business, corporate and commercial based on the score sheet they achieved.

Generally, in this study, the applicability of knowledge of prototype self-learning knowledge based system is proved as hopeful approach in banking industry for credit evaluation. The researcher also recommends further work; - like credit scoring, decision support system in credit evaluation and credit analysis.

Keywords: knowledge based system, self-learning, credit (loan).

CHAPTER ONE

INTRODUCTION

1.1. Background of the study

Banks are financial institutions that accept deposit and make loans. Its role in the economy of any country is very significant. Availing credit to borrowers is one means by which banks contribute to the growth of economy. Commercial bank of Ethiopia extends credit (loan) to different types of borrower for many different purposes [1]. When, banks extend credit to the borrowers, it is important to evaluate borrower's credit application carefully to reduce risks that come due to poor loan assessment.

Credit evaluation and approval is the process a business or an individual must go through to become eligible for a loan or to pay for goods and services over an extended period. It is also the process businesses or lenders undertake when evaluating an applications. Granting credit approval depends on the willingness of the creditor to lend money in the current economy. It also depends on assessment of the ability and willingness of the borrower to return the money or pay for the goods obtained and interest in an appropriate manner [2].

According to [2], the granting of credit depends on the confidence of the lender in the borrower's credit worthiness. Credit worthiness which includes the borrower's ability and willingness to pay is one of many factors defining a lender's credit criteria. Borrowers and lenders utilize a number of financial tools to evaluate the credit worthiness of a potential borrower. When both lender and borrower are businesses, more of the assessment relies on analyzing the borrower's balance sheet, cash flow statements, inventory turnover rates, debt structure, management performance, and market conditions. Creditors favor borrowers who generate net earnings in excess of debt obligations and any contingencies that may arise. There are various factors lender take into consideration when evaluating an individual or business that is seeking credit such as Credit value, Frequency of borrowing and the like [2].

In doing such boring and complex tasks, a bank has a high probability expose to risks, because of credit scoring evaluation process depends on domain experts, who are accountable for assessment of the credit applications and making decision to accept or to reject it. The problem appears, when there is lack of such human experts on the labor market. Besides, the assessment made by human expert could be subjective to some extent. The human expert may also commit some mistakes due to fatigue, stress or other negative factors. As consequence, the banks can fall under the credit risk [3].

The credit risk has long been an important and widely studied topic in Banking. For lots of Commercial Bank, the credit risk remains the most important and difficult risk to manage and evaluate. In the last years the advances in information technology have lowered the costs of acquiring, managing and analyzing data, in an effort to build more robust and efficient techniques for credit risk management. Therefore, bank suffers from these risks when a mechanism and control techniques are take place [4].

As Bryant [5] noted, implementing computing technology for delivery of financial services is one way banks can reduce cost and possibility of loan defaults. Artificial Intelligence (AI) systems, particularly expert systems, are computer-based technology finding a place in the banking industry. Expert systems are computerized advisory programs that try to imitate or substitute the reasoning processes and knowledge of experts in problem solving.

According [47] ,knowledge based system is applicable in domain of medical diagnosis, plant disease diagnosis, crop management problem diagnosis, credit evaluation and authorization, financial evaluation, identification of software and hardware problems and the like.

The use of knowledge based systems should encourage the systematic and thoughtful assessment of loan applications without the need for time consuming supervision by more experienced officers. Finally, the knowledge base is easily updated and maintained the basic information of borrowers. In this study, the researcher wants to develop a low-cost automated self-learning knowledge-based system fitting in the skills of credit evaluator experts to help domain experts within evaluation of loan application and provide advisory services for any credit customers.

1.2. Problem statements

Banks and micro finance have great role in growth of one county. In developing counties like Ethiopia, Bank plays great role in growth by encouraging saving culture as well as lending to individual or sector in order to run the business. Currently the banking business is so sensitive because more of their income (revenue) will be generated from credit (loan) given to their customers [1].This credit creation process exposes the banks to high credit risk which leads to loss. Without effective credit risk management good bank performance or profit will be unthinkable.

According to Bryant [5], all Bank loans necessarily contain an element of risk. In order to minimize this risk, it is essential that procedures and control mechanisms are in place to ensure that each loan is objectively assessed and the bank's total loan portfolio does not compromise the bank's overall integrity. That is, the financial soundness of a Bank is largely dependent on the riskiness of its loan portfolio.

In the case of Commercial Bank of Ethiopia, each individual loan applicant is assigned to customer relationship manager for the purpose of evaluation of their application. This is very difficult and time consuming in the case of more applicants. Moreover, these problems become worse due to the scarcity of domain experts. As a result, bank can lose a lot of customers due to lack of domain experts in the areas.

According to Nassali [7], banks and micro finance institutions often rely on information to screen loan applicants and for monitoring borrowers through repeated interaction with their customers. This normally applies to the subsequent borrowers than the new entrants since it requires ample time to determine the true credit worthiness of individual borrowers.

Besides, in Ethiopia, the case of commercial bank of Ethiopia, loan applicants can be issued only at head office and district level. As a result, customers are expected to travel long distances to their nearest head office or bank district level in order to get loan service. Most of the rural people of Ethiopia travel along distances to reach their nearest bank district level. Since they travel a distance, they are forced to spend cost. This problem is occurred due to absence of domain expert at Branch level, who can provide loan services and advisory services. Due to this, lots of people in rural areas are

limited from these services. So that, it is needed to develop knowledge based system which is use to overcome this problem.

Implementing computing technology for delivery of financial services is one way banks can reduce cost and possibility of loan defaults. Expert systems are of great interest to business and scientific communities because of their potential to enhance productivity and to boost work forces in areas where human experts are becoming harder to find and retain. Such systems can also be expected to improve the quality of the bank's asset base and increase overall profitability [5]. However, in Ethiopia, in the case of Commercial Bank of Ethiopia, there is no such like knowledge based system currently implemented. In the rural areas of Ethiopia, most of the people are not aware about loans. Lack of awareness of about loan hinders the banks to lose lot of customer which has a great impact on benefits comes from credits.

Because of personal impression and inconsistency, bank can be exposed to risks. These problems occurred due to personal bias and knowledge gap. According to Bryant [5], the major advantage in automating loan evaluations is the improvement in the bank's lending record through the uniform application of credit and security guidelines. That is, the system will ensure awareness of and adherence to relevant bank policies. Decision-making is more consistent and evaluations are more accurate that may result in more applications being accepted and fewer losses through defaults.

Hence, to overcome the above problem, the researcher initiated to design and develops self-learning knowledge based system incorporating the skills of domain experts to assist credit evaluator or officer in a credit evaluation as well as, provide advisory services for credit applicant requirements.

General research question

To this end, the study attempts to explore and find solution for the following general research question.

- What is the common credit production types advanced to the customer?
- What are the main criteria used in evaluation of each credit production type?
- How to model and represent the acquired knowledge for developing self- learning knowledge-based systems?
- How to design prototype self-learning knowledge based system for credit evaluation?

- Is a self-learning knowledge based system providing acceptable performance in credit evaluation in Commercial bank of Ethiopia?

1.3. Objective of the study

The general and specific objectives of this study are described here under.

1.3.1. General objective

The main objective of this study is to explore applicability of self-learning knowledge based system and to develop a prototype self- learning knowledge based system for credit evaluation of loan application and to provide advisory service for any credit customer.

1.3.2. Specific objectives

The following specific objectives are incorporated for achieving the general objective of the study.

- To review literature in order to have basic concepts, techniques, tools and principles of self-learning knowledge based system in credit evaluation.
- To explore tacit and explicit knowledge from the domain experts and written documents using suitable techniques.
- To identify the suitable models, representation techniques and implementing tools for the proposed self-learning knowledge base system.
- To develop a prototype self –learning knowledge based system for credit evaluation.
- To test and evaluate the performance of the developed prototype with domain experts.
- To forward further research direction in the area of KBS for credit evaluation

1.4. Methodology of the study

Methodology provides an understanding of how a research is conducted and organized in order to obtain information that is helpful for developing the design of a research and achieving objective of the study. The methods used in this study are described as follows.

1.4.1. Literature Review

In order to have the deep understanding on the problem of this study, it is important to review several literatures such as books, articles, journals, Internet, website and research works to acquire the concepts , domain knowledge , principles and methods that are essential for developing self-learning knowledge based systems for credit evaluation.

1.4.2. Methods of knowledge collection

Knowledge acquisition is the process of acquiring knowledge from a human expert or a group of experts for the development of knowledge-based systems. It comprises a set of techniques and methods that attempt to elicit knowledge of domain experts through some form of direct interaction with the expert.

In this research to acquire the required knowledge, both secondary and primary (codified and non-codified) sources of knowledge are used. Primary or non-codified knowledge is collected from credit evaluator experts, credit advisors and customer relationship manager, in Commercial Bank of Ethiopia by interviewing and critiquing knowledge elicitation methods (evaluating the acquired knowledge). In a similar way, secondary or codified sources of knowledge are acquired by using document analysis.

Semi-structured interview is used to gather tacit knowledge from the domain experts. In addition, analyzing elicitation methods are used to cleanse the acquired knowledge. The knowledge is validated with the consultation of the experts. Moreover, codified (documented) sources of knowledge are gathered from documented sources such as Internet, credit evaluation produces, research papers and website of the organization by using document analysis technique.

In this study, purposive sampling technique is used in order to select domain experts for knowledge acquisition. Purposive sampling is one of the most common sampling techniques in qualitative research in which participants are decided to preselected criteria relevant to a particular research question [61]. The selection criteria of domain experts for the study are based on the experts: - professional/expertise, educational qualification level and experience of work on credit evaluation. From twelve (12) domain experts, eight (8) domain experts were selected purposely from credit evaluator experts, credit advisors, and customer relationship manager to discover relevant tacit knowledge and for further consultations throughout the study.

1.4.3. Knowledge Modeling and Representation Methods

After the knowledge is gathered, the next step is modeling and representation. There is several knowledge modeling techniques. These techniques are decision tree, ladder, network diagrams, table and grids are some of knowledge modeling techniques. Ladders are hierarchical tree-like diagrams. Laddering techniques include the creation, reviewing and modification of hierarchical knowledge in the form of ladders. Network diagrams modeling techniques shows nodes connected by arrows and its nodes can represent concept, attribute, value or task and the arrows between the nodes any types of relationship. Table and grid modeling techniques are tabular representations make use of table or grids. For this study, decision tree knowledge modeling technique has been selected. The reason that the researcher select decision tree modeling technique, decision tree is used to model both tacit and explicit acquired knowledge. Decision tree is structure that can be used to divide a large collection of records into successively smaller sets of records by applying a sequence of simple decision rules. Its model consists of a set of rules for dividing a large heterogeneous population into smaller, more homogeneous groups with respect to a particular target variable. In addition, decision tree is suitable for rule based knowledge modeling. Decision trees models by constructing a tree based on training instances with leaves having class labels is used. There easy to interpret (can be represented as if –then –else rule).

The acquired knowledge is organized in a useable way. There are various techniques used to represent acquired knowledge in knowledge base system. Some of them are logic, frames, semantic network, production rule or rule-based knowledge representations, etc. The researcher select a rule based knowledge representation method to represent the relationship between facts and rules in the form of IF-THEN, which shows condition-action relationships. The reasons that, rule based knowledge representation is selected by researcher are that:

- It is easy to understand the knowledge content,
- Uncertainty can be incorporated,
- Easy to maintain or modify.

1.4.4. Implementation Tool

There are many programming tools used to develop knowledge based system. Among these, prolog, Lisp and expert system shells like CLIPS are widely used to develop knowledge based system. Also there is a tool used to develop case based recommender system which is called jCOLIBRI. For this research SWI- Prolog programming language is used to develop the prototype self-learning knowledge based system. Prolog (programming in logic) is one of the most widely used programming language, especially in the artificial intelligence research, natural language processing, system development, and so on. It is very useful especially on those mentioned areas to specify the situation (rules and facts) and the goal (query).The reason of the selection of this programming language is the features and abilities of the language that incorporate it. Prolog is a declarative language (we specify what problem we want to solve rather than how to solve it) and has the capacity to describe the real world.

According to Jasiński [3], SWI-Prolog editor has debugging tool and flexible help system as well as the code is readable and easier to update and maintain. Also, it offers backward reasoning capability. In addition,

- it is easy to learn the design tools;
- it has rule based programming and built in pattern matching features;
- it has comprehensive help system on each feature and
- It is readable code that will also make updating of the system a relatively manageable task.

SWI Prolog is the most inclusive and widely used Prolog development environment.
It has flexible and fast interface. In addition, it is portable to many platforms, including almost all UNIX/Linux platforms and Windows Vista. Additionally, it is non-commercial version of Prolog. So, it can be easily accessed. Therefore, the prototype self-learning knowledge based system is developed in SWI Prolog.

1.4.5. Testing and Evaluation

The evaluation of knowledge based system is an important aspect of knowledge based system development that is required to validate whether a system fulfills the desired objective. The developed prototype self-learning knowledge based system is extensively tested and evaluated including both performance of the prototype system and user's acceptance. To do this, six (6) domain experts were

selected from credit evaluator, credit advisor and customer relationship manager by using purposive sampling technique.

User acceptance measurements are deal with issues how well the system addresses the needs of the user, whereas validation measurement determine if the system perform the required objective successfully or not. The system evaluators use visual interaction methods together with questionnaire. Based on that, they evaluate the acceptance of prototype system by using questions.

Likewise validation process of the prototype self-learning knowledge based system has been tested using eighteen (18) test cases. Evaluators from the domain experts interacted with the system by taking a sample of test cases. Each case are selected purposively and used to test the performance of the prototype. The testing procedure is carried out by identifying correct and incorrect categorization of cases into their respective category. The comparison has been the decision made by system against evaluators. Decisions without significant difference between the domain experts and the knowledge based system would be accepted as good performance. After assessing the results concluded by system against human expert decision, then system evaluator has been measure its performance.

1.5. Scope and Limitation of the study

The study is intended to develop a prototype self-learning knowledge based system for domain expert and for any credit customers who want to apply or request for loan. There are about eight credit production types such as overdraft credit facility, import letter of credit facility, revolving export credit facility, merchandise, and pre-shipment export credit facility, Letter of guarantee Facility, term loan and consumer loan. The research concerns only on overdraft credit facility, import letter of credit facility, revolving export credit facility, merchandise and pre-shipment export credit facility. The reason that the researcher selects only these credit production types is due to the time limitation and due to high risks that came from these loan types as the researcher acquired the knowledge from domain experts.

The developed prototype self-learning knowledge based system gives advisory services for new and existing customer and helps to assist credit evaluators by evaluating the customer's request or application. The prototype evaluates the customer requests whether it is eligible or ineligible for the loan. Even though most eligibility is evaluated, some like general eligibility, specific eligibility, etc.

However, the developed prototype system did not evaluate credit analysis and credit scoring all at. To evaluate the credit risk of the customer's requests, it needs a serious evaluation. It needs detail study on those evaluation. Due to the short time available for the research, the study does not address all the credit risk analysis of the customer's request and credit scoring. Additionally, due to confidentiality (to keep the privacy of the bank) some data are not exposing to other person, i.e. for the purpose of keeping confidentiality of data.

Clearly, the developed prototype self-learning knowledge based system helps to assist the credit officer in evaluating application of the customer whether eligible or ineligible for the loan based on the criteria. The developed prototype also classifies the customer based on the specified criteria. Further, the system provides advisory services for both new and existing customer based on their request about requirements and criteria's that must be fulfilled. As knowledge based system, it also enables to remember the customer information from experience and update its knowledge.

1.6. Significance of the study

The immediate beneficiaries of this study are primary credit customer and credit evaluators or a domain expert who evaluates customer's requests. The prototype has great significance to teach primary credit evaluator experts and credit customer in order to have well understanding about credit requirements and criteria. As a result, those credit evaluator experts can use the system for credit evaluation of customer's application based on rule and procedure of the loan. The developed prototype self-learning knowledge based system is used to give advising services for both new and existing credit customer. The prototype self-learning knowledge based system is developed using the knowledge of credit evaluator or credit officer domain experts, customer relationship manager, credit advisors and credit procedure documentary sources which is used as organizational memory. In addition to these benefits, the developed prototype can use an input for further research conducted in the areas.

1.7. Organization of the Thesis

The study is organized in to five chapters.

Chapter one is the introduction part, which contains the background, statement of the problem and justification, objectives, scope and limitations of the study, significance of the study and methodology to carry out the research.

Chapter two is overview of knowledge based system, about knowledge, types of knowledge, architecture of knowledge based system, concepts of self-learning, knowledge acquisition, modeling, and representation, advantage and disadvantage of knowledge based system, expert system and related work are present in this chapter.

Chapter three

Chapter three discusses the core parts of the research such as knowledge acquisition, knowledge modeling and knowledge representation of credit application.

Chapter four

Is deals about the development of the prototype system the under study, results found in the evaluation and testing process of the prototype self –learning KBS.

Chapter Five focuses on the conclusion and recommendation based on the finding of the research and recommendations are proposed for future work.

Chapter Two

2.0. Literature Review

2.1. Introduction

Under this Chapter, the researcher provides a brief overview of the field of knowledge based system. The architecture and the approaches used to represent and model knowledge are reviewed and presented. The application areas of knowledge based system, the concept of self -learning knowledge based system are also reviewed and presented. Method of knowledge acquisition, tools used in knowledge based development are also presented in this chapter.

2.2. Overview of knowledge based system

A Knowledge base is organized Repository of information consisting of concepts, data, rules and specifications for efficient knowledge management. It is a repository where information can be collected, organized, shared and searched. Knowledge bases can be classified into Machine readable knowledge bases that largely consist of Artificial intelligence (AI) or expert system based retrieval techniques and Human readable knowledge bases that comprise of physical documents and textual information such as Tutorials [8].

In machine readable knowledge bases, the knowledge is in a computer readable form, mainly for the purpose of having an automated deductive reasoning applied to it. They consist of a primitive set of data, often in the form of rules that describe the knowledge. These rules are then extended to deduce or derive a logical conclusion.

A knowledge base comprises of large amount of detail about the configuration and facts pertaining to a specific domain or subject of interest. If the domain knowledge is encoded in a computer, the knowledge based system should be able to answer some questions that normally require human expertise. Further, the encoding should also be understandable by a human, so that it can be used, verified and expanded. In Order to develop such knowledge based systems, one needs to be able to efficiently model the knowledge and also be able to represent it. Knowledge based system (KBS) provides intelligent decisions with justifications and uses AI for problem solving and to support human

learning and action. It is part of an expert system that contains the facts and rules needed to solve a problem. It contains an underlying set of concepts, assumptions and rules, which a computer system has available to solve any problem.

Therefore, knowledge based systems are basically computer programs that contain large amounts of information, rules and a reasoning system for making intelligent inferences [8].

2.3. Knowledge

Knowledge is "a fluid mix of framed experience, contextual information, values and expert insight that provides a framework for evaluating and incorporating new experiences and information" [9]. Knowledge is also defined as information that changes something or somebody either by becoming grounds for actions, or by making knowledge an individual or an institution capable of different or more effective action [10]. Philosophers have been thinking about knowledge for thousands of years. Part of their activities has been the identification of various types of knowledge and classification system. These typologies have been adopted by knowledge engineers when analyzing texts and constructing knowledge models [9].

2.4. Types of knowledge

According to Pan. SL and Scarbrough H [9], there are various types of knowledge which is discussed as follows.

I. Declarative vs. Procedural knowledge

The main difference between declarative knowledge (knowledge of facts) and procedural knowledge (knowledge of how to do things, or what has been called "knowing that "and "knowing how". Within knowledge engineering, these two types of knowledge are often referred to as object knowledge and process or task knowledge.

Declarative knowledge is a descriptive representation of knowledge. It tells us facts what things are. It is expressed in a factual statement, such as "there is a positive association between smoking and cancer." Domain experts tell us about truths and associations.

This type of knowledge is considered shallow or surface level, information that experts can verbalize. Declarative knowledge is especially essential in the initial stage of knowledge acquisition [11].

In contrary, procedural knowledge considers the manner in which things work under different sets of situation. For instance, "compute the ratio between the price of a share and the earnings per share. If the ratio is larger than 12, stop your investigation. Your investment is too risky. If the ratio is less than 12, check the balance sheet". Thus, procedural knowledge includes step-by-step sequences and how-to types of instructions; it may also include explanations. It involves automatic responses to stimuli and it may also tell us how to use declarative knowledge and how to make inferences [11].

II. Tacit vs. Explicit Knowledge

Another well-known types of knowledge is that of tacit knowledge (cannot be articulated easily) and explicit knowledge (can be articulated easily).This is particularly important for knowledge engineers, as special techniques have to be used with an expert to try to elicit tacit knowledge, which is the hardest and often the most valuable knowledge to obtain.

Explicit knowledge can be easily express in words or numbers and shared in the form of data, scientific formulae, product specifications, manual and universal principles. It is more formal and systematic. In another ways, tacit knowledge is the knowledge stored in subconscious mind of experts and not easy to document. It is highly personal and hard to formalize, and hence difficult to represent formally in system subjective insights, intuitions, emotions, mental models, values and actions are examples of tacit knowledge [12].

III. Generic vs. Specific Knowledge

A further way of classifying knowledge is to what extent it is generic (applies across many situations) or specific (applies to one or a few situations). Developing ways in which specific knowledge can be made more generic, and generic knowledge can be made more specific, has been a major effort in knowledge engineering.

Iv. Factual vs. Heuristic Knowledge

According to R. S.E and Edward, F [13], knowledge is classified as factual and heuristic. Factual knowledge is knowledge of the task domain that is widely shared, typically found in textbooks or journal, and commonly agreed upon by those knowledgeable in the particular field.

Heuristic knowledge is less accurate, more empirical and judgmental knowledge of performance. In contrast of factual knowledge, heuristic knowledge is rarely discussed, and is largely individualistic.

It is the knowledge of good practice, judgment, and plausible reasoning in the field. It is knowledge that underlies the "art of good guessing".

2.5. Level of knowledge

Knowledge can be represented at different levels. According to [11], there are two type levels of knowledge which is discussed as follow.

Shallow knowledge (surface knowledge): is the representation of surface –level information that can be used to deal with very specific conditions. The shallow knowledge basically represents input/output relationship of a system and its representation is limited, i.e. a set of rules by itself may have little meaning for the user. It may have little to do with the manner in which experts view the domain and solve problems. This may limit the capability of the system to provide appropriate explanations to the user. Its knowledge may also be insufficient in describing complex situations. Therefore, a deeper presentation is often required.

Deep knowledge: is the internal and causal structure of a system and involves the interactions between the system's components. It can be applied to various tasks and various situations. It is also hard to automate this kind of knowledge. The system developer should have a complete intellectual ability of the main components and their relations.

2.6. Architecture of Knowledge based System

KBS incorporates the following major components to accomplish it mission which is established for. These parts are discussed below both diagrammatically and theoretically.

- The knowledge base
- The inference engine
- The user interface
- The explainer and the knowledge acquisition subsystem

Figure 2.1 below illustrates the building blocks of knowledge based system architecture

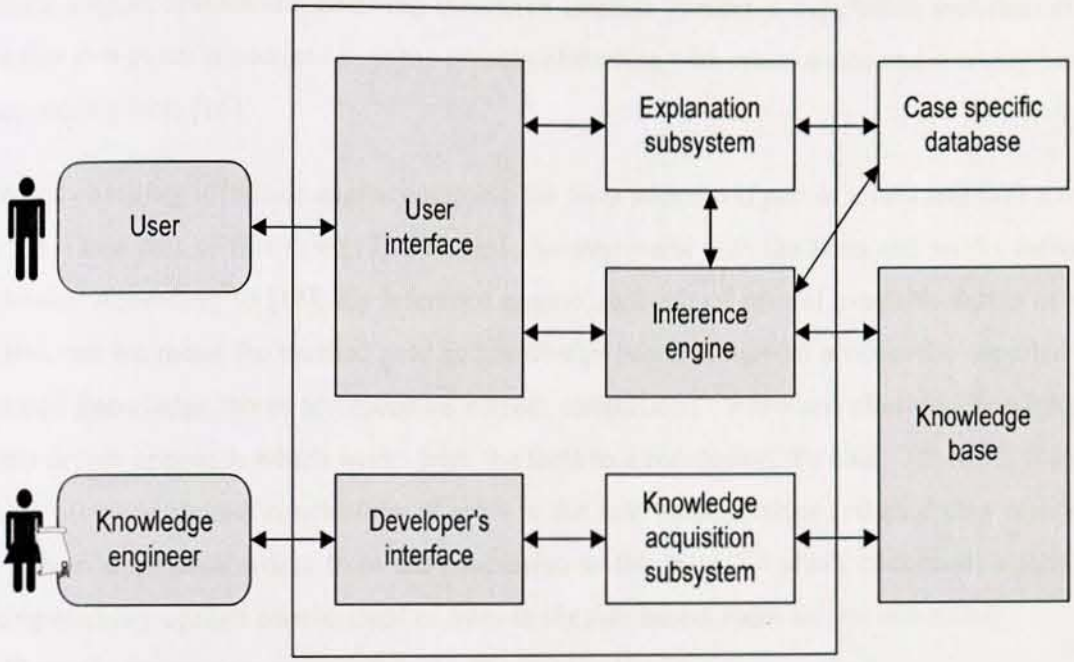


Figure 2.1: Components of KBS Architecture [62]

2.6.1. Knowledge base

Knowledge based is the heart of the KBS, contains the specific knowledge about the system of expertise in the form of facts and rule. The rule uses the facts in driving the conclusion [14]. 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, the main techniques used for representing the knowledge are rule, first order predicate logic, frame and network [15].

2.6.2. Inference Engine

The purpose of the inference engine is to seek information and relationships from the knowledge base and to provide answers, predictions, and suggestion the way a human expert would. It must find the right facts, interpretation, and rules and assemble them correctly [16]. Inference engine compares the user's information with the knowledge in knowledge base, and derives whatever conclusions may

logically follow. There are two common inference methods. These are backward and forward chaining inference engine. **Backward chaining inference engine:** guesses a conclusion and then attempts to prove that this guess is correct i.e., is the process of starting with conclusions and working backward to the supporting facts [16].

Forward chaining inference engine compares the facts with the **If** part of a rule and fires a conclusion from the **Then** part of that rule [17]. Forward chaining starts with the facts and works forward to the conclusion. According to [18], the inference engine uses one of several available forms of inference. By inference we mean the method used in knowledge based system to process the supplied data, and the stored knowledge, so as to procedure correct conclusions. **Forward chaining** Sometimes called the data driven approach which works from the facts to a conclusion. To chain for word, match data in working memory against conclusions of rules in the rule based. **Backward chaining** which is called **goal driven approach** works from the conclusion to the facts. To chain backward, match a goal in working memory against conclusions' of rules in the rule based. Here are the two rules:

If corn is grown on poor soil, then it will rot.

If soil hasn't enough nitrogen, then it is poor soil.

Forward chaining: this soil is low in nitrogen; therefore this is poor soil; therefore corn grown on it will rot.

Back word chaining: this corn is rotten; therefore it must have been grown on poor soil; therefore the soil must be low in nitrogen [18].

2.6.3. User Interface

According to Castillo et al. **[19]** noted that, user interface is a channel for communication between the KBS and the end-user. Therefore, in order for the KBS to be an interactive tool, it should include a means to show and retrieve information in a simple manner. Examples of information to be shown are the consequences made by the inference engine, the justifications for such consequences, and an explanation for the actions made by the KBS. The user interface offers a mechanism for attaining the desired information from the end-user. Therefore, an insufficient implementation of the user interface that does not assist this process would hinder the importance of the KBS by the end-users. Moreover, the reason for the significance of the user interface component is that end-users usually evaluate KBSs based on the quality of the user interface instead of the KBS itself **[19]**.

The user interface is basically a language processor which allows the end-user to communicate with the KBS in a problem solving, usually some restricted variant of English. Typically, the user interface parses and interprets user questions, commands and volunteered information. On the other hand, the interface formats information's generated by KBS, including answers to questions, explanations and justifications for its behavior and requests for information [20].

2.7. 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 **[21]**. According to Akerkar and Sajja **[22]**, "Self-learning" is a scientific task that enables the knowledge-based system to learn automatically from the inference process, cases executed. 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". One of the key characteristics of KBS is the capability to learn. According to Castillo et al. **[19]**, there are three methods of learning. These are structural learning, parametric learning and learning by memorization. According to Saxena [23], learning is the most critical attribute of intelligence and an evolving knowledge base. The system should learn from experience about how the environment behaves and should create a model of this environment. So that, if the environment changes, system should be able to recognize the changing behavior and adapt to new behavior of the environment [23].

Structural learning denotes to certain features associated to the structure of knowledge such as rules and probability distributions. For example, finding new related criteria for a certain application or incorporating a new rule in the knowledge base.

Parametric learning denotes to conjecturing the parameters required to build the knowledge base.

Learning by memorization denotes the capability of KBS to learn from experience based on the existing data. Using this method, KBS can carry out different activities such as storing or memorizing knowledge, and learning from the facts base. The following figure 2.2 shows a program that learns by memorization method **[24]**.

```
? - start.
Type names all in lower case, followed by period.
Type "stop." to quit.
Please enter the name of state? England.
The capital city of England is London.
Please enter the name of state? China.
I do not know the capital city of that state.
Please tell me.
Please enter the name of capital city? Beijing.
Thank you.
Please enter the name of state? Egypt.
The capital city of Egypt is Cairo.
Please enter the name of state? China.
The capital city of china is Beijing.
Please enter the name of state? Stop.
Saving the facts base...
Done.
```

Figure 2.2: A program that shows self-learning [24]

As shown in above figure 2.2, the program has learned what the capital city of china is. The learning process is continuous, i.e. when we run the program at the next session and question for the capital city of china, the program replies the right answer. As one can easily understands from the above figure 2.2, the program learns the capital city of china after the user told to the system. The capital city of china is stored in knowledge base of the program and the program memorize when the user inserts the state china.

2.7.1. Data Storing Strategies

According to Covington et al. [24], there are three places you can store data in a prolog program. These are: **In the instantiation of a variable**. This is the least permanent way of storing information, because a variable exists only within the clause that defines it. Further, variables lose their values upon

backtracking. That is, if a particular sub goal instantiates a variable and execution then backs up past that sub goal, the variable will revert to being uninstantiated.

In arguments of predicates. The argument list is the only way a Prolog procedure normally communicates with the outside world. (Input/output predicates and predicates that modify the knowledge base are exceptions, of course.) By passing arguments to itself when calling itself recursively, a procedure can perform a repetitive process and save information from one repetition to the next.

In the knowledge base. This is the most permanent way of storing information. Information placed in the knowledge base by asserta or assertz remains there until explicitly retracted and is unaffected by backtracking. A simple example of storing knowledge in the knowledge base is the predicate

2.7.2. Rule- learning

According to [25], there are two type of rule learning. These are Inductive and Deductive rule learning. Inductive rule learning creates rule about a domain, not derivable from any previous rule. The best example of inductive rule learning is neural network.

The second one is Deductive rule learning which enhance the efficiency of a system's performance by deducting additional rules from previously known domain rules and facts. Explanation-Based Generation (EBG) is the best example.

2.8. Knowledge Engineering Process

The process of acquiring knowledge from experts and building a knowledge base is called Knowledge Engineering [11]. According to [11], the knowledge engineering process includes five major activities as described as follows.

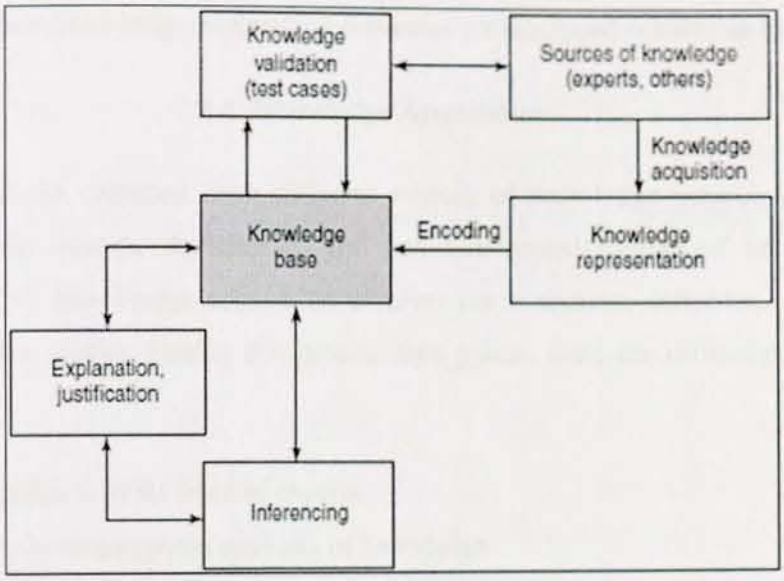


Figure 2.3: process of knowledge Engineering [11].

I. **Knowledge Acquisition**: knowledge acquisition involves the acquisition of knowledge from human experts, books, documents sensory, or computer files. The knowledge may be specific to the problem domain or to the problem solving procedures, it may be general knowledge (knowledge about business), or it may be Meta knowledge (knowledge about knowledge).

II. **Knowledge Representation:** Acquired knowledge is organized so that it will be ready for use in activity called knowledge representation. This activity includes preparation of a knowledge map and encoding of the knowledge in knowledge base.

III. **Knowledge validation:** Knowledge validation or verification involves validating and verifying the knowledge. This is done by using test cases until its quality is acceptable. Testing results are usually shown to a domain expert(s) to verify the accuracy of the ES.

IV. **Inference:** This activity includes the design of software to enable the computer to make inferences based on the stored knowledge and specifies of a problem. The system can then provide advice to non-expert users.

V. **Explanation and justification:** This step involves the design and programming of an explanation capability (e.g., programming the ability to answer question such as why a specific piece of information is needed by the computer or how a certain conclusion was derived by the computer).

The above knowledge engineering processes are discussed detailed as following.

2.8.1. Knowledge Acquisition

Knowledge can be collected from different sources of knowledge sources such as book, Internet, website, domain experts, documented and non-documented sources of knowledge. According to chakraborty [26], Knowledge acquisition involves the elicitation, collection, analysis, modeling and validation of knowledge. During this process take places, there are various problem/issues occurred. These are:

- Knowledge is in the head of experts
- Experts have enormous amounts of knowledge
- Experts have lots of tacit knowledge; Experts do not know all that they know and use. The tacit knowledge is hard (impossible) to describe.
- Experts are very busy and valuable people
- One expert does not know every thing

2.8.2. Techniques of knowledge acquisition

As chakraborty [26] noted, there are basic techniques acquiring, analyzing and modeling knowledge are: protocol generation techniques, protocol analysis techniques, hierarchy generation techniques, matrix –based techniques, sorting techniques, and diagram based techniques.

Protocol-generation techniques

This technique engages many types of interviews (unstructured, semi-structure and structured) reporting and observation techniques for knowledge gathering.

Protocol analysis techniques

The protocol analysis technique used with transcripts of interviews or text-based information to identify basic knowledge objects within a protocol, such as goals, decisions, relationships and attributes. These act as a bridge between use of protocol- base techniques and knowledge modeling techniques.

Hierarchy generation techniques

It involves creation, reviewing and modification of hierarchical knowledge. Hierarchy-generation techniques, such as laddering, are used to build taxonomies or other hierarchical structures such as goal trees and decision networks. The Ladders are of various forms like concept ladder, attribute ladder, composition ladders.

Matrix-based techniques

The matrix-based knowledge acquisition techniques involve the construction and filling-in a 2-D matrix (grid, table), indicating such things, as may be, for example, between concepts and properties (attributes and values) or between problems and solutions or between tasks and resources, etc. The elements within the matrix can contain: symbols (ticks, crosses, and question marks), colors, numbers, and text.

Sorting Techniques

Sorting knowledge acquisition techniques used for capturing the way people compare and order concepts; may reveal knowledge about classes, properties and priorities.

Diagram-based techniques

This method of knowledge acquisition include generation and use of concept maps, state transition networks, event diagrams and process maps.

These are particularly important in capturing the "What, how, when, who and why" of tasks and events.

2.8.3. Methodology for KBS Development

2.8.3.1 CommonKADS

CommonKADS is considered the leading methodology to support structured knowledge engineering. It has been gradually developed and has been validated by many companies and universities in the context of the European ESPRIT IT program. CommonKADS enables the recognition of opportunities and how organizations develop, distribute and apply their knowledge management. It also provides the

methods to perform a detailed analysis of knowledge-intensive tasks and processes and supports the development of knowledge base system [11].

According to [63] commonKADS methodology is contains of a number of elements. These elements are shown in the form of a pyramid. The methodological pyramid has five layers (as illustrated in figure 2.4 below). Regarding to these layer, there are a number of principle and rules. These principles are:

- Knowledge engineering is not some kind of "mining from the expert's head" however consists of constructing different aspect models of human knowledge.
- In knowledge modeling, first concentrate on the conceptual structure of knowledge, and leave the programming details for later.
- Knowledge has a stable internal structure that is analyzable by distinguishing specific knowledge types and roles.

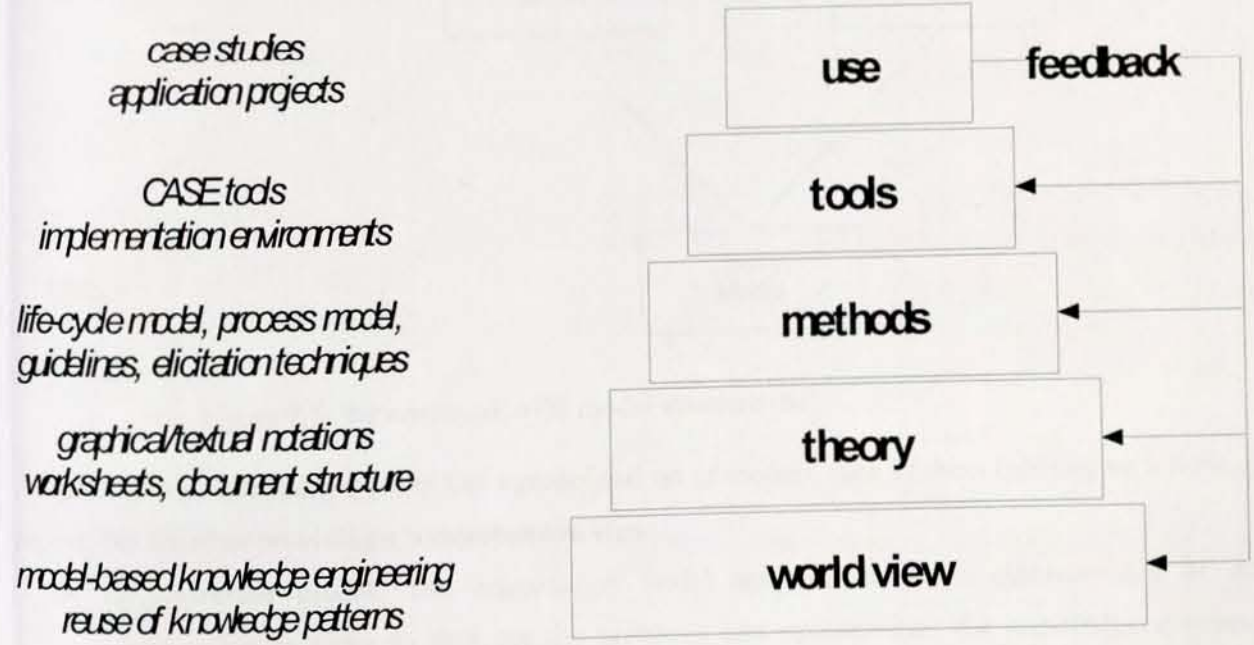


Figure 2.4: Methodological pyramid [63]

2.8.3.2 CommonKADS model structure

Figure 2.5 below shows the CommonKADS model structure that is the practical expression of the principle underlying knowledge analysis. It includes different section of the CommonKADS knowledge-engineering methodology which should be developed in order to create a comprehensive knowledge management system.

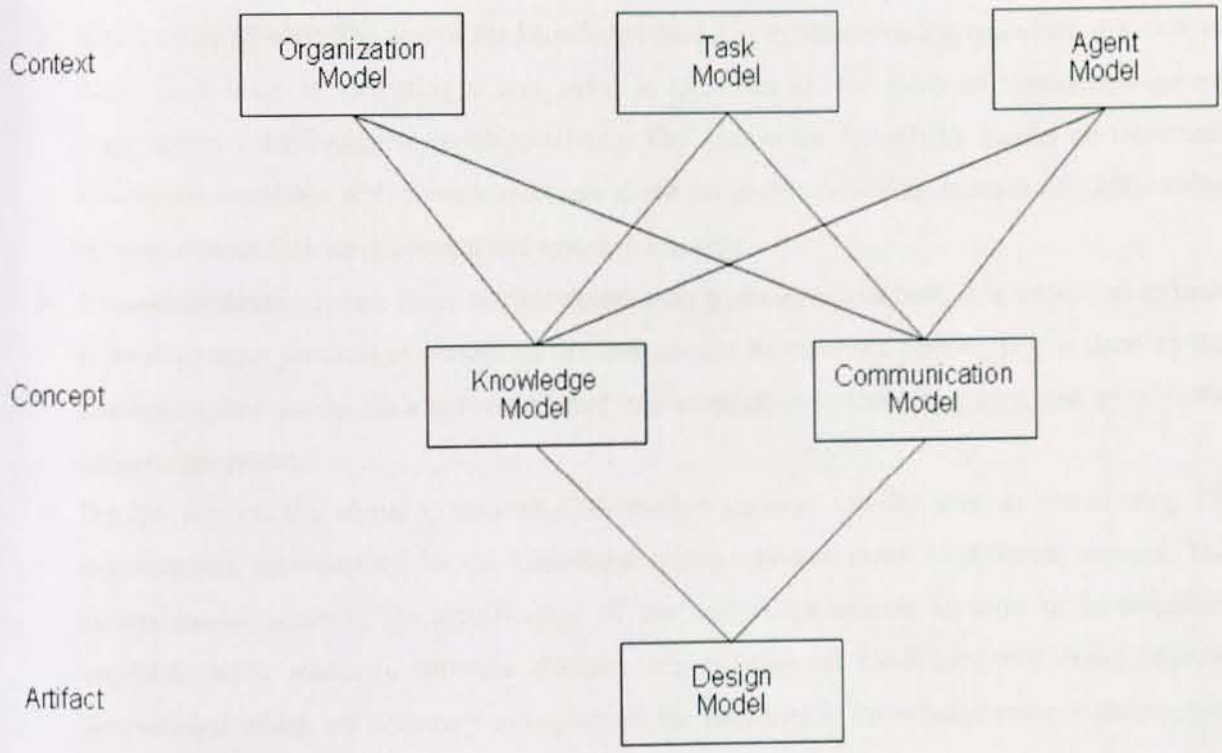


Figure 2.5: the commonKADS model structure [64]

According to [64], commonKADS has a predefined set of models, each of them focusing on a limited aspect, but together providing a comprehensive view:

- **Organization model:** The organization model analyzes the main characteristics of an organization in order to find out the problems and opportunities for knowledge systems. Furthermore, it includes the feasibility study and the impacts of the intended knowledge system on the organization.

- **Task model:** Tasks are the sub-processes of a business process. The task model analyzes the task layout, its input and output, preconditions and performances criteria and the needed resources and competences.
- **Agent model:** Agents are executors of a task. An agent can be human, an information system, or any other entity which are able to perform a task. The agent model describes the features of agents, in particular their competences, authority to act, and constraints in this respect. Moreover, it lists the communication links between agents in carrying out a task.
- **Knowledge Model:** The aim of the knowledge model is to determine the types and structure of knowledge used in executing a task. Also it identifies all the roles of knowledge-system components contributing in problem-solving. This makes the knowledge model an important tool to communicate with experts and users about the problem-solving features of a knowledge system, during both development and system execution.
- **Communication model:** Since several agents may participate in a task, it is important to have communication protocol to present all the transactions between the agents. This is done by the communication model, in a conceptual and implementation independent way, just as with the knowledge model.
- **Design model:** the above CommonKADS models together can be seen as constituting the requirements specification for the knowledge system, broken down in different aspects. The design model presents the specification of the knowledge system in term of architecture, implementation platform, software modules, representational constructs, and computational mechanisms which are necessary to implement the functions in knowledge and communication models.

Together, the organization, task, and agent models analyze the organizational environment and the corresponding critical success factors for a knowledge system. The knowledge and communication models create the conceptual description of problem-solving functions and data that are to be handled and delivered by a knowledge system. The design model converts this into a technical specification that is the basis for software system implementation. Thus process is depicted in above figure 2.5. It should be noted, however, it is not necessary to construct all the models [64].

2.8.4. Difficulties in knowledge acquisition

Knowledge acquisition is not an easy task. It includes identifying the knowledge, representing the knowledge in a proper format, structuring the knowledge, and transferring the knowledge to a machine. The process of knowledge acquisition can be greatly influenced by the roles of the three major participants: the knowledge engineer, the expert, and the end user [27].The following are some factors that add to the complexity of knowledge acquisition from experts and its transfer to a computer:

- Experts may not know how to articulate their knowledge or may be unable to do so.
- Experts may lack time or may be unwilling to cooperate.
- Testing and refining knowledge is complicated.
- Methods for knowledge elicitation may be poorly defined.
- System builders tend to collect knowledge from one source, but the relevant knowledge may be scattered across several sources.
- Builders may attempt to collect documented knowledge rather than use experts. The knowledge collected may be incomplete.
- It is difficult to recognize specific knowledge when it is mixed up with irrelevant data.
- Experts may change their behavior when they are observed or interviewed.

2.9. Knowledge Modeling

Knowledge models are views of knowledge based using diagram and other structured representation like trees, maps, matrices and annotation pages [13]. Models are applied to express the important characteristics of real-time systems to understand in a simple way by dividing them into small parts. Models are more related with problem domain they represent **[28]**. Real-time systems are huge objects comprising of interconnected elements doing in complications as teamwork. Models assist individuals to weigh-up and know such complications by supporting them to explore every specific area of the system. Models are applied in the construction process of systems to draw the architecture of the system and to simplify the exchange of information between several individuals in the group at various levels of abstraction. Individuals have several understandings of the system and models can assist them to know these understandings in a coordinated way.

The generation and modification of a knowledge model is an essential aspect of knowledge acquisition, as the model helps to clarify the language being used and quickly convey information for validation and modification where necessary. Thus, the use of knowledge models is of great important during knowledge elicitation from an expert, validation with the same expert, cross-validation with another expert, knowledge publication, maintenance and updating of the knowledge [13].

Different techniques can be used in modeling the domain knowledge, for example, decision trees, hierarchical structure and maps. Decision trees can help steps (decisions) to find a solution for a certain problem domain. Decision trees play a crucial role in the knowledge modeling process. A decision tree is a graphical representation of the search space of a certain problem domain. It carries out classification by building a tree based on training instances with leaves having class labels. A node in the tree represents a decision rule on one or more attributes when solving the problem and the leaf nodes growing out from the node represents the predicted class labels of the decision [29].

Hierarchical structure hierarchical structured knowledge is easy to find and understand by the, easy to use by software's and easier for maintenance, management and re-use [59]. In hierarchical structure, each component in a system belongs at a certain conceptual layer. More complex components are designed starting from simpler components from the same layer or from the lower layers. Drawing a hierarchically organized tree of components that spans a across multiple layers can represent the architecture of the system [59].

2.10. Knowledge Representation

Knowledge representation is the process of encoding formalizing and organizing the knowledge acquired into rule or cases or patterns for use by expert system [13]. Common knowledge representation methods include First Order Predicate Logic (FOPL), production rules, frame, semantic network and ontology. One widely used representation is the production rule. Expert systems whose knowledge is represented in the rule form are rule- based system. As [30] noted that, there are four basic techniques for representing the acquired knowledge in a knowledge base. These are Logic, Semantic networks, Frames and production rule. Each of them is described as follows.

Logic Knowledge and reasoning could be represented using predicate logic. This is the basis of the programming language PROLOG. Prolog is an abbreviation for PROgramming in LOGic. It is designed basically to handle/manipulate knowledge representation using FOPL [31].

The expressiveness of Prolog is due to three major features of the language: rule base programming, built in pattern matching, and backtracking excision. The rule-based programming allows the program code to be written in a form which is more declarative than procedural. This is made possible by the built-in pattern matching and backtracking which automatically provide for the flow of control in the program. Together these features make it possible to elegantly implement many types of KBSs [32].

Semantic networks: is illustrates the natural relationships between objects, concepts and used to represent declarative or descriptive knowledge. Semantic networks are constructed using nodes linked by directional lines called arcs. Nodes represent a fact description of physical object, concept, event and arcs or links represents relationships between nodes.

As Sowa [33] noted, semantic network or net is a graphic notation for representing knowledge in patterns of interconnected notes and arcs. It is basically a graph where the nodes are labeled by atomic formulas, and arcs represent relations between them. The nodes of this graph then represent entities and classes of entities.

Frame is a data structure containing typical knowledge about a concept or object. It represents knowledge about real world things (or entities). Frame encompasses both semantic and procedural knowledge and contains descriptions of attributes and procedural details. Expert (knowledge base) systems that use frames as their fundamental knowledge representation scheme are called frame-based systems. Frame contains two key elements; **slot** and **facet**. Slot is set of attributes for specific object being described and facet extended knowledge about the attribute in a frame.

Production rule consist of conditional statements and expresses relationships between parameters and variables. It is easy to understand, express heuristic knowledge and incorporates uncertainty and also expressed in module. Expert systems that use a knowledge base consisting of production rules are called rule-based systems. It is one of the most popular and widely used knowledge representation languages. Rules represent a very human friendly knowledge representation. They are composed of simple if –then clauses that are activated usually according to a custom heuristic function. One of the cited advantages of rule- based systems is their modularity, simplicity and good performance.

Disadvantages of production rules as a knowledge representation language includes: inefficient (not suitable for modeling complex world relationships) and less expressive [14]. Example for rule based knowledge representation as adopted from [33].

For two color lights green and red:

If the 'traffic light' is green, then the action is go

If the 'traffic light' is red, then the action is stop.

The following table 2.1 summarizes the advantages and disadvantages of knowledge representation techniques

Scheme	Advantages	Disadvantages
Production rule	Simple syntax, easy to understand, simple interpreter, highly modular, flexible (easy to add to or modify)	Hard to follow hierarchies, inefficient for large system, not all knowledge can be expressed as rule, poor at representing structured descriptive knowledge.
Semantic networks	Easy to follow hierarchy, easy to trace associations, flexible	Meaning attached to nodes might be ambiguous, exception handling is difficult, difficult to program.
Frames	Expressive power, easy to set up slots for new properties and relations, easy to create specialized procedures, easy to include default information and detect missing values.	Difficulty to program, difficulty to inference, lack of inexpensive software.
Formal logic	Facts asserted independently of use, assurance that only valid consequences are asserted(precision), completeness	Separation of representation and processing, inefficient with large data sets, very slow with large knowledge bases.

Table 2.1: Advantages and Disadvantages of knowledge representation techniques [34].

2.11. Advantage of knowledge Base System

The main benefits of knowledge based system depicted as follows [12]:

- When intelligent assistance and/or training are required for the decision making for problem solving.
- When more than one experts' knowledge have to be grouped at one platform.
- knowledge based systems integrate knowledge of different expertise's in a particular domain and providing in one place the union of what several different experts know about a particular domain.
- In addition, knowledge based systems provide a clear record of the best knowledge available for handling a specific problem. Hence, knowledge based systems are the best technology to preserve expertise knowledge for future use.

They help to distribute widely rare human knowledge and minimize human expertise needed at a number of locations at the same time, and with less amount of time. When expertise is unavailable, a knowledge based system can act as an expert on demand to save time. Knowledge based systems can save money by leveraging expert, and allowing users to function

- At higher level and promoting consistency. Additionally, knowledge based systems can increase cost-effectiveness in the transfer and dissemination of existing knowledge.
- Similarly, knowledge based systems can be used to distribute experts' knowledge in a structured manner. Particularly, they provide beginner with expert advice on a specific subject and aids in training new employees. As a result, knowledge based systems bring greater innovation by allowing creative professionals to explore, understand; discard and rework many alternative paths to a needed solution.

In general, with the proper utilization of knowledge, the knowledge-based systems increase productivity, document rare knowledge by capturing scare expertise, and enhance problem solving capabilities in most flexible way. Such systems also document knowledge for future use and training. This leads to increased quality in problem solving process.

In addition to the above listed advantages, there are some better features of knowledge base system to identify from the other system. The following table 2.1 summarizes the main difference between knowledge based system, human experts and conventional program [35].

Human Experts	**Knowledge based system**	**Conventional program**
Use knowledge in the form of thumb or heuristic to solve problems in a narrow domain	Process knowledge expressed in the form of rules and use symbolic reasoning to solve problems in narrow domain	Process data and use algorithms in a series of well defined operations to solve general numerical problems
In human brain, knowledge exists in a compiled form	Provide a clear separation of knowledge from its processing	Do not separate knowledge from the control structure to process this knowledge
Use inexact reasoning and can deal with incomplete, uncertain and fuzzy information	Permit inexact reasoning and can deal with incomplete, uncertain and fuzzy data	Work only on problems where data are complete and exact
Can make mistakes when information is incomplete or fuzzy	Can make mistakes when information is incomplete or fuzzy	Provide no solution at all, or wrong one, when data are incomplete or fuzzy.
Enhance the quality of problem solving via years or learning and practical training. This process is slow, inefficient and Expensive	Enhance the quality of problem solving by adding new rules or adjusting old ones in the knowledge base. When new knowledge is acquired, changes are easy to accomplish.	Enhance the quality of problem solving by changing the program code, which affects both the knowledge and its processing, making changes difficult

Table 2.2: Comparison of Human Experts, KBS and Conventional programs

2. 12. Limitation of Knowledge Base System

Even though the knowledge based system has benefits, it has also its own drawbacks which are illustrated as follows [12]. The scarcity and nature of knowledge make the KBS development process difficult and complex. The transparent and abstract nature of knowledge is mainly responsible for this. In addition, this field needs more guidelines to accelerate the development process

- Acquisition, representation and manipulation of the large volume of the data/information/knowledge are very complex.
- High-tech image of the AI field.
- Abstract nature of the knowledge.
- Limitations of cognitive science and other scientific methods.
- their knowledge is from a narrow field, don't know the limits .
- the answers are not always correct (advices have to be analysed).
- don't have common sence (greatest restriction) → all of the self-evident checking have to be defined many exceptions → increase the size of KB and the running time).

2.13. Expert system

Expert system is computer applications which represent some non-algorithmic expertise for solving certain types of problems. It is an interactive computer based decision tool that uses both facts and heuristics to solve difficult decision making problem based on knowledge acquired from domain expert. Expert system is a model and associated procedure that exhibits within a specific domain, a degree of expertise in problem solving that is comparable to that of a human expert [26].

An expert (knowledge based) system is a problem solving and decision making system based on knowledge of its task and logical rules or procedures for using knowledge. It is a program that emulates the interaction a user might have with a human expert to solve a problem [36].

Expert system is a computer program that represents and reason with knowledge of some specialist subject with a view to solving problems or giving advice. To solve expert system level problems, expert systems will need efficient access to a substantial domain knowledge based, and reasoning

mechanism to apply the knowledge to the problems they are given. The expert system will generally build upon the ideas of knowledge representation, production rules, search and the like [37].

2.13.1. Characteristics of expert systems

Expert system (ES) distinguished from traditional computer system in different ways. As Tripathi [38] noted that, expert system is different from traditional computer system in that:

- Expert system simulates human reasoning about the problem domain, rather than simulating the domain itself.
- It performs reasoning over representations of human knowledge and contains corresponding distinct models referred to as the inference engine and knowledge.
- Problems tend to be solved using heuristics or approximate methods or probabilistic methods which, unlike algorithmic solution, are not guaranteed to result in a correct or optimal solution.
- It usually has to provide explanations and justifications of their solutions or recommendations in order to convince the user that their reasoning is correct.

According to chakraborty [26], expert system is characterized as operates as an interactive system and make logical inference based on knowledge stored as well as it has the ability to explain reasoning and update knowledge based on a continuing basis.

2.13.2. Architecture of Expert system

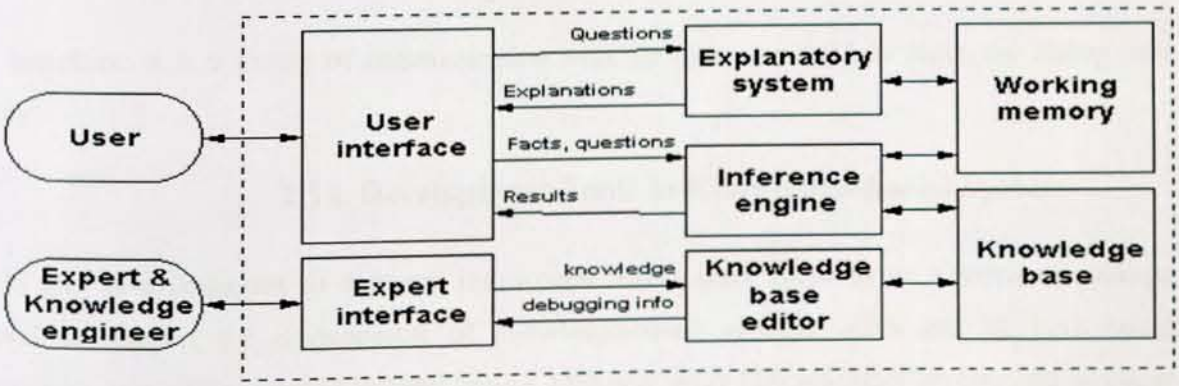


Figure 2.6: Architecture of ES [30]

The inference engine and knowledge base are separated because of the reasoning mechanism needs to be as stable as possible and the knowledge base must be able to grow and changed, as knowledge is added. Any practical expert system needs an explanatory facility. It is essential that an ES should be able to explain its reasoning because of it gives the user confidence on the system and it makes easier to debug the system **[30].**The main architecture of ES is described as follows **[38].**

Knowledge base: the knowledge base contains the knowledge necessary for understanding, formulating and for solving problem. It is a warehouse of the domain specific knowledge gathered from domain expert thorough the knowledge acquisition methods. The knowledge base of expert system contains both factual and heuristic knowledge. Factual knowledge is the knowledge of the task domain that is widely shared. Heuristic knowledge is the less rigorous, more experiential and more judgmental knowledge of performance. It is the knowledge of good practical, judgmental and plausible reasoning in the field.

Inference Engine: inference engine is a brain of expert system. It uses the control structure (rule interpreter) and provides methodology for reasoning. The major task of inference engine is to draw is ways through a forest of rules to arrive at a conclusion. Here two approaches forward chaining and backward chaining are used.

Explanation: it is a subsystem that explains the system's actions. The explanation can range from how the final or intermediate solutions were arrived at to justifying the need for additional information. Here user would like to ask the basic question.

User interface: it is a means of communication with the user, and used to make the dialog user friendly.

2.14. Development Tools in Knowledge-Based System

A KBS tool is a collection of software instructions and utilities taken to be a software package designed to support the development of knowledge-based systems. KBS can be built using programming languages namely LISP and Prolog. John McCarthy **[38]** published an outstanding paper showing a handful of simple operators and a notation for functions, one can develop a full programming language. He named this language LISP (List Processing) because one of his main personal views was to use a simple data structure called a list for both code and data.

2.14.1. SWI Win-Prolog Programming language

WIN-PROLOG provides a complete development environment including easy-to-use pull-down menus, support for multiple edit windows and rich edit (e.g. automatic syntax coloring, multiple fonts in a window, etc.).**WIN**-PROLOG has incremental and optimized compilation, together with a hashed compilation mode which allows a matching clause to be found almost instantly.

WIN-PROLOG allows you to create polished Windows applications; it provides an extensive range of graphics predicates allowing convenient access to a large number of Windows Graphical User Interface (GUI) functions [39].
WIN Prolog is a programming language which is completely different from other languages. Programming language such as BASIC, C, C++ and PASCAL uses their main techniques or methods to splitting a problem into discrete steps and following those steps in sequential order [40].

Prolog is attractive logic programming language for professionals in the area of knowledge Engineering and Artificial Intelligence. Indeed it has been used in a various real world applications. Some of the most common domain areas are environmental modeling, sales modeling, medical domain, fungus identification, image recognition, management consultancy, etc. [41].

In Prolog the data and the program are the two different ways of looking at the Prolog objects. Prolog has the ability to change its program whilst that program is running. Another important aspect of Prolog is that it relates to a logic called predicate calculus. This gives Prolog a number of distinct properties it inherits from logic and gives better foundations than other conventional programming languages. One of the properties is that prolog is a declarative language. This allows one to develop a program by concentrating on "what" needs to be done instead of "how" it is done. It can also allow a programmer to understand without the need of following through its dynamic execution [42].

2.15. Testing and Evaluation of the KBS

Testing and evaluating of a knowledge based system requires elaborate methodology than a simple iterative test and refines cycle. At the design stage an adequate knowledge base structure is required to permit focused modification of the knowledge base when errors are happened.

Evaluation of a knowledge base system by domain experts is very useful to determine the quality and interactive feature of the knowledge based system. Furthermore, verification and validation of a

knowledge base system is to demonstrate the consistency, completeness and correctness of the knowledge base system so as to make users confident enough in using it. According to Berry D. and Hart E [43], the success of a system not only about the system matching user needs and supporting users in their tasks, but also deals with the match between the system and the social and political factors within the host organization. This is performed by give emphasis to the usability, through interviews, questionnaires, formal observation while users interact with the system, system logging, simple testing and experiments.

According to C.J and D [44], there are two most common and general approaches which are used to evaluate knowledge base system. These are objective and subjective approach. The subjective approach employs qualitative comparison of performance and it assumes observation results that depend on context and observation. Due this, a system value depends on an individual's performance and opinion .The second approach is objective approach, it focused on import attributes of system which can be measured and interpreted. This qualitative approach uses statistical experts. Both approaches comprise many knowledge system evaluation methods.

According to Burkle et al. [45], stated that knowledge based system evaluation may be divide into various phases. In the most cases, the evaluation process of knowledge based system starts during the development of the system and can be split into verification, validation and assessment of human factors.

Verification: it is a knowledge based system evaluation process, which is employed during the development of the knowledge based system. It is also used to answer the question "Did we build the system correctly?" In addition, verification is the work of reviewing, examining, testing, checking, documenting of a system. It ensures whether the system has been developed according to the predefined specifications and objectives and verifies consistency, completeness and correctness of the system [45].

To verify a knowledge based system, it is possible to use either a program proof or a test strategy. The first methodology proves the total correctness of the program logic with mathematical methods whereas the later methodology checks partial correctness of the program with given test cases.

Validation: Validation is an evaluation process that is implemented after a program developed to answer the question "Did we build the right system?" It checks whether the system performs the tasks

for which it has been designed in the real working environment or not. This process is very essential to test the accuracy of knowledge based systems.

Assessment of Human Factors: this phase is a very essential part of knowledge based system evaluation process. There are varieties of methods to assess human factors of a knowledge based system. Some of the most commonly used methods include interviews, questionnaires, log studies, reaction studies and visual interaction. Among these visual interaction is the most commonly method which allows the experts or domain users to make comments while interacting with the system.

2.16. Application of Knowledge Based Systems

Knowledge based systems have many differing functions and application areas. The area of applications for knowledge based system technology ranges from highly embedded turnkey expert systems for controlling certain functions in a car or in a home to systems that provide financial, medical, or navigation advice to systems that control spacecraft [46],[47].The following table shows major types of problems, which can generally solve by using knowledge based systems.

Problem Type	Knowledge Based System Application Areas
Diagnosis	Inferring System Malfunction from observables
Design	Configuring Objects under constraint
Control	Governing system behavior to meet specifications
Instruction	Diagnosing, debugging, and repairing student behavior
Interpretation	Inferring situation description from data
Monitoring	Comparing observations to expectations
Planning	Designing actions
Prediction	Inferring likely consequences of given situation
Prescription	Recommending solution to system malfunction
Selection	Identifying best choice from a list of possibilities
Human resources	In training and education
Finances	In assessment report

Table 2.3: Application Areas of Knowledge Based Systems [47]

As indicated in the above table, there are many different types of problems that can be solved by using knowledge based system technology. Some of the application of knowledge based system technology was in the financial industries, which, with its highly intangible products, is especially well suited to its use. The knowledge based system technology can be employed to reduce money laundering by identifying suspicious patterns in money transfer, to assess loan risk and for application decisions [48]. Recently, a number of financial institutions and consulting firms have been investigating artificial intelligence techniques to address problems that have been rather difficult to solve using conventional computer technology. Such problems include the evaluation and selection of a wide range of commercial risks, and the monitoring of various services over a period of time. The application of artificial intelligence techniques to such problems looks very promising for a number of reasons. One is that artificial intelligence systems are very flexible and they offer significant new capability [48].

2.16.1. Knowledge base System in Financial services

As **[49]** agreed that, KBS has found a home in financial services and is recognized as a valuable addition to numerous business applications. Sophisticated technologies encompassing neural networks and business rules along with KBS based techniques are compliant positive results in transaction-oriented scenarios for financial services. It has been widely adopted in such areas of risk management, compliance, and securities trading and monitoring, with an extension into customer relationship management (CRM). Knowledge base system can be applied in financial decision making. The financial services are the vigorous user of knowledge base system techniques. Advisory programs have been created to assist bankers in determining whether to make loans to businesses and individuals. Insurance companies to assess the risk presented by the customer and to determine a price for the insurance [26]. In the field of Finance, knowledge base system has long been used. Some applications of knowledge base system are:

- Credit authorization screening
- Mortgage risk assessment
- Project management and bidding strategy
- Financial and economic forecasting
- Risk rating of exchange-traded, fixed income investments

- Detection of regularities in security price movements
- Prediction of default and bankruptcy
- Security/and or Asset Portfolio Management.

2.17. Related works

Since there is no local research done in our country on knowledge based system for credit evaluation, the researcher review foreign researches on the use of expert systems and how it affect banking sector and also review local researches related to business area. Some of the related works conducted by foreign and local researches related to business have been reviewed as follows.

There is a number of works that attempted to show the use of expert system, how this technology is performed and how it affects the banking industry. According to [50] survey conducted in British banking industry, areas that are using expert systems are debt counseling, bad –control decision, behavioral scoring, branch risk assessment, business advice, commercial loans, corporate loan application, credit evaluation and control, financial advice, Fraud detection, Lending risk analysis, loan decision, mortgage selection, security perfection and system fault diagnosis. The main objective of this research project was to find out how extensive expert system technology is being used in banking sector and how it affects banking organizations. According to this work, 66.7% where use expert system in banking; which is take high percentages and 23.8% are not using this technology in banking. The rest percent which is 9.5% are planning to use ESs. As the results of this study indicate 50% secretarial staff is actual ES users. The next are middle management. In this research, the researcher recommended for further work ways/ methods to develop expert systems used by banking industry and neural networks in this sector. In general, this study indicates a possibility of knowledge base system in the areas.

Kay Bryant [5], has done research study on the integration of qualitative factors into ESs for evaluating agricultural loans. The main goal of this study is to examine whether ES technology is an effective and efficient means of providing advice and support for the agricultural loan evaluation process. The research was conducted in Australia. The researcher tries to incorporate qualitative factor such as a loan officer's intuition, experience and judgment as well as quantitative factors. According to this study, the subjective knowledge is extract from two bank institution of loan officers through questionnaires and the acquired knowledge is represented using dependency diagram. The developed

ES system enables the loan officer's to make decision easily in agricultural loan evaluation. After the ES is developed the performance testing of the system was made with 45 loan applications of two bank institution and 73% performance were achieved.

The author concludes that, expert system is required to lower operating costs and increase productivity as well as profits. All of the loan officers regarded the ES highly, that is as being useful and effective. This finding has particular relevance for the less experienced loan officers who found the expert system most useful [5].

Desalegn [51], has done research on designing a knowledge based system for VAT (Value Add Tax) administration. The main focus of the researcher is to explore and design an applicable knowledge based system that support the stakeholders of tax by providing appropriate VAT related advice based on the tax law of the country and working procedures of the concerned bodies. The developed prototype knowledge is extracted from documented and non-documented sources of knowledge and from domain experts of VAT administration. The knowledge base of the system contains the domain knowledge for solving VAT refund related problem. The knowledge is represented as a set of rules and facts. Each rule specifies a relationships, recommendation, directive, strategy or heuristic and has the **IF (condition) THEN** (action) structure. In this study, the researcher use SWI prolog tool to develop rule based knowledge based system because of its suitability for the production rule and capacity to minimize the complexity of the problem. After developing the prototype of the system, testing of the prototype rule based system for VAT administration was done to evaluate the performance of the system. The researcher found accuracy of 82.5%. The researcher recommended for further study issues like assessment, audit, custom case of VAT, intelligence tasks of VAT; tax types like turnover and sure tax.

Wondimagegnehu [52], has conducted research study on determinants of nonperforming loans the case of Ethiopian Banks. The objective of this study was to identify and investigate the determinants of nonperforming loans of Banks. In this study the survey technique were used. The two approaches of research qualitative and quantitative approach were applied. As the researcher found out, the factor that neglect loans of banks to borrower are poor credit assessment, failed loan monitoring, underdeveloped credit culture, weak institutional capacity, unfair competition among banks, relaxed credit term and condition and default by borrowers and their knowledge limitation. The researcher also recommends that banks should put in place a vibrant credit process that ensures proper customer selection, robust

credit analysis, authentic authorizing process, proactive monitoring and clear recovery strategies for sick loans; formulate a clear policy framework that addresses issues of conflict of interest, ethical standard and check and balance in credit process; organizational capacity enhancement of banks; deliberate effort to develop culture of the public towards credit and its management by banks and ensuring prudent policies that govern bank loans.

Josephine Nassali[39], has conducted a research on a Loan Assessment System for Centenary Rural development Bank. The main objectives of the study is to design a loan assessment system that can be used to overcome the challenges being experienced in Uganda's financial institutions as a result of lack of good decision making mechanisms in disbursing loans. In order to address the problem, a structured approach to analysis and design of systems was followed in the development of the prototype in the study.

The main methodology used in the study was the research approach where an interview guide was designed to elicit data required on critical issues towards establishing a loan assessment system for Centenary Bank. The qualitative research methods were used in the study and to examine the nature of loan assessment system in Ugandan financial institutions. In the study different methods of data collection were involved. These included, an interview guide, observation and reviewing of existing data on the loan assessment system.

The findings of the study showed that, the loan assessment system in place is time consuming as it takes too long (up to a month) for a loan to be approved and the amount approved is too little (sometimes less than 50 percent) compared to what a client applies for. As the result of the study showed that, the officers also identified these as complaints raised by a big percentage of customers and revealed that this is as a result of bias which is inherent in individuals..

Martin Omara [53], has conducted study on credit assessment process and repayment of Bank Loans in Barclays Bank Uganda Ltd. The main objective of the study was to examine the appropriateness of credit assessment process used by Barclays Bank Uganda Ltd; to establish the level of loan default on Barclays Bank performance and to design strategies on how credit assessment and repayment of Bank loans can be improved. The research was a case study of Barclays Bank Uganda Ltd with a sample size of 73 respondents comprising staff and customers of Barclays. As the researcher found out, there was delay by Barclays Bank in scoring loans. The Barclays charged commitment fees to both new and existing borrowers. As result found implies that Bank was found to charge higher interest rate than the

competitor. The Bank also did not do proper monitoring and follow up of loans once disbursed. The result found shows that Barclays was not to have a central reference point where records about customer borrowing from other financial institutions are kept.

The researcher recommends based on the result found. The bank needs to fasten the credit assessment process by putting appropriate mechanism to attract more business. The researcher also recommends proper monitoring and follow-up of loans disbursed and credit reference bureau be instituted where credit information on borrower can be required.

From the review made, one can understand that there is no research conducted to design self-learning KBS for credit evaluation. However, international experiences show that [5] on the integration of qualitative factors into ESs for evaluating agricultural loans. This research was conducted using rule based representation techniques to show the effectiveness and efficiency of expert system in agricultural loan evaluation. In this study, the researcher attempted that as expert system is lower operating costs, increase productivity and profit. This study is limited only to agricultural loan evaluation and the study not covered about self-learning Knowledge Based System.

Josephine Nassali[39], has conducted a research on a loan assessment system for centenary rural development Bank. Even though, the study was conducted on loan assessment system, there many things that makes differ from this study. These are the researcher uses structured approach to design and analysis the loan assessment which is quite different from method used in this study. Another thing that makes different is the researcher uses procedural programming language which is different from this study which uses a declarative programming language. The main thing that makes differ is the study not consider about self-learning which is covered in this study.

So, the proposed a prototype self-learning knowledge based systems in this study is conducted to explore the applicability of a self-learning knowledge based system for credit evaluation of loan applications. The main objective of the research study is to evaluate loan application or requests align within the rule and procedure of credits. Therefore, the proposed self-learning knowledge based can assist domain expert during loan evaluation process and credit customer by providing advisory services. This work will also be used as an input for further development of credit evaluation in banking industry and micro financial institutions.

Chapter Three

3.0. Knowledge Acquisition, Modeling and Representation

3.1. Knowledge Acquisition

In knowledge engineering, there are two basic important steps during the development of knowledge-based systems that every knowledge engineer should consider. The first and the most important one is acquiring the required knowledge from domain experts like, customer relationship manager(CRM), credit analyst, credit advisor and other relevant documents. The second one is representing the acquired knowledge with the appropriate knowledge representation technique.

Knowledge acquisition is the process of acquiring relevant knowledge from domain expert and other sources of information such as books, databases, guidelines, manuals, journals articles, computer files, etc. knowledge acquisition is the process of eliciting , structuring and representing (formalizing) domain knowledge acquired from different sources. Knowledge acquisition is the first step and time consuming task in the development of knowledge based system [54].

The acquisition of knowledge is the most important and critical phase in building knowledge-based systems. However, it is an extremely hard and capable of making an error task that knowledge engineer does while developing a knowledge- based system. As a result of the challenges and difficulties faced in the transfer of expertise knowledge, knowledge acquisition has been depicted as the difficulty of knowledge based systems development [11].

3.1.1. Steps in Knowledge Acquisition

Knowledge acquisition process has many steps. Some of them are: selecting a problem to be solved by the program, interviewing an expert, questionnaires, observation, record reviews, codifying the knowledge in some representation language, and refining the knowledge base by testing it and extending its capability **[55].** This process is generally called knowledge elicitation.

As the work of Solomon **[6]**, noted there are two main steps in knowledge acquisition process that are accomplished by the knowledge engineer so as to develop knowledge-based system. These are knowledge elicitation and knowledge structuring.

3.1.1.1. Knowledge Elicitation

It involves extracting knowledge from domain experts, and/or written documents to build a knowledge-based system. In this study, the knowledge required to build a knowledge-based system was elicited from both tacit and explicit sources of knowledge. Tacit knowledge is collected from eight experts in the domain area from credit evaluator, and customer relationship by using semi-structured interviews. Domain experts are chosen purposefully for wide-ranging discussion using semi-structured interviews to understand the domain knowledge. These experts are essentially taking part during the study and asked to verify the correctness of the acquired knowledge. Moreover, explicit source of knowledge has been collected from the Internet, manuals, research papers and journal articles, etc.

3.1.1.2. Knowledge Structuring

Knowledge structuring involves using concepts discovered during the knowledge elicitation session to build a model or representation of the domain experts. It is a process where knowledge engineer uses concepts discovered during the knowledge elicitation phase to build a model of the domain. The knowledge used for building of the knowledge-based system in this study focused on knowledge regarding the credit evaluation.

The process of knowledge acquisition of this research encompasses some basic activities such as gathering the desired knowledge, analyzing that knowledge, identifying important concepts (credit evaluation criteria) and finally modeling them in using decision tree.

3.1.2. Knowledge Acquisition from Domain experts

Primary sources of knowledge are collected from domain experts in Commercial Bank of Ethiopia at credit management department. The domains of interview with expert covered issues such as how credit evaluators assess credit customer request, what are the main points to focus on for credit evaluation and what are the main criteria for each types of credit expected from a credit request (see full interview questions in appendix I). During the extensive discussion, the researcher tries to acquire the relevant tacit knowledge which is significant to generate the proposed prototype self –learning knowledge based system. In addition the domain experts are actively participated throughout the research work end. They are consulted to valid the correctness of the acquired knowledge. During

interview, the acquired knowledge from domain experts has been recorded manually by using pen and paper sheet.

3.1.3. Knowledge Acquisition from Relevant Document

Document analysis involves collecting knowledge from existing documentations. Hence, document analysis has been carried out to acquire explicit knowledge which is found in various secondary source of knowledge. In order to elicit knowledge for this study relevant documents which are related to credit evaluation have been reviewed. The relevant documents used in this research are: Articles that are published in different journals, research papers, manuals, guideline and criteria that are used in the process of credit application evaluation. The website of CBE especially related to advance and credit facility is also reviewed. As the result, relevant and technical knowledge were extracted and structured in a manner that suitable for knowledge modeling and finally knowledge representation.

The detail of this knowledge acquired from different sources that focus on credit evaluation is discussed; structure and conceptually modeled in the next section 3.2.

3.2. Conceptual Knowledge Modeling

Once the required and valid knowledge is obtained from domain experts, websites and, other relevant documents, the next step is modeling the knowledge. During the knowledge modeling phase, the acquired 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.

During the knowledge acquisition stage, knowledge engineer collects both tacit and explicit knowledge. The knowledge engineer will try to understand both the tacit and the explicit part of the knowledge and then simple visual diagrams to stimulate discussion amongst user and knowledge experts. Then knowledge engineer has to construct the conceptual model from what has been discussed during the knowledge acquisition. This communicates the knowledge to the knowledge engineer who transforms the model into workable computer programs or codes.

There are different conceptual knowledge modeling techniques such as decision tree and hierarchical knowledge modeling. **Hierarchical knowledge modeling**

For this study decision tree is used to model how credit applications/requests are evaluated. The reason that the researcher use this modeling technique is, decision tree is very widely used technique for conceptual model of knowledge. According to [56], decision tree learning is one of the most widely used and practical method for inductive inference. It is a method for approximation of discrete - valued functions, in which a tree represents the learned function. Decision tree classifies instances by starting at the root node of the tree, testing the attribute specified by this node, then moving down the tree branch corresponding to the value of the attribute. This process is repeated for the sub-tree rooted at the new node as long as it takes to reach the appropriate leaf node then returning the classification associated with this leaf [50]. The decision tree model for credit evaluation of each credit type is depicted under section 3.2.1 below. Figure 3.1 bellow summaries credit production type.

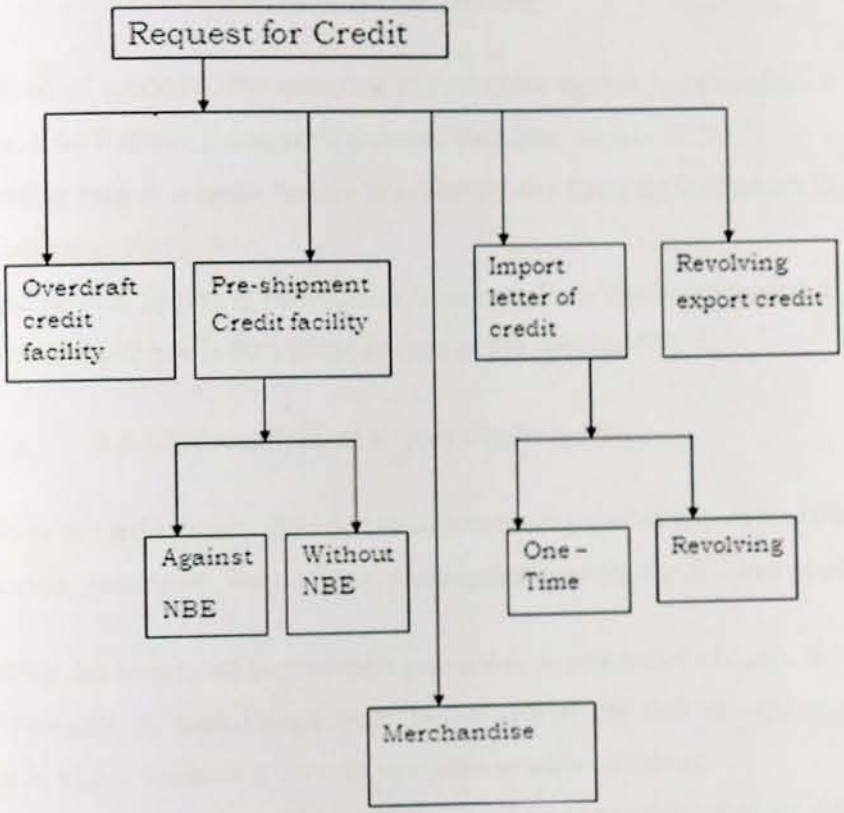


Figure 3.1: Credit Production Types

3.2.1. Knowledge of Credit

As knowledge acquired from interview and relevant document, CBE extends the following credit facilities to its esteemed customs:

3.2.1.1. Overdraft (OD)

- It is a form of credit facility by which customers are allowed to draw cash beyond the deposits of their current accounts for the day to day operational needs of business.
- The facility is availed to customers up to a maximum period of one year and it can be renewed every year based on the request of customers.

3.2.1.2. Merchandise loan facility

- It is a form of credit facility extended to customers against merchandise or its documentary evidence. Like Railway Receipts, Warehouse Receipts, Airway Bills.
- Merchandise loan is a credit facility provided by the Bank against which the merchandise is held as collateral for the loan.
- Merchandise loan facility is extended to customers for a maximum period of one year and its maximum advance rate is 80% of the amount of the merchandise.

3.2.1.3. Pre-shipment Export Credit facility

- It is a form of credit facility extended to customers engaged in export business for purchase of raw material, processing, warehousing, packing, transporting the finished goods to shipment.

- The facility can be granted to customers engaged in export sector and able to present receipts of export proceeds at least United State Dollar (USD) 300,000 or equivalent currencies, or engaged in viable business at least for two years or offer collateral.
- The advance rate ranges from 70% to 90% depending on type of goods to be exported.
- The facility is availed to the maximum of one year and the lending interest rate is 7.5%.

3.2.1.4. Revolving Export Credit Facility

- It is an advance extended to exporters upon presentation of acceptable export documents except bill of loading. It is to solve working capital problems of exporters with continuous export transaction emanating from money tied up in goods in transit of shipment.
- Customers should submit export documents indicating the goods are in transit of shipment to port. Like irrevocable letter of credit (LC) way bill, insurance contract, and other documents specified in LC.
- The maximum advance rate is up to 80% of the value of the document.

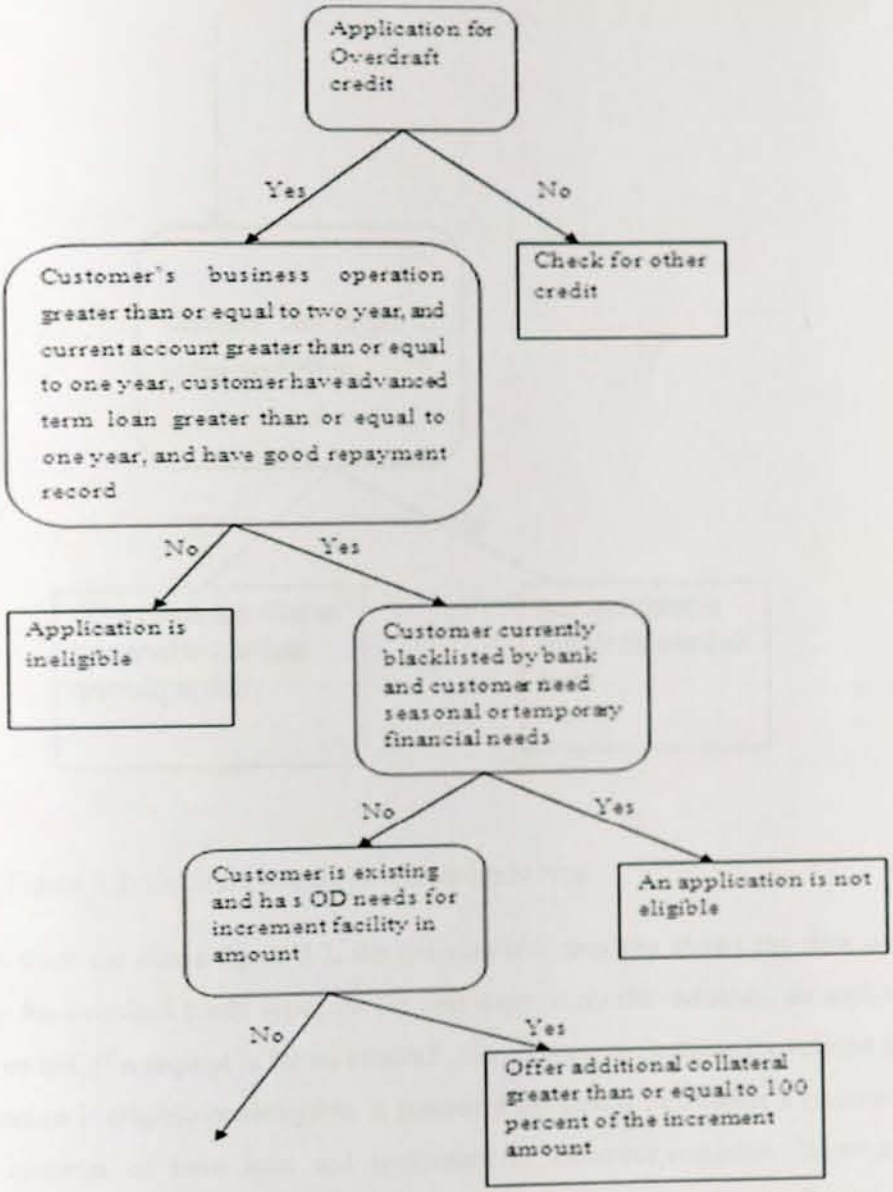
- The facility is availed to the maximum of one year and the lending interest rate is 7.5%.

3.2.1.5. Import Letter of Credit facility

It is a credit product that the CBE extends to applicants engaged in the import business, or other applicants who import for various purposes on payment of a certain percentage of the value of the document while opening a Letter of Credit. Import Letter of Credit facility shall be renewed every .The Bank may extend a one-time and/or revolving Import Letter of Credit Facilities.

1. A one-time Import Letter of Credit Facility is a non-renewable letter of credit facility extended to applicants, such as investors, importers, and others that have no Import Letter of Credit Facility or who want to import over and above the existing Import Letter of Credit Facility limit.
2. Revolving Import Letter of Credit Facility is a form of credit facility where the limit is renewed periodically when the customer fulfills the Banks requirement. Figures bellow illustrates the conceptual mode of the above credit types.

To summarize the above credit type, decision tree used to model concept as follow for each types of credit production type.


Application for Overdraft credit
Yes
No
Check for other credit
Customer's business operation greater than or equal to two year, and current account greater than or equal to one year, customer have advanced term loan greater than or equal to one year, and have good repayment record
No
Yes
Application is ineligible
Customer currently blacklisted by bank and customer need seasonal or temporary financial needs
No
Yes
An application is not eligible
Customer is existing and has OD needs for increment facility in amount
No
Yes
Offer additional collateral greater than or equal to 100 percent of the increment amount

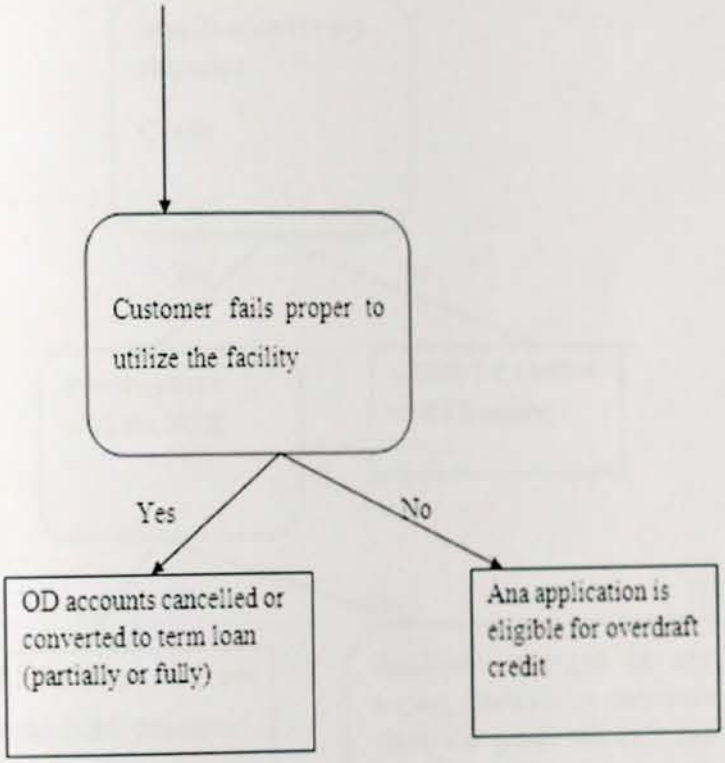


Figure 3.2: Decision tree for overdraft credit type

As shown from the above figure 3.2, the decision tree structure shows the flow of knowledge in the evaluation for overdraft credit type . At the first stage, it checks whether an application or request is overdraft or not. If a request is for an ovedraft, then it starts to evalaute the request to identify whether the application is eligible or ineligible. It considers the year o f customer's business aperation,current account, histories of term loan and repayment of customer,customer information, condition of customer financial need, etc to decide whether the request or application is eligible or ineligible for the loan. if the request is eligible, then further evaluated for credit analysis such risk analysis,financial statement etc.

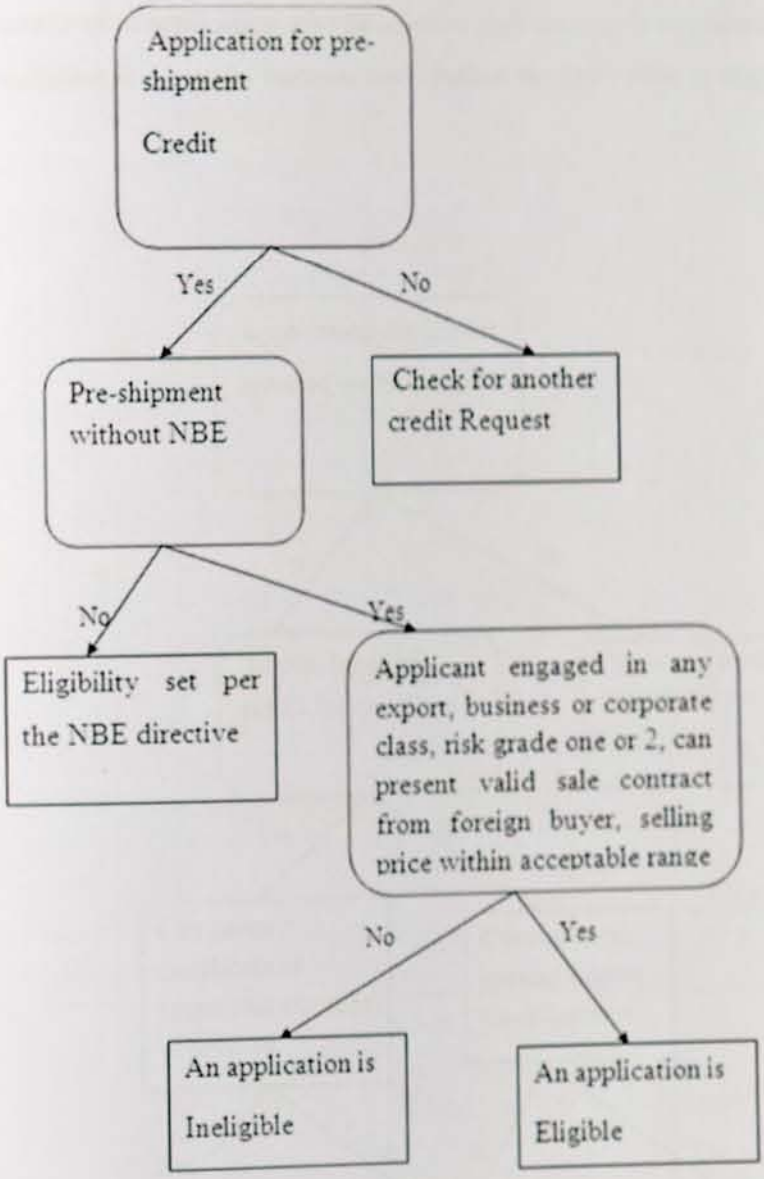


Figure 3.3: Decision tree for pre-shipment credit

As shown from the above figure 3.3, the decision tree structure checks whether the request belongs to pre-shipment or not. If the request is not for pre-shipment, it looks for another credit production type. If the request or application is checked as request for pre-shipment, then it considers whether the pre-shipment credit request is against NBE or without NBE. After that, it considers pre-shipment against National Bank of Ethiopia or pre-shipment request without National Bank of Ethiopia. If the request is pre-shipment without NBE, further it evaluates engagement of applicant's in any export business;

checks risk grade level of application, checks whether the customer is corporate class or not and so on . Finally, the conclusion is drawn by decision tree whether the application is eligible or ineligible for the loan.

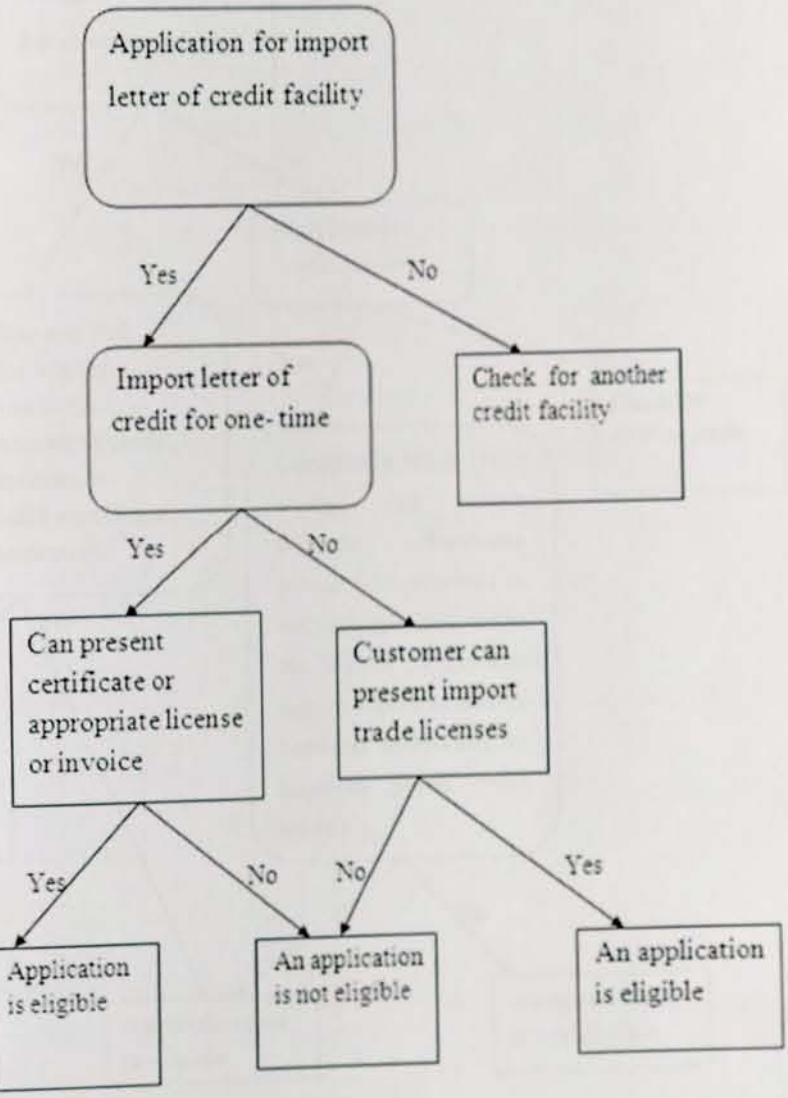


Figure 3.4: Decision trees for import letter of credit type

The above figure 3.4 illustrates the decision tree structure for import letter of credit request. The decision tree first checks for the request whether it is a request for import letter of credit facility or not.

If the request is for import letter of credit, it further checks, whether request for import letter of credit is for one time or revolving import letter of credit. It takes one from them and continues to evaluate the request align within rule and procedure of import letter of credit criteria to be fulfilled for the loan is eligible.

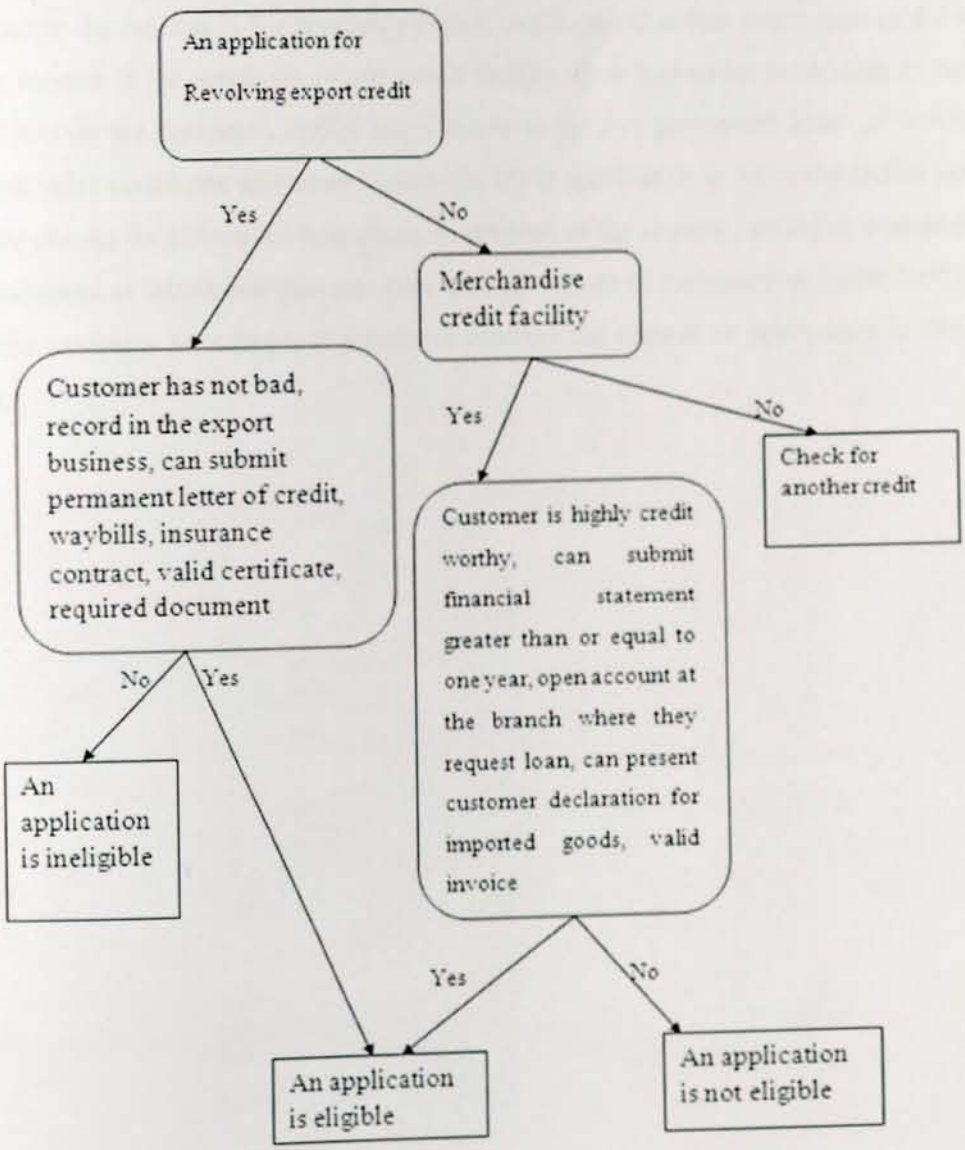


Figure 3.5: Decision tree for revolving export Credit facility

And Merchandise credit Type

As shown from the above figure 3.5, shows the combination of decision tree for both revolving export credit facility and merchandise credit facility type. The decision tree structure first checks for credit request whether the request is for revolving export credit, merchandise credit type or for other credit type. If the request is for revolving export credit facility, then it goes for evaluation of the record on export problem of the customer, ability of customer to present permanent letter of credit, insurance contract, and valid certificate and so on. Likewise, if the application is for merchandise loan type, the decision tree checks for criteria such as credit worthiness of the request , ability of customer to present financial statement at least more than one year, and all criteria of merchandise credit facility. After the tree structure evaluates all criteria, it concludes whether the request or application is eligible for the loan or not.

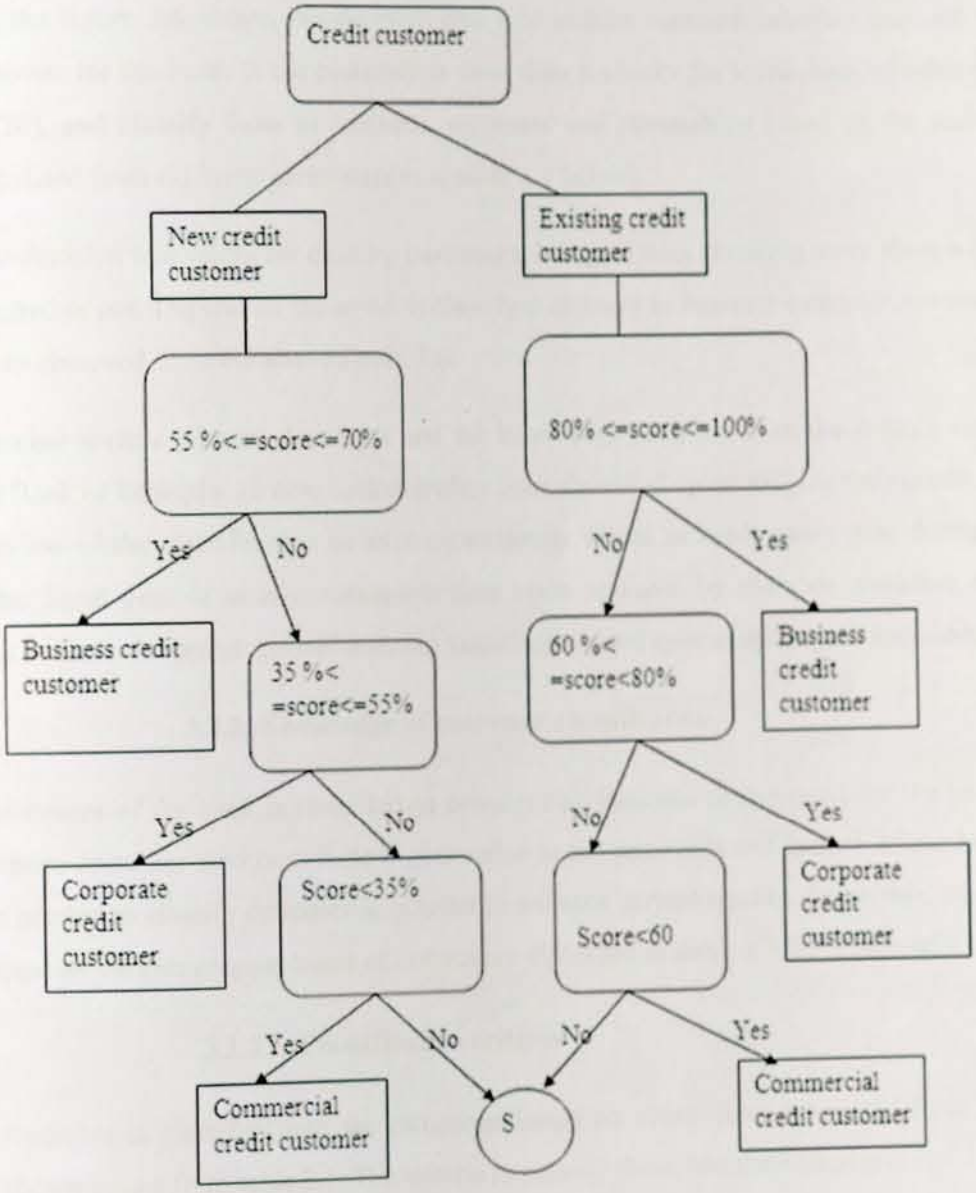


Figure: 3.6: Decision tree for customer classification based on score sheet

Key:-

S -Stop/ terminate

The above figure 3.6, illustrate decision tree that shows credit customer classification. Credit customer is classified for the purpose of identifying those customers who contribute higher value to the profitability and growth of the bank and to enhance service quality and customer satisfaction. As

shown from the figure 3.6 above, the decision tree first checks customer whether they are new or existing customer for the bank. If the customer is new, then it checks for score sheet whether it is out of seventy (70), and classify them as business, corporate and commercial based on the score sheet which is calculated from different parameters (see table 3.1 below).

Likewise, the decision tree works for existing customers. It begins with checking score sheet whether it is out of hundred or not. Depend on the score, it classify customers as business customer, corporate and commercial as observed from the above figure 3.6.

As the researcher review relevant document and the knowledge acquired from the domain experts of Commercial Bank of Ethiopia, all new customers has been classified up on lodging their credit request. However, review of the classification on existing customer would be made every year during the 4th quarter of the fiscal year or at any convenient time upon approval by the vice president of credit manager. As a result, the prototype self-learning knowledge based system updates its knowledge.

3.2.2. Knowledge of customer classification

The credit customer of the bank is classified as commercial, business or corporate for the purpose of identifying those customer who contribute higher value to the profitable and growth of the bank. The other reason needed to classify customer is in order to enhance service quality. To do this, customer is classified based on various criteria. Some of criteria are discussed in section 3.2.2.1 bellow.

3.2.2.1. Classification criteria

The credit customer is classified into the categories based on score sheet calculated from different parameters shown below from table 3.1. The criteria to classify them into their class are:

1. Classification of credit customer shall be done based on the parameters and score sheets listed under this section table 3.1 and 3.2.
2. Data to be considered for each of the parameters shall be an average of the recent three years data. However, if the business is new and / or relationship is less than three years, average of the available data shall be considered.
3. The following annotations on the interpretation of the parameters shall be considered while conducting the classification process:
    -
    -

I. Income generated from customer –refers to the yearly income that the bank collected from individual credit customer in the form of interest, commission and loan processing charges.

II. New customer shall not have score in relation to income generated from customer.

III. Total loan credit exposure: shall refer to the sum of loan facility limit/s and outstanding balance of term loan/s for existing credit customers and the amount of loan requested for the new customers.

IV. Sale Volume: refer to report sales proceed for existing business/projected sales for newly established businesses.

No	Parameters	Condition		Weight (%)
1	Income generated the customer(A)	A>10,000,000		30
		5,000,000<=A<=10,000,000		20
		2,000,000<=A<=5,000,000		10
		A<2,000,000		5
2	Total Credit Exposure(B)	B>100,000,000		25
		50,000,000<=B<=100,000,000		20
		25,000,000<=B<=50,000,000		15
		B<25,000,000		10
3	Customer's credit Risk Grading(C)	C=1		25
		C=2		20
		C=3		15
		C=4		10
		c>=5		0
4	Sales volume Registered by customer (D)	D>=50,000,000	Audited	20
			Un audited	13
		25,000,000<=D<50,000,000	Audited	15
			Un audited	8
		D<25,000,000	Audited	7
			Un audited	3

(Source: Commercial Bank of Ethiopia)

Table 3.1: Credit customer classification criteria

As shown from the above table 3.1. Various parameters are considered to which helps classify customer into their classification. This involves income generated from the existing customer, Total loan credit exposure, sales volume registered by customer and customer's credit grading risk. The value is assigned to it depend on the condition as observed in the above table3.1.

After the total score obtained, rating the customer based on the score sheet under table 3.1 evaluated as per the following matrix in order to classify the customers as Business, Corporate or Commercial Customer.

Customer classification	Score (X)	
	New customer/70	Existing customer/100
Business	55% <=X<=70%	80% <=X<=100%
Corporate	35% <=X<55%	60% <=X<80
Commercial	X<35%	X<60%

Table 3.2: credit customer classification based on score achieved

As shown from table 3.2 above, credit customer classified as business, corporate and commercial based on score sheet obtained from different parameters as indicated in table 3.1 above. If customer is new, the score sheet is calculated out of seventy percent (70%). In the contrary, if the credit customer is existing customer, score sheet is calculated out of hundred percent (100%). If the customer is new customer and the score is greater than or equal to fifty five percent (55%) and less than or equal to seventy percent (70%), the customer is classified as business. For the customer is existing customer and score greater than or equal to eight percent (80%) and less or equal to hundred percent(100%), then the customer is classified as business. New customer is classified as corporate, if the score is greater than or equal to thirty five percent (35%) and less than fifty five percent (55%). In different ways, existing customer is classified as corporate if his/her score is greater than or equal to sixty six percent (66%) and less than eighty percent (80%). For the customer scoring low score, the class is commercial. New customer is classified as commercial is the score is less than thirty five percent (355). For existing customer to be classified as commercial, the calculated score sheet must less than sixty percent (60%).

3.2.3. Concept of Credit Criteria

There are various credit criteria's to evaluate loan applications/requests. According to [57], an organization can set the credit criteria in order to manage risks due to loan. This includes:

- An institution should establish specific credit criteria to define the types and characteristics of its preferred obligors. These criteria would include the following:
  - business track record vis-à-vis industry peers;
  - key financial indicators such as equity, profitability, turnover, influence and debt servicing ability;
  - Target obligor risk grade (where available) and terms and conditions under which the institution is prepared to extend credit, such as quantum of financing, maximum amount of clean exposure and acceptable collateral.
- To ensure that the obligor meets the credit criteria, the institution should have sufficient information about the obligor, the source of repayment, and the purpose of the credit. Credit should not be granted on the basis of casual familiarity or general perceptions about the obligor.
- An institution's credit criteria shape the risk profile of its credit portfolio. As such, deviations from the criteria should be approved by the appropriate authority. Such credit criteria should be subject to periodic review to be in line with the institution's credit risk management strategy [57]. As [58] noted, there are five basic credit components of analysis. These are;

Character is the general impression of the customer makes on the prospective lender or investor. The lender will form a subjective opinion as to whether or not the company is sufficiently trustworthy to repay the loan or generate a return on funds invested in the company. The background, experience in business and in the industry will be considered.

Capacity to repay is the most critical factor of credit analysis. It is the primary source of repayment cash inflows and cash generated by company. The prospective lender will want to know exactly how the borrower intends to repay the loan.

Capital is the money personally invested in the business by the shareholder borrower and is an indicator of how much the shareholder has at risk should the business fail. Interested lenders

and investors will expect a contribution from borrower's own assets and to have under taken personal financial risk to establish the business before asking them to commit any funding.

Collateral (or guarantees) are additional forms of security the customer can provide the lender. Providing a lender collateral means that an own asset is mortgaged, such as a property, to the lender with the agreement that it will be the repayment source in case the loan is not repaid from the established sources as per terms and conditions agreed for the financing.

Conditions describe the intended purpose of the loan and the conditions under which the credit being granted. Checking the lender will be used money for working capital, additional equipment, and investor or for long term investment.

3.2.4. Eligibility of each Credit Type

As the information obtained from both interview and relevant document of CBE, every credit application/request must be eligible to general and specific eligible criteria. As the application loan request come to the bank, the credit advisor advices the applicant about general eligibility (see general eligibility for every credit type in appendix II) and other consultation based on the credit request. As the knowledge obtained, the specific eligibility for each credit products type are illustrated bellow in different respective table.

Credit Product Types	Eligible criteria
Overdraft(OD)	To be eligible for the facility/for the loan, customers should meet the following conditions/criteria's: • The business must be in operation for at least two years. • Applicants should have a record of satisfactory utilization of current accounts for at least the year preceding their application for overdraft facility. • Applicants must have settled at least one term loan with a good repayment record. • OD requests will not be considered for businesses with non-performing credit status and/or currently blacklisted by the CBE or any other bank. • Customers' seasonal or temporary financial needs will not be entertained by an overdraft. • Existing customer, who has OD facilities in different banks (including CBE) and applies for increment of the OD facility amount, shall also offer additional collateral to cover at least 100% of the increment amount, regardless of the risk grade. • The outstanding balance of the OD facility shall be within the approved limit at time of processing the renewal request. • Customers' OD accounts may be cancelled or converted to a term loan (partially or fully) if they fail to properly utilize the facility.

Table 3.3: Eligibility criteria of OD credit production Type

As shown from the above table 3.3, a request or application for overdraft credit facility to be eligible, it must go through both general and specific eligible criteria. As shown from the table 3.3 above, applicants should have a record of satisfactory utilization of current accounts for at least the year preceding their application for overdraft credit facility and. In addition to specific eligible criteria the

applicant must fulfill the general (see in appendix II of this study) criteria to be eligible for the loan. In the contrary if, the request is fail to meet the specific criteria or general criteria, and then the request is ineligible or rejected.

Credit production Type	Eligible criteria
Pre-Shipment Export Credit Facility	1. Pre-Shipment Export Credit Facility against National Bank of Ethiopia (NBE) Guarantee if the facility is availed against the NBE guarantee, the eligibility, amount, tenure and other criteria of the pre-shipment export loan shall be set per the NBE directive. 2. Pre-Shipment Export Credit Facility without NBE Guarantee If the facility is availed without NBE Guarantee: ○ The applicant shall be Business or Corporate Class customers that are engaged in any export business rated as Grade 1 or 2. ○ The applicant shall present valid sales contract/a bona-fide order from a foreign buyer. ○ The selling price of the exportable item shall be within acceptable range and this shall be confirmed by the Trade Service process team. ○ Each advance shall not exceed 70% of the sales contract. ○ The facility shall require opening of irrevocable Letter of Credit for each advance made by the Bank. ○ To help in credit analysis of such requests, the applicant shall provide receipt of export proceeds in the 12 months preceding the date of application from local banks for Pre-Shipment Export Credit

	Facility. 3. The Pre-Shipment Export Credit Facility availed by the Bank without NBE Guarantee shall be reviewed every year unless the Bank demands it to be reviewed by the credit approving team for any remedial action when the performance of the account is deteriorating. The advance shall be settled from the proceeds of the respective irrevocable Letter of Credit. This is attentively followed up by Customer Relationship Manager/Customer Relationship Officer/Branch Manager to avoid diversion of fund and timely settlement of the advance.

Table 3.4: specific eligible criteria for pre-shipment export Credit

As one can understand from the above table 3.4, there are two types of pre-shipment credit facility. These are pre shipment credit facility against national bank of Ethiopia and pre shipment credit facility without national bank of Ethiopia. The pre shipment credit facility against national bank of Ethiopia guarantee if the facility is availed against the NBE guarantee, the eligibility, amount, tenure and other criteria of the pre-shipment export loan shall be set per the NBE directive. Every eligible criterion should be set per the national Bank Ethiopia. The second one is pre shipment credit facility without NBE. It is availed without NBE Guarantee. Pre shipment without NBE to be eligible, it must fulfill both general and specific criteria which set per the CBE.

want to import over and above the existing import letter of credit facility limit. Both are must go through its specific criteria and general criteria that set per bank to be eligible or qualified for the loan.

Credit	Eligible Criteria
Revolving Export Credit Facility	A revolving export credit facility can be approved only for exporters with a clean track record in the export business is an advance extended to exporters upon presentation of acceptable export documents, except a bill of lading. • The loan amount to be advanced to the customer is up to a maximum of 90% depending on the financial strength and track record of the customer. • The facility shall be availed for one year but can be renewed every year unless the Bank demands it to be reviewed by the credit approving team for any remedial action when the performance of the account is deteriorating. • The customer should submit the following export documents, indicating the shipment of goods to the port: o Irrevocable Letter of Credit; o Waybills such as truck way, railway o Insurance contract; o Certificate of cleanliness (quality certificate) from appropriate organ; and o Other documents as specified in the Letter of Credit.

Table3.6: Eligibility criteria for Revolving Export Credit

Revolving export credit facility is also another credit production type which is advanced to credit customer of the bank. It can be eligible only for exporters with a clean track record in the export business are an advance extended to exporters upon presentation of acceptable export documents.

Addition to this, the customer must fulfill general (see appendix II) and specific eligible criteria as seen from the above table 3.6, to be eligible for the loan.

Credit	**Eligible criteria**
Merchandise	This type of loan is granted to prime customers or to customers who are considered by the Bank as being highly credit-worthy and should meet the following conditions: • Submit financial statements, including projected cash-flow statement, for at least one year. • Open an account at the branch where they request the loan. • Submit plans that justify the purpose and utilization of the loan. • Prepare temporary financial statements on a regular basis or as requested by the Bank. • Present an ownership title for the merchandise to be offered as collateral, i.e., o Customs declaration for imported goods. o Valid invoices checked with respective suppliers for locally purchased merchandise. o Internal documents like production report for manufactured goods.

Table 3.7: Eligibility criteria for merchandise

3.2.5. Concept of Collateral

Collateral is one of the credit criteria borrower offer the lender. This collateral must be valid and acceptable as the lender requirement. As CBE acceptable collateral are:

- Building/ houses. The building/houses should be constructed within the city's limits; and they can be used for residential purposes, as were houses or business organizations.

- Motor vehicles; this includes trucks, tankers, trailers, combiners, public transport, buses and automobiles
- Bank guarantee
- Local bank guarantee
- Foreign bank guarantee

As knowledge acquired, CBE's collateral criteria, some of the goods that are not acceptable as security for merchandise loan are: Chemicals, Packed foods, Pharmaceuticals, Batteries, Butter, Oil, yeast and other similar products. These and the like are not acceptable collaterals by CBE as to granting loan.

3.3. Knowledge Representation

Knowledge representation is the process of encoding formalizing and organizing the knowledge acquired into rules or cases or patters for use by the expert system **[16].** It is also defined as the process of describing and mapping expert knowledge using a set of symbol and attaching meaning to the syntax. There are various techniques to represent expert knowledge which includes semantic net, frames, logic and rule as discussed earlier in chapter two.

The knowledge representation technique used for this study is the production rule or rule based. The reason is rules are relatively easy to understand and generated from the acquired knowledge. According to **[59],** noted a ruled- based expert system lends itself well to solving underwriting problems. A rule within a rule- based system can naturally express an underwriting guideline. Within a rule –based system, rules can be added or modified easily and quickly, allowing new releases to be made on demands, sometimes immediately- an important consideration in an industry where conditions change rapidly. The system is also predictable, and regression testing can be performed at the rule level, module level, and system level to verify that the decisions are consistent with the requirements **[59].**

Knowledge is represented in the form of condition-action pairs: IF this condition (or antecedent-condition or premise) occurs, THEN some action (or conclusion or consequence) will occur.

Once the required knowledge is acquired from various sources of knowledge, validated, modeled and the next step is representation of the knowledge. The following rules in the knowledge base of the

prototype are expressed with natural language rules IF … THEN …the production rules for each credit product type are illustrated as follows.

Production rule for Overdraft Credit production Type

Rule 1: IF the application/request is for Overdraft loan

AND the customer's business operation >=2 year

AND the customer's current account >=1year

AND the customer have advanced term loan at least>=1

AND have good repayment record

THEN the applicant is Eligible for overdraft credit facility.

Rule 2: IF the customer currently blacklisted by CBE or any other bank

AND seasonal or temporary financial needs

THEN the applicant is ineligible for Overdraft Credit Facility

Rule 3: IF the applicant is existing customer

AND has Overdraft credit facilities in different bank (including CBE)

AND applies for increment of the OD facility amount

THEN the customer offer additional collateral >=100% of the increment amount

Rule 4: IF customer fails to properly utilize the facility

THEN customers' OD accounts cancelled or converted to term loan (partially or fully)

Rule 5: IF the customer request for OD credit facility

AND can present acceptable collateral

AND can present required document

THEN the applicant is eligible for overdraft loan.

Rule For pre-shipment export credit facility

Rule 1: IF the request is for pre-shipment

AND request is pre-shipment without the National Bank of Ethiopia

AND applicant is engaged in any export business

AND applicant is business or corporate class

AND risk grade level 1 or 2

AND can present valid sales contract from foreign buyer

AND the export item selling price within acceptable range

THEN the applicant is eligible for pre-shipment loan

Rule 2: IF the request for pre-shipment

AND request is pre-shipment against the NBE

THEN the applicant's eligibility is set per the NBE directive

Rule for Import Letter of Credit facility

Rule 1: IF the request for import letter of credit

AND request is import letter credit for one-time

AND the customer can present investment certificate or appropriate license or invoice

THEN the customer is eligible for import letter of credit

Rule 2: IF the customers apply for import letter of credit

AND application is for Revolving Import Letter of Credit

AND can present import trade licenses

AND can present required documents

THEN the customer eligible for Revolving import letter of credit

Production rule for Revolving Export Credit Facility

Rule 1: IF request is for revolving export credit

AND the customer has clean track record in the export business

AND can submit permanent Letter of Credit

AND Waybills such as truck way, railway

AND Insurance contract

AND acceptable certificate from appropriate organ

AND required documents

THEN the customers Eligible for revolving export credit facility

Rule 2: IF customers apply for revolving export credit

THEN the loan amount advanced is maximum of 90%

Rule 3: IF the requests for revolving export credit

THEN the credit facility is offered for one year

Production rule for merchandise

Rule 1: IF request is for merchandise

AND application is highly credit worth

AND customer can present financial statement >=1 year

AND open account at the branch where they request loan

AND can present plan that justify the purpose and utilization of the loan

AND prepare temporary financial statement as request by bank

AND present customs declaration for imported goods.

AND can present valid invoices

AND present internal production report for manufactured goods

THEN the request is eligible for merchandise loan

Rule for customer classification

Rule 1: **IF** customer is new AND 55% <=score<=70%

THEN customer is business category

Rule 2: **IF** customer is new AND 35% <=score<55%

THEN customer is corporate category

Rule 3: **IF** customer is new AND score <35%

THEN customer is commercial

Rule 4: IF customer is existing AND 80% <=score<=100%

THEN customer is business

Rule 5: IF customer is existing AND 60% <=score<80

THEN customer is corporate

Rule 6: IF customer is existing AND score < X<60%, **THEN** customer is classified as commercial

Chapter Four

4.0. Knowledge Based System Design and Implementation

The knowledge has been extracted from its source of knowledge. Tacit knowledge extracted from domain experts by interview and explicit knowledge is extracted through relevant document analysis. Once the knowledge is acquired, modeled and represented in previous chapter the next step is coding the represented knowledge using prolog programming language into a suitable format that is understandable by the inference engine. The inference engine simulates the domain experts reasoning process. It works from the facts in the working memory and stored knowledge in the knowledge based to generate the rule.

4.1. Architecture of the system

Architecture is a blueprint showing how the components of the prototype self-learning knowledge-based system interacts and interrelates. Prototype is concrete representation of part or all of an interactive system. A prototype is a tangible artifact, not an abstract description that requires interpretation. Designers, as well as managers, developers, customers and end-users, can use this artifact to visualize and reflect upon the final system. Figure 4.1 illustrates the architecture of the prototype system.

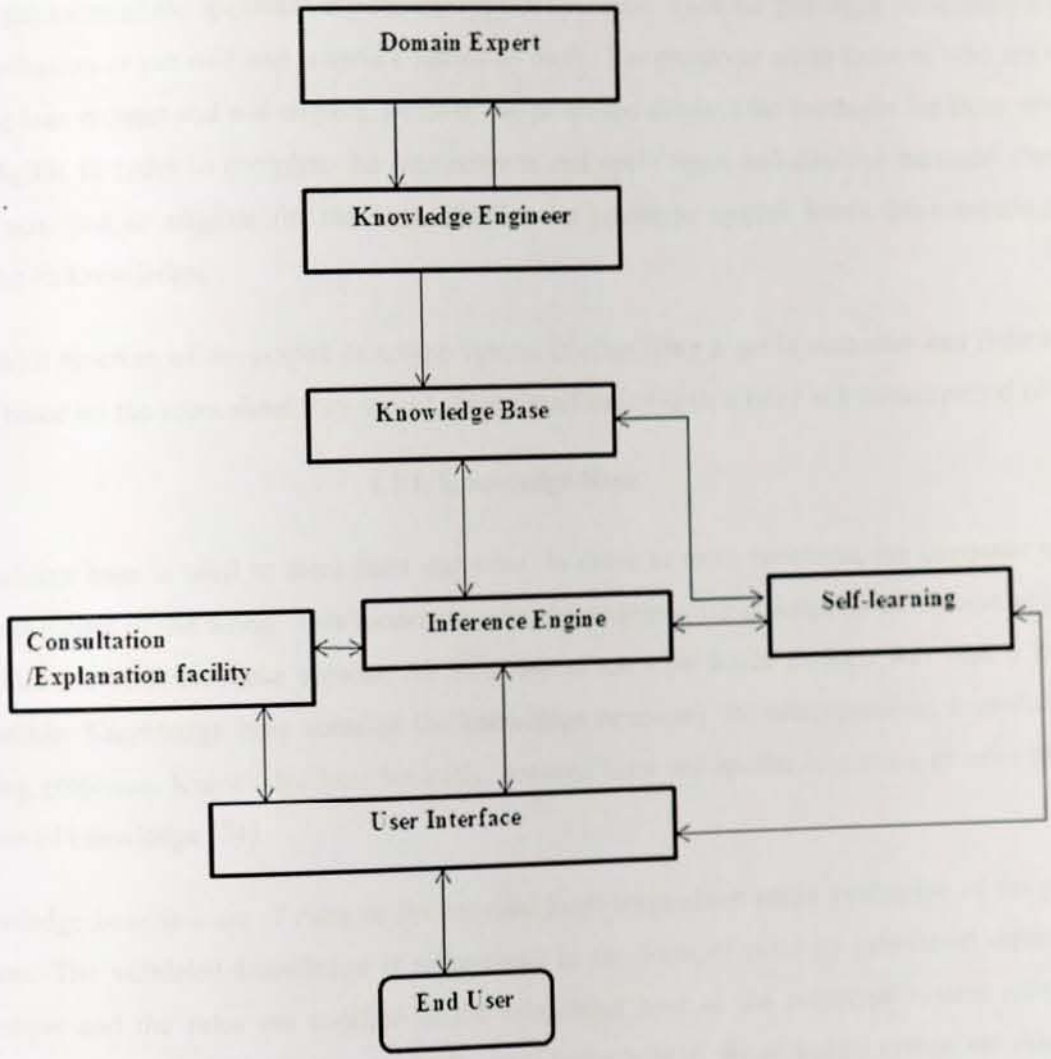


Figure 4.1: Architecture of the prototype self-learning knowledge-based system

As shown in figure 4.1, the developed prototype system functions by asking questions which came for borrowing money from the Bank. The developed prototype used both for customer or credit applicants who came for loan by advising the basic requirement or criteria's' of credit and for domain experts. The prototype provides the customer with advising such as general eligibility of the credit, document requirements and priority sectors that bank provides the loan to the customer. Developed prototype system served both new and existing customer by providing consultation services. The second function of developed prototype system is evaluating the credit customers' applications/requests. The credit evaluator or credit officer uses this developed prototype system to evaluate whether the customer application or request for credit are eligible or ineligible. The prototype asks the credit evaluator to

insert the name of the applicant and request type of applicant. Then the prototype evaluates the request or application as per rule and criteria's settled by bank. The prototype alerts those of who are eligible for the loan request and not eligible. Besides, the prototype displays the messages for those who were not eligible in order to complete the requirements and apply again and displays messages those who were qualified or eligible for the loan. Finally, the prototype system learns from experience and updates its knowledge.

The third function of developed prototype system is classifying a credit customer into their business class based on the score sheet they scored. This classification is circulated in a certain period of terms.

4.2.1. Knowledge Base

Knowledge base is used to store facts and rules. In order to solve problems, the computer needs an internal model of the world. This model contains, for example, the description of relevant objects and the relations between these objects. All information must be stored in such way that it is readily accessible. Knowledge base contains the knowledge necessary for understanding, formulating, and solving problems. Knowledge base basically, contains facts and special heuristics, or rules that direct the use of knowledge [34].

Knowledge base is a set of rules or the encoded knowledge about credit evaluation of the prototype system. The validated knowledge is represented in the form of rules by rule-based representation technique and the rules are codified to the knowledge base of the prototype system using Prolog programming language. Sample rules in the knowledge base of the prototype system are discussed as follows.

Rule: - Rule for overdraft credit production type:

(The applicant's business operation is >=2 years)AND

(The applicant's current account>=1 year) AND

(Applicant's advanced a term loan>=1), write ('the applicant is Eligible for Overdraft Credit'), assertz (request (Name, Type)),

tell('best.pl'),write(':-dynamic(request/2).'),listing(request),told;write('the applicant is

not eligible For Overdraft credit'),assertz(request(Name,Type)),tell('best.pl'),

write(':-dynamic(request/2).'),listing(request),told.

In the above rule, the prototype requests the credit evaluator or credit officer to insert the year of applicant's business operation, current account and the amount of term loan advanced to the applicant's before request for overdraft credit. After the credit evaluator feed the year of business operated, current account, the amount of term loan advanced to the applicant's before the request of overdraft and other rules, if inserted information fulfills the condition, the system automatically drawn the conclusion (**'the applicant is Eligible for Overdraft Credit'**), or if one or more inserted data do not satisfy the condition, then the prototype automatically drawn the conclusion (**the applicant is not Eligible For Overdraft credit').**

After the system drawn the conclusion whether the request is eligible or not, then appends name of applicant and type of credit requested by the applicant into the fact base request (Name, Type). This helps to store or keep the information about applicant for the future use. The next section 4.2.2 illustrates details about the fact base.

4.2.2. Fact Base

The fact base is database which is used to accumulate the set of facts which is used by the rules of the prototype system. It contains facts about the specific case of the problem being evaluated. Initially, the facts base can comprise known facts by the prototype system which is used by the inference engine to acquire facts and match them with the rules of the prototype system. The facts about the problem solved are added to the facts base by using rules of the prototype system.

The contents of the facts base changes with each problem circumstances. Therefore, it is the dynamic component of a knowledge-based system, i.e., the contents of facts base updated when required. In this research, the researcher used elements of the facts base of the prototype system in the following sample format:

Request(Name, Type) %% predicate of fact base

request(hailu, overdraft) %% to represent the fact that hailu requests or apply for overdraft credit production type.

request(abebe, pre-shipment) %% to represent the fact that abebe requests for pre-shipment credit production type.

Cust_clas(Name,Btype) %% predicate of fact base for credit customer classification

Cust_clas(abel, business) %% to represent the fact that abel is classified a business

credit customer.

According to the above sample format, the researcher represented the facts about the problem in the facts base of the self-learning knowledge-based system for credit evaluation. The facts base of prototype is updated as the information of the credit customer.

4.2.3. 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 draw 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. According to [60], the inference engine is responsible for combining the knowledge stored in the knowledge base and the problem case stored in the working memory. It guides the search from the problem case to its solution; apply the necessary knowledge from base as needed. The search engine checks the knowledge base for rule whose premise or conditions match the contents of the working memory.

Inference engine 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. It also seeks information and relationships from the knowledge base and providing answers, predictions, and suggestions in the way a human expert would [61]. Inference engine contains both forward and backward reasoning mechanisms. Forward chain reasoning mechanism is method of reasoning that starts with the facts and works forward to the conclusions whereas backward chain reasoning mechanism is method of reasoning that starts with conclusions and works backward to the supporting facts. As the result, the proposed prototype system uses backward chaining reasoning mechanism. During the reasoning process, the inference engine starts from the resulting (type of credit) and checks

riteria's or requirements of this request or credit type. If certain criteria's and requirements are valuated as true, then it logically follows the resulting are proved, then the inference fire the onclusions.

As mentioned in sections 4.1 in this chapter, the prototype system is used for both the credit customer of the bank and credit evaluator or credit officer who evaluates the applications of the customer. The developed prototype system provides advising services to both new and existing customers of the bank. The customers of the bank got advising on requirement and criteria which is expected from them. Figure 4.2 below, shows advisory service for new customer.

```
1 ?- start.
% best.pl compiled 0.00 sec, 752 bytes


Welcome To a Self-learning Knowledge Based System For Credit Evaluation!

written by Wesenu Bekele  April,2014!!
Please Enter your name::hailu.

Do you want to see some requirements of Loan hailu?
Answer by writing(yes/no):
|: yes.
| Are  you a new or existing customer for the Bank  hailu?
Answer by writing (new/exist):new.


***To be eligible for the loan, you must come up with the following things****!

A feasibility study, Lease agreement and certificate,land holding-certificate and
bill of quantity and specification (if the project involves construction
 A business license from authorized government bodies
 Memorandum and Articles of Association Proforma invoice
 (not exceeding two months)Equity contribution by the customer
Curriculum vitae of the management group

Do you want to see the priority sector?( yes/no).
|: yes.

THE PRIORITY SECTORS THAT BANK GIVE PRIORITIES FOR THE SERVICES ARE

agricultural loan,
Export credit facility,
preshipment  credit facility,
merchandise loan
Loan for manufacturing  and
import letter of credit
```

Figure 4.2: Sample Dialogue Windows with new customer counsel

As shown from the above figure 4.2, the system asks the user to enter their name. After the customer inserts his/her name, the prototype asks the customer "Do you want to see some requirements of Loan or counsel service? Answer by writing (yes/no)". IF the customer wants to acquire some criteria and requirements of credit before request for loan inserts "yes". Since there are advice services for both new and existing customer, the system asks the customer" Are you new or existing customer for the bank? Answer by writing (new/exist)". If the customer is a new customer for the bank, he/she inserts "new", and then the prototype provides answers by displaying requirements and criteria which is expected from the new customer that is fulfilled before application or request. Finally, the system asks the customer "Do you want to see the priority sector? (yes/no)" .There is priority sectors that bank gives loan priority. If the customer needs to see, he/she inserts "yes".

This helps to aware the customer which credit type is advanced to the credit customer. If the customer inserts "no" the system is logout and displays "Good bye".

```
1 ?- start.
% best.pl compiled 0.00 sec, 752 bytes

Welcome To a Self-learning Knowledge Based System For Credit Evaluation!

written by Wesenu Bekele  Appril,2014!!
Please Enter your name::alemu.

Do you want to see some requirements of Loan alemu?
Answer by writing(yes/no):
|: yes.
! Are  you a new or existing customer for the Bank  alemu?
Answer by writing (new/exist):exist.


===To be eligible for the loan, you must come up with the following things==!!

 A feasibility study, Audited financial statements,
a list of fixed assets which include their book value and market value,
A list of the market value of fixed assets to be purchased .
Projected financial statements;without project expansion and
with project expansion

IF you want to see the proirity sector
type yes or  no to exit
|: no.
Good bye!!
% Break level 1
```

Figure 4.3: Sample Dialogue Windows with existing customer counsel

Similar to the new customer, if the customer is an existing customer for bank and inserts "exist", automatically, the system responds to the answer by displaying the requirements and criteria's that bank expected from their existing customer to be eligible/qualified for reapplying or increase the amount of loan. Then the user visits the requirement, criteria and lastly the system waits the user to insert either "yes" or "no" in order to see the priory sector or logout the system. If the customer inserts "yes", the system responds by displaying priority sectors or if the customer inserts "no", the prototype displays "Good bye" and the system log out.

The second and the main purpose of this prototype system are used for applicant's credit evaluation. The developed prototype system evaluates the customer's request whether the application for loan is eligible/qualified or ineligible.

```
1 ?- start.
% best.pl compiled 0.02 sec, 1,060 bytes


Welcome To a Self-learning Knowledge Based System For Credit Evaluation!

written by Wesenu Bekele  Appril,2014!!
Please Enter your name::samson.

Do you want to see some requirements of Loan samson?
Answer by writing(yes/no):
|: no.
Wellcome to credit evaluation!
Enter samsons request from the following credit type please!!

<< Overdraft Credit>>
<< importletter of credit>>
<< preshipment Export>>
<< Merchandise>>
<< Revolving Export>>
|: overdraft.

Please Answer the Following Question inorder to check
the Eligibility of the samson Loan  request !

How long does the customer  business operated?:3.

How loang does customers cuurent account ?:2.

For how many applicant advanced a term loan?:3.

Does the customer has good repayment record on term loan?(yes/no): yes.

Does the customer currently blacklisted by CBE or any other?(yes/no): no.

Does applicant need money for seasonal or temporary?(yes/no): no.

Collateral offerred by applicant?(acceptable/unacceptable): acceptable.

Documents Required from the applicant?(completed/incompleted): completed.

samson are Eligible For overdraft
  Then the next  step is Credit Analysis!
```

Figure 4.4: Dialogue windows for credit production type evaluation

From figure 4.4 above, the system requests the credit evaluator to enter the name of applicant. Then the system offered or asks the credit evaluator for advising services and the evaluator skips this part by inserting "no". As loan evaluator inserts "no", the system displays "Welcome to credit evaluation! Enters the Samson's request from the following credit type please" and the system display the lists of credit production type. The evaluator may insert requests of the customer from the displayed lists of credit type. For example, from figure 4.4, the evaluator inserts "overdraft" which is requested by customer called Samson. As soon as the evaluator inserts the overdraft credit type, the developed prototype system interacted with the evaluator by asking various criteria and requirements. The system

accepts all the information from the evaluator, then drawn the conclusion. If the entered data is qualified or fulfills the condition the system automatically draws the conclusion by displaying "Samson is eligible for overdraft, and then the next step is credit analysis". On the contrary, if one or more condition is not fulfilled the prototype dawns the negative conclusion (as shown below in the figure 4.5), which indicates that the applicant is not eligible for the request. In order to evaluate other requests such as import letter of credit, pre-shipment export, merchandise and revolving export the same steps were applied as overdraft credit facility.

```
1 ?- start.
% best.pl compiled 0.00 sec, 1,260 bytes

Welcome To a Self-learning Knowledge Based System For Credit Evaluation!

written by Wesenu Bekele  Appril,2014!!
Please Enter your name::tsion.

Do you want to see some requirements of Loan tsion?
Answer by writing(yes/no):
|: no.
Wellcome to credit evaluation!
Enter tsions request from the folloving credit type please!!

<< Overdraft Credit>>
<< importletter of credit>>
<< preshipment Export>>
<< Merchandise>>
<< Revolving Export>>
|: revolvingexport.

"Welcome to Revolving Export Credit evaluation!"
Please interact with the following question  in order to evaluate  revolvingexport

Does the customer has clean track record in the export business?(yes/no):
|: no.

Does the customer submit permanent Letter of Credit?(yes/no):
|: no.

Does the customer submit Waybills such as truck way, railway ?(yes/no):
|: yes.

Does customer submit Insurance contract?(yes/no):
|: yes.

Does a customer have acceptable certificate from appropriate organization ?(yes/no):
|: yes.

Sorry!tsion is ineligible for revolving export loan!
```

Figure 4.5: Dialogue windows for credit evaluation shows ineligibility of the request

The above figure 4.5 shows the ineligibility of the request. The system starts by asking the name of the applicants. As loan evaluator inserts the name of the applicant, the prototype asks the evaluator "Do you want to see some requirements of Loan by calling the name of customer? Answer by writing (yes/no)". The evaluator ignores this part by inserting "no". If the evaluator inserts "no", the system automatically takes to the credit evaluation part and displays the lists of menu credit production type. Subsequent, the credit officer or evaluator inserts request of the customer from the displayed lists. As shown from figure 4.5 the applicant's request is Revolving Export Credit, then the evaluator inserts "revolving export". Next to this, the prototype starts to evaluate the request that is inserted by interacting within the evaluator. After all data are fed to system, the system infers knowledge base and draws the conclusion by displaying "sorry! tsion is ineligible for revolving export loan". This indicates that, there is some or more requirements are missing and the system alerts the customer to fulfill and came back again.

4.2.4. Consultation/Explanation Facility

Explanation facility justifies or makes the system more understandable. It explains situations that the user did not expect. The explanation facility involves the design and programming of an explanation capability. For instance, programming the ability to answer question such as why a specific piece of information is needed by the computer or how a certain conclusion was derived by the computer [11]. The explanation facility is the component of knowledge based system that provides insight to the reasoning process. It can suggest which rules were used to acquire results. If an explanation of how the result was achieved is wanted, the explanation facility can provide this suggestion as justification. This process can uncover insufficient or incorrect knowledge [60].

In this study, if the customer is not eligible for the loan, the system displays "why" for the evaluator and asks the credit evaluator to enter the "why" to see the reason that the request is ineligible. Then, if credit evaluator inserts "why", prototype justifies or explains the reason that for the request is ineligible. The figure below 4.6 illustrates detail about explanation facilities.

```
1 ?- start.
% best.pl compiled 0.00 sec, 1,464 bytes

Welcome To a Self-learning Knowledge Based System For Credit Evaluation!

written by Wesenu Bekele  Appril,2014!!
Please Enter your name::alex.

Do you want to see some requirements of Loan alex?
Answer by writing(yes/no):
|: no.
Wellcome to credit evaluation!
Enter alexs request from the following credit type please!!

<< Overdraft Credit>>
<< importletter of credit>>
<< preshipment Export>>
<< Merchandise>>
<< Revolving Export>>
|: overdraft.

Please Answer the Following Question inorder to check
the Eligibility of the alex Loan  request !

How long does the customer  business operated?:1.

Hov loang does customers cuurent account ?:3.

For how many applicant advanced a term loan?:2.

Does the customer has good repayment record on term loan?(yes/no): yes.

Does the customer currently blacklisted by CBE or any other?(yes/no): no.

Does applicant need money for seasonal or temporary?(yes/no): no.

Collateral offerred by applicant?(acceptable/unacceptable): acceptable.

Documents Required from the applicant?(completed/incompleted): completed.

MESSAGE:!alex  is Ineligible For overdraft
 why?
  Type why if you want to know the reason
|: why.

alex  is  not fulfill one or more requirements of  overdraft
Tell to him to complete and come back again
```

Figure 4.6: Dialogue window with "Why" Explanation Facility

The above figure 4.6 shows the explanation facility. The request is evaluated accordingly. If the request does not fulfill the requirements, the system gives answer by displaying message of ineligibility for the request. At the same time, the system displays "why" and asks credit evaluator "Type why if you want to know the reason". The system needs the response of the credit evaluator in

order to derive a certain conclusion. If the credit evaluator inserts "why", the prototype derives the conclusion "Alex did not fulfill one or more requirements of overdraft. Tell him to complete and come back again". The system explains the reason for request's ineligible.

4.2.5. Self-learning

As discussed earlier in section 2.5.4, Self-learning is one of the elements of Knowledge Base System which tries to imitate the learning capability of human beings. Computer changes how it functions or reacts to situations based on feedback. It is possible to update the knowledge base of the KBS either manually or automatically using machine learning algorithms **[21]**. Adding new information to its knowledge base as it runs, and then remembering that information at the next session is the capability of learning.

The learning prototype system attempts to store the details of a specific evaluated credit. The facts base is stored on a separated file called"best2.pl" and becomes updated whenever the credit evaluator ends the program. Once the request is evaluated and the eligibility is not approved for the loan and those applicants request is eligible, the system learns by memorizing or learns from the experiences. Figure 4.7 below shows a sample dialogue with the prototype system.

```
1 ?- start.
% best2.pl compiled 0.00 sec, 760 bytes

% pep3.pl compiled 0.00 sec, 2,900 bytes

Welcome To a Self-learning Knowledge Based System For Credit Evaluation!

written by Wesenu Bekele  Appril,2014!!

Please Enter customer name::
|: abebe.

customer is new for a bank!
Do you want to see some requirements of Loan abebe?
Answer by writing(yes/no):
|: no.
Wellcome to credit evaluation!
Enter abebes request from the following credit production type please!! or
classify credit customer

<<customer classification>>
<< Overdraft Credit>>
<< importletter of credit>>
<< preshipment Export>>
<< Merchandise>>
<< Revolving Export>>
|: preshipment.

Answer the following question to check validity of the application

Does the application for pre-shipment without the NBE?(yes/no):yes.

Does the customer engaged in any export business?(yes/no):
|: yes.

Does an applicant  is business or corporate class ?(yes/no):
|: yes.

Does customer risk grade related as grade 1 or 2?(yes/no)::
|: yes.

Does an applicant present valid sales contract from foreign buyer(yes/no):
|: yes.

Does the export item selling price within acceptable range?(yes/no):
|: yes.

abebes  request is eligble::: The next  step is credit analysis .
```

Figure 4.7: show a sample dialogue with the prototype system for Pre-shipment credit evaluation

As shown by figure 4.7 above, the prototype system evaluates the requests by interacting within the credit evaluator. As seen from the figure 4.7, the customer's request is "pre-shipment export credit facility", and then the evaluator inserts "pre-shipment" for evaluation. The requirements and criteria

are being evaluated accordingly and the applicant's request was eligible. As seen from the figure, the system learns customer as a new customer by displaying" customer is new for a bank".

```
1 ?- start.
% best2.pl compiled 0.00 sec, 860 bytes

% pep3.pl compiled 0.00 sec, 2,900 bytes

Welcome To a Self-learning Knowledge Based System For Credit Evaluation!

written by Wesenu Bekele  Appril,2014!!

Please Enter customer name::
|: abebe.

customer  is existing

 Last Time abebe is Eligible For preshipment Credit Type

Does the customer vants to reapply or request for another Credit? vrite(yes/no).
|: yes.

Wellcome to credit evaluation!
Enter abebes request from the following credit production type please!! or
classify credit customer

<<customer classification>>
<< Overdraft Credit>>
<< importletter of credit>>
<< preshipment Export>>
<< Merchandise>>
<< Revolving Export>>
|: merchandis.
PLEASE RETYPE  CORRECTLY!: merchandise.
can applicant  submit financial statement >=1 year?(yes/no):yes.

Does the customer open account at the branch where they request loan?(yes/no):no.

Does customer submit plan that justify the purpose and utilization of the loan?no.

 Does applicant prepare temporary financial statement as request by bank?(yes/nyes.

Does customer present customs declaration for imported goods?(yes/no):yes.

Does customer present internal production report for manufactured goods?(yes/noyes.

 customer is Not Eligible for merchandise loan
```

Figure 4.8: Dialogue windows for learns by memorization or learns from experience

As shown on figure 4.8, the prototype system has learned by memorizing the details of the credit applicant. As shown by figure 4.7, customer called "abebe' " is request for pre-shipment credit production type. The request is being evaluated and eligible. After a certain time, as shown from the above figure 4.8, the customer came to reapply or increase the amount of credit. The system learns the customer by displaying" customer is existing Last Time abebe is Eligible for pre-shipment credit type". This is because the system learns from experience that the customer applied for the credit called

pre-shipment before and after a certain time the customer wants to reapply for another credit type or increase the amount of previous credit. To continue, the prototype system asks the credit evaluator by saying "Does the customer want to reapply or request for another credit? Write (yes/no)". As can be seen from figure 4.8 above, the customer reapplied for merchandise credit type. The request is evaluated accordingly the prototype system drawn a conclusion which is ineligible. Then, the prototype updates the request or application of the customer in the facts base of the prototype system. This learning is permanent. When, the prototype system is run for the next time and the previous request and learned one are saved in fact base.

The following figure 4.9 below shows self-learning of credit customer classification.

```
1 ?- start.
% best2.pl compiled 0.00 sec, 760 bytes

% pep3.pl compiled 0.00 sec, 2,772 bytes


Welcome To a Self-learning Knowledge Based System For Credit Evaluation!

written by Wesenu Bekele  Appril,2014!!

Please Enter customer name::
|: abel.


customer is new for a bank!
Do you want to see some requirements of Loan abel?
Answer by writing(yes/no):
|: no.
Wellcome to credit evaluation!
Enter abels request from the following credit production type please!! or
classify credit customer

<<customer classification>>
<< Overdraft Credit>>
<< importletter of credit>>
<< preshipment Export>>
<< Merchandise>>
<< Revolving Export>>
|: customer.

Please Enter Customer Name

|: abel.

abel  is a new credit Customer for bank

Retype a customer name to insert in a fact base!
|: abel.

Do you want to classfy Customer to Business Class?(yes/no).
|: yes.

Please Enter Score sheet out of 70%
|: 60.
abel  is classified as business credit customer
please Retype busines class to insert in a fact base
|: business.

Good Bye,abelis classified as business
% Break level 1
```

Figure 4.9: Dialogue windows for self-learning of credit customer classification

As shown from the above figure 4.9, a new credit customer called,"Abel" comes to a bank. The credit evaluator wants to classify this credit customer to the business category. Then the credit evaluator inserts" customer" into a prototype system to classify "Abel" to business class. The system asks a credit evaluator "Please enter customer name" and credit officer fed the name of the customer into the system. Since the customer is new for the bank, the system displays" Abel is a new credit customer for

bank", then the system asks credit officer to insert in fact base by displaying "Retype a customer name to insert in a fact base". The credit customer is saved into the fact base and the system asks "Do you want to classify customer to business class? (Yes/no)". Credit officer respond to the system by typing yes", since credit customer is classified based on the score sheet, the system asks to insert credit score out of seventy percent. The value of score sheet is fed into the system and the system classifies "Abel" as business credit customer, and then saved into fact base.

The existing credit customer is also reclassified, after a certain period of terms by calculating their score sheets. The figure 4.10 below, illustrates a reclassification of existing credit customer into business category after a certain period of terms.

```
1 ?- start.
% best2.pl compiled 0.00 sec, 860 bytes

% pep3.pl compiled 0.00 sec, 2,836 bytes

Welcome To a Self-learning Knowledge Based System For Credit Evaluation!

written by Wesenu Bekele  Appril,2014!!

Please Enter customer name::
|: abel.

customer  is existing

 Last Time abel is Eligible For overdraft Credit Type

Does the customer wants to reapply or request for another Credit? write(yes/no).
|: yes.

Wellcome to credit evaluation!
Enter abels request from the following credit production type please!! or
classify credit customer

<<customer classification>>
<< Overdraft Credit>>
<< importletter of credit>>
<< preshipment Export>>
<< Merchandise>>
<< Revolving Export>>
|: cutomer.
PLEASE RETYPE  CORRECTLY!: customer.
Please Enter Customer Name

|: abel.

abel is existing credit customer

Do you want to reclassify abel?(yes/no)::
|: yes.

Please Enter current Scored score sheet out of 100%:
|: 45.
abel is Reclassified as commercial credit customer

please enter business class to save in fact base
|: commercial.

Good Bye, the customer is reclassified
% Break level 1
```

Figure 4.10: Dialogue window shows reclassification of existing credit customer.

As shown from figure 4.10 above, the credit officer wants to reclassify the credit customer after a certain period of terms based on current score sheet they scored. When this process take place, the prototype system learns from the experiences and updates its knowledge. As explained on figure 4.9 above, the credit customer called "Abel" is classified as business category for the first time. Again, the

credit officer wants to classify "Abel" after a certain period of term based on his current score sheet achieved. As observed from figure 4.10, the system ask" Please enter customer name", then the credit offer respond to the system by inserting "abel", since abel is existing customer for bank, the prototype system learns from experiences and display " abel is existing credit customer" message to the credit officer. Next to this, the system asks the credit officer "Do want to reclassify abel", then credit officer responds to the prototype by inserting "yes". The prototype asks the current score sheet and reclassify abel as commercial credit customer. The prototype updates its knowledge and the fact base holds abel as business and commercial credit customer.

4.2.6. User Interface

The user interface is used for effective communication both domain experts and users with prototype system. It enables to communicate easily with the prototype self-learning knowledge based system. According to [60], the user interface should allow the user to start the consultation with the system and enter the problem case data. It should also allow the user to exit the system. The same interface is responsible for permitting the user to ask how a result was obtained or why a question was asked or to provide answers to the system's questions. The explanation is also given through the same interface.

The user and the domain experts start to use by writing "start",".", then by pressing "enter key" from the key board. For instance, figure 4.9 below shows the interaction between credit evaluator and prototype system for import letter of credit request.

```
1 ?- start.
% best2.pl compiled 0.00 sec, 860 bytes

% pep3.pl compiled 0.00 sec, 2,900 bytes

Welcome To a Self-learning Knowledge Based System For Credit Evaluation!

written by Wesenu Bekele  Appril,2014!!

Please Enter customer name::
|: seifu.

customer is new for a bank!
Do you want to see some requirements of Loan seifu?
Answer by writing(yes/no):
|: no.
Wellcome to credit evaluation!
Enter seifus request from the following credit production type please!! or
classify credit customer

<<customer classification>>
<< Overdraft Credit>>
<< importletter of credit>>
<< preshipment Export>>
<< Merchandise>>
<< Revolving Export>>
|: importlette.

PLEASE RETYPE  CORRECTLY!: importleter.
PLEASE RETYPE  CORRECTLY!: importletter.

Answer the following questions inorder
to check Eligibility of  applicant loan Request

Does the request for one time?(yes/no):
|: yes.

Does the customer have investment certificate or
appropriate license or invoice ?(yes/no):
|: yes.

The applicant  is  eligible for the request:: Then the next  step is Credit Analysis!
```

Figure 4.11: Sample dialogue for import letter of credit request.

From figure 4.9 above, the request or application evaluator starts the prototype system by writing "start.", then press "enter" key from the key board. After that the prototype system displays the welcoming message and asks the credit evaluator to insert name. Once the credit evaluator feeds the name, prototype system asks "Do you want to see some requirement of loan?" by calling the name.

If the credit evaluator didn't want to see the advisory services, he/she insert "no" directly in order to go to the credit evaluation processes. As shown in figure 4.9 above, credit evaluator answers the question by inserting "no". Automatically, the prototype system displays "Welcome to the credit evaluation!

Enter" the customer's request by calling the name" from the following credit type please", additionally, the system displays the lists of credit production type from which the credit evaluator inserts the request that belongs to the customer's request. As seen in the above figure 4.9, the customer request belongs to import letter of credit facility.

Whenever the credit evaluator inserts the credit type, he /she may types an error, the input validity checker, asks the credit evaluator to reenter the correct credit type by displaying the message "please retype correctly". The evaluator retypes the correct credit production type and the prototype system continues to evaluate the request by interacting with the evaluator. The prototype system asks "Does the request for one time? (Yes/no)". Since there are two type of import letter of credit; import letter of credit for one time and revolving import letter of credit, the prototype system asks the credit evaluator for which import letter is evaluated. If evaluator inserts "yes", the prototype system evaluates a request as one time import letter of credit. If evaluator reacts by answering "no", the prototype system evaluates the request as revolving import letter of credit facility. In figure 4.9 above, the evaluator answers by inserting "yes", so that the prototype deals with the import letter of credit for one time. Finally, the prototype draws a conclusion by inferring the knowledge base and displays "the applicant is eligible for the request. Then the next step is credit analysis". This indicates that the request fulfills the condition.

4.3. Prototype System Testing and Evaluation

After prototype self-learning knowledge based system is developed, it should be tested and evaluated to make sure that the acceptance and the performance of the prototype system is precise. Testing and evaluation of the prototype self-learning knowledge based system is the final step that assists the knowledge engineer to measure that whether the prototype system is met the proposed objective or not.

4.3.1. User Acceptance Evaluation

User acceptance evaluation is the basic problem for the application of successful and effective prototype self-learning knowledge based system. To the problem of user acceptance, the researcher uses visual interaction along with checklist for domain experts. Six (6) loan officer where purposively selected for this purpose. Every domain expert's evaluator officer various credit customer application requests test to the prototype system and search decisions made by the prototype system. Credit customer is not participated in user acceptance evaluation, because credit customer has no right to

change criteria and all requirements of credit request rather the domain experts. The domain experts evaluate the prototype system performance based on the following evaluation criteria.

These are: simplicity to use and interact with prototype system, easy to learn / adapt with prototype, prototype system efficiency in time, the involvement of adequate knowledge to evaluate requests, the ability of the prototype system to remember the customers' credit information, The ability of the prototype system in advising credit customer, and contribution of the developed prototype system in domain area. These evaluation criteria' are adapted from Solomon [6]. The questionnaires used to test the user performance of the prototype system by credit evaluator, i.e. domain experts is found in appendix IV.

The researcher set values for each attributes of the checklist for the purpose of evaluating the performance of the prototype system by credit experts. The values for all attributes are fixed as: Excellent = 5, Very good = 4, Good = 3, Fair = 2 and Poor = 1.
Based on the given scale, system evaluators provide a value for each checklist. Thus, this method helps the researcher to manually examine the user acceptance based on evaluator's response. The user acceptance of the system is measured manually as follows [62]:

$$AveS = SV1 * \frac{nr1}{tnr} + SV2 * \frac{nr2}{tnr} + SV3 * \frac{nr3}{tnr} + ... \sum_{i=1}^{n} SVi * nri / tnr$$

Where, AveS average score, SV scale value, TNR total number of respondent and NR is number of respondent. To get the result of user acceptance average performance is calculated out 100%.

$$Avp == AveS / NS * 100$$

Where, NS is number of scale and Avp is average performance. The following table summarizes the results obtained from the respondents'. Table 4.2 indicates the results obtained after the evaluation by domain expert. The following table 4.1 illustrates the outcomes achieved after evaluation by domain experts.

No.	Parameters of evaluation criteria	Poor	Fair	Good	Very good	Excellent	Average
1	Simplicity to use and interactive with prototype system	0	1	1	2	2	3.83
2	Easy to learn / adapt with prototype	0	0	1	2	3	4.33
3	Does the prototype system Efficient in a time?	0	0	1	3	2	4.16
4	Does the system include adequate knowledge to evaluate requests?	1	0	2	1	2	3.50
5	The ability of the prototype system to remember the customer information	0	0	1	2	3	4.33
6	The ability of the prototype system in advising credit customer	0	0	0	2	4	4.66
7	contribution of the developed prototype system in domain areas	0	0	1	2	3	4.33
		Total average					**4.16**

Table 4.1: Performance Evaluation by Domain Experts

In table 4.1above, from the evaluators who scored the simplicity to use and interact with the prototype system criteria of evaluation, 33.33% of them scored both as excellent and very good, 16.67% as good, and 16.67 % as fair. In relation to easy to learn / adapt with the prototype system criteria of evaluation, 50% of the evaluators scored as excellent, and 33.33% as very good and 16.67% as good. The criteria of evaluation with respect to the prototype system efficiency in time, was evaluated by 33.33% as excellent, by 50 % as very good and by 16.67 % as good. In the case of fifth criteria of evaluation, i.e., whether or not the prototype system include adequate knowledge to evaluate requests or application, the it was scored by 33.33% as excellent, by 16.67% as very good, by 50% as good and by 16.67 % as

poor. The evaluation criteria with respect to the ability of the prototype system to remember the customer's information was rated by half (50%) of the evaluators as excellent, by 33.33% as very good and by 16.67% as good. At the side of, the ability of the prototype system in advising credit customer, 66.67% of the evaluators scored the prototype system "excellent" and 33.33% of them "very good".

The final evaluation criteria, i.e., concerning the contribution of the developed prototype system in domain area, half (50%) of the evaluators rated "excellent", 33.33% of them "very good" and 16.67% of them "good". Finally, the average performance of the prototype system according to the evaluation results filled by the domain experts is 4.16 out of 5. This result indicates that the overall average performance of the prototype self-learning knowledge based system is about 83.2%. This implies that the modeled prototype was performs well in making right evaluation on the credit evaluation of customer application.

4.3.2. Prototype System Performance Testing

Performance testing is the process of determining whether the developed prototype system is valid or invalid, that is whether it achieves the required level of accuracy or not. To address the issue of validation, eighteen test cases were used from Commercial Bank of Ethiopia credit application. For the test, three types of cases were selected purposively. These cases are overdraft credit facility, import letter of credit facility and pre-shipment export credit facility. For these tests (6 from each type) test cases were select for testing cases. Half of them selected from the requests or applications that are evaluated as ineligible by human expert and the rest of them from the requests evaluated as eligible by domain experts. The reasons for taking both ineligible and eligible test cases that evaluated by domain experts are to check the correctness evaluation from both sides. For each case three test cases from ineligible requests and three of them from eligible requests or applications were selected. So that, each case has equal number of test cases from both ineligible and eligible credit customer applications or requests.

Additionally, six domain experts or credit evaluators were selected to evaluate the developed prototype system by interacting with the developed prototype. These evaluators have participated in the user acceptance evaluation. The reason why domain experts were selected for the second time was that they

are familiar with the system prototype during visual interaction evaluation. So they can easily understand about the prototype. Table 4.2 below shows the test results found by test cases.

Selected cases	Total number of cases selected for testing	Number of correctly evaluated cases	Number of incorrectly evaluated cases	Accuracy
Overdraft credit Facility	6	5	1	83.33%
Import letter of Credit facility	6	4	2	66.67%
Pre-shipment Export credit	6	4	2	66.67%
Total	18	13	5	**72.22%**

Table 4.2: Testing the Accuracy of Prototype System Using Testing

During the testing procedure, the selected experts evaluated and identified correctly and incorrectly evaluated cases by comparing the decision made by the prototype system with that of the experts' decision on those cases. As shown in table 4.2 above, the highest accuracy rate is obtained by case of overdraft credit facility. The same results were achieved for both import letter of credit facility and pre-shipment export credit facility which is less accurate than overdraft credit facility. The overall results of the testing have revealed 72.22% accuracy in evaluating the evaluation of customer loan request.

4.3.3. Discussion

As shown in the above table 4.2 and 4.1, the accuracy of the prototype system is calculated is 72.22% and the average user performance evaluation results filled by the domain experts in the domain fields is 83.2%, respectively. In general, the overall performance of the prototype system is 77.71%.

Kay Bryant [5], has done research study on the integration of qualitative factors into expert systems for evaluating agricultural loans. The researcher use dependency diagram to represent knowledge. The developed expert system enables the loan officer's to make decision easily in agricultural loan evaluation. The researcher achieves 73% performance of the developed system.

As comparing to the result found by Kay Bryant with the result of this study, the result found in this study is better than the result found by Kay Bryant. The performance achieved by this study is greater than the work of Kay Bryant by 4.71% performances. This can be resulted because the method of knowledge modeling and method of knowledge representation. So that, it is better to use decision tree for knowledge modeling and rule base for knowledge representation.

During the study starting from the beginning to end of the research are various challenges were faced. These challenges are discussed as follows.

- Building the knowledge based system is not an easy task. To build knowledge base system, tacit and explicit knowledge must be extracted from the domain experts as well as from different sources of knowledge that help to develop the prototype self-learning knowledge base system for loan evaluation. To do this, extracting tacit knowledge from the domain experts is very difficult due to the personal nature of tacit knowledge. Besides, extracting tacit knowledge is by itself hard to reveal to others. So the researcher a faced difficult to extract or to obtain the tacit knowledge of credit evaluators.

- The main factor that hinders the prototype system to register higher accuracy is that the attitudes of the domain experts' credit evaluators since there is no similar knowledge base system for credit evaluator or advisory system in banking industry and micro financial institutions in Ethiopia are adopted currently.

- During coding the represented knowledge about credit evaluation using the SWI-prolog editor tool, the facts base of the prototype system is able to update its knowledge automatically. However, the researcher faced a challenge to update the rules of the knowledge base of the prototype system automatically.

Depending on the results found the main strength of the prototype system and its applicability in the domain areas are:

- The prototype self-learning knowledge based system helps to solve problems in the domain areas where an experienced and skilled man power are unavailable as well as helps to reduce inconsistence.

- The prototype system has the capability to learn the histories of credit customer from the experience and updates the knowledge.
- The prototype is system applicable everywhere.
- Prototype system stores the facts in fact base or database which helps to remember easily during credit evaluation.

Generally, all the evaluation and testing results of the prototype show encouraging finding for further research work to fully implement and apply self-learning knowledge based system technology in credit evaluation in banking industry and micro financial institutions. As a result, from the research findings, it is possible to conclude that the study achieve its objectives.

Chapter Five

5.0. Conclusion and Recommendations

5.1. Conclusion

Credit evaluation is the process a business or an individual must go through evaluation to become eligible for loan. It is also a process that a lender undertakes when evaluating a request for a loan. When this process is taking place, there are a number of factors that expose the bank, the micro financial institution or the lending institution to risks. These factors include lack of domain experts or shortage of credit evaluator, inconsistencies, impression, personal bias and knowledge gap. In order to reduce the risks that come due to these factors, it is essential that procedures and control mechanisms are in place to ensure that each loan is objectively evaluated. But, in our county in the case of Commercial bank of Ethiopia, the loan service is only advanced at head office and district level, there is no loan advanced at branch level. This condition leads the bank's customer to an unwanted expense to go to head office or district level. The banks may lose their customers due to the distances. Because of this problem, banks cannot get many credit customers.

New strategies such as expert systems are required to lower operating costs and increase productivity as well as profits. Expert system will play major role in resolving such problem in credit evaluation. In recent years, tools, technologies and applications of information technologies have emerged as effective and efficient measures for up gradation of the whole banking industries.

Hence, in this research an attempt has been made to design and develop a prototype of a self-learning knowledge based system that can provide an advice for credit customer and credit evaluators to facilitate the evaluation of customer application or requests for the loan.

In developing the prototype system, knowledge is acquired using semi-structured interviews with domain experts and from relevant documents like credit evaluation procedure by using document analysis method to find the solution of the problem. The acquired knowledge is modeled using decision tree that models concepts and procedures involved in credit evaluation. After that, the validated knowledge is represented using rule-based knowledge representation technique and implemented using SWI-prolog develop tools for developing the prototype self-learning knowledge

based system to provide advisory services both for customer(new and existing customer) and assists domain experts in applications evaluation

Also in testing and evaluation of the prototype system, eighteen (18) cases of credit request or application are selected using purposive sampling method in order to test the accuracy of the prototype system. The selected cases include both cases that are evaluated as ineligible and eligible by human experts. The selection is equal for both of them, i.e. nine (9) of cases are eligible cases and the rest of them are ineligible cases. The correct and incorrect evaluation results are identified by comparing the decision made by the evaluators on the cases credit applications and with the conclusions of the prototype system. And also the process of ensuring that the prototype system satisfies the requirements of the user is performed. As the testing results show, the overall performance of the prototype system registers 77.71%.

Furthermore, the study concludes that the major credit production type that advanced to customer is import letter of credit facility, export credit facility, pre-shipment credit facility and merchandise. The eligibility of application is focused on general and specific criteria. Credit customer is classified as business, corporate and commercial based on the score sheet they achieved.

Generally, in this study, the applicability of knowledge of prototype self-learning knowledge based system is proved as hopeful approach in banking industry for credit evaluation.

5.2. Recommendations

The system achieves its objectives by demonstrating the applicability of self-learning by developing a knowledge based system for credit evaluation with hopeful of performance and user acceptance. This study is the promising study for further research works to fully implement the self-learning knowledge based system in the credit evaluation domain area. As a result, researcher recommends the following challenges as areas of future research works based on this study.

- In this study the explanation facility given by the proposed system is not user friendly. The interactive user interface is the most significant. As a result, further research can be done to add interactive user interface that can help the user to interact with the system.
- To enhance the performance of the prototype of self-learning knowledge base system the combination strategy approaches should be discovered which combines case based reasoning

and rule based reasoning. The involvement of cased based reasoning in this study helps the proposed system to handle qualitative factors of the experts on the credit evaluation.

- The rules in the knowledge base of the prototype system should be updated with the aim of learning from experience so as to update its knowledge. Therefore, further work should be accomplished to update the rules of the system automatically.
- Due to the short time available for the research, the study attempted to develop a self-learning knowledge based system for credit evaluation (about five credit production type). However, the scope of the self-learning knowledge based system should be extended to include other credit production type such as term loan, agricultural loan and consumer loan. Therefore, further investigation should be done on term loan, agricultural and consumer loan.
- The scope of the prototype is limited to evaluating credit production type based on general and specific eligible criteria and credit customer classification. For credit analysis and scoring detail evaluation of application are required. Therefore, the further work should be done on credit analysis and credit scoring.

References

[1] Tibebu T., " Credit Risk Management and Profitability of Commercial banks in Ethiopia", MA Thesis, Addis Ababa University School of business and Public administration Department of Accounting and Finance, Ethiopia, 2011.

[2] Credit Eva+6luation and Approval, Available At: http://www.inc.com/encyclopedia/credit-evaluation-and-approval.html,Accessed Date: November 21, 2013

[3] A. JASIŃSKI, "Credit Expert: expert system for Credit applications evaluation", Interdisciplinary research, University of Lodz, Faculty of Management, Poland, 2000.

[4] V. Pacelli1 and M. Azzollini, "An Artificial Neural Network Approach for Credit Risk Management", Intelligent Learning Systems and Applications, Vol.3, No.2, PP. 103-112, 2011.

[5] K. Bryant, "The integration of Qualitative factors into Expert Systems for evaluating Agricultural loans" Griffith University, Brisbane, Australia, 1999.

[6] Solomon G., "A self-learning Knowledge Based System for Diagnosis and Treatment of diabetes", MSc Thesis, Addis Ababa University School of Information Science, Ethiopia, 2013.

[7] J. Nassali,"A Loan Assessment System for Centenary Rural Development Bank", Master of Science in Computer Science, Makerere University Faculty of Computing and Information Technology, Uganda, 2005.

[8] A. Krishnan, "Knowledge bases, Ontologies and Key-Value Stores", Available At: www.cbrg.ethz.ch/education/SDB/L4.pdf, Accessed Date: Jan 20, 2014.

[9] Pan. SL and Scarbrough H.," knowledge management in practice": An exploratory case study of Buckman Labs Technology analysis and Strategic Management, Vol. 11, No.3, PP.359-78, 1999.

[10] Scarborough H. and Swan, J.,"knowledge management": a literature review: issues in people management London: Institute of personnel and Development, 1999.

[11] Pearson Education, "Chapter18-Knowledge Acquisition, Representation, and Reasoning", Available at: http://wps.prenhall.com/wps/media/objects/3778/3869053/Turban_Online_Chapter_W18.pdf, Accessed date: Feb 22, 2014.

[12] P. Sajja and R., Akerkar," Knowledge-Based Systems for Development", Advanced Knowledge Based Systems: Model, Applications & Research, Vol. 1, No.1, PP. 1 – 11, 2010.

[13] R. S.E and Edward, F."Expert system and Artificial Intelligence", WTEC hyper librarian, Japan, Available At:
http://www.wtec.org/loyola/kb/cl_s5.html, Accessed Date: Jan 22, 2014.
[14] M.Petrik, "knowledge Representation for Expert System", WTEC hyper –Librarian, Japan, 2003.
[15] N. Saleem and A.N Azad"Expert Sytems as a Statistical Tutor on call",computer in mathematics and Sc.Teaching, University of Houston and Rock, USA,1992.
[16] Brain Mennecke,"Decision support, Knowledge management and Expert system", IOWA STATE UNIVERSIT, College of business.
[17] J. Purwardi," The Architecture of Knowledge-based Expert System", Available at: www.cs.ubc.ca/~poole/ci/slides/ch6/module08.pdf, Accessed Date: Feb 27, 2014.
[18] Inference in Rule-based Systems:" forward and backward chaining'', Available at: lecturer.ukdw.ac.id/.../6-7Penalaran%20pada%20**Inference**%20Engine2, Accessed Date: Feb 27, 2014.
[19] E. Castillo, J.M. Gutierrez and A.S. Hadi, "Expert Systems and Probabilistic Network Models", Springer, USA, 1997.
[20] RAMANI, R. V. and PRASAD. K. V.K. ,"Applications of knowledge based systems in mining engineering", APCOM 87. Proceedings of the Twentieth International Symposium on the Application of Computers and Mathematics in the Mineral Industries, Volume 1: Mining. Johannesburg, SAIMM. 1987. pp. 167 - 180.
[21] P.S. Sajja and R. Akerkar, "Advanced Knowledge Based Systems: Model, Applications & Research", Vol. 1, No.3, PP. 1 – 11, 2010.
[22] R.A. Akerkar and P.S. Sajja, "Knowledge-Based Systems", Jones and Bartlett Publishers, USA, 2010.
[23] A. Saxena," knowledge-based architecture for integrated condition based maintenance of engineering systems", A Dissertation presented to the academic Faculty, Georgia Institute of Technology, August, 2007.
[24] M.A. Covington, D. Nute, and A. Vellino,"*Prolog Programming in Depth*", Prentice Hall, Athens, 1995.
[25] Rule based Expert Sytems",2000-2002 SNU CSE Biointelligence Lab".
[26] R.C chakraborty, "AI courses Lectures 35-36, slide notes, topic:", expert systems", June 01,2010.

[27] Breuker, J. & Wielinga, B., "KADS: Structured Knowledge Acquisition for Expert Systems", Proceedings of Expert Systems and their Applications, Avignon, 1985.

[28] T. Savolainen "Positioning of Modeling Approaches, Methods and Tools", Computers in Industry, Vol.25, PP.255-262, 1995.

[29] B.F. Richard, G. Violetta, and O.L. Mieczyslaw, "On Features of Decision Trees as a Technique of Knowledge Modelling", Proceedings of the Workshop on Computer Science and Information Technologies CSIT99'', Moscow, Russia, 1999.

[30] "Knowledge Representation and Rule Based Systems", Available at: www.arun555mahara.files.wordpress.com/.../knowledge-representation.p, Accessed Date: Jan 26, 2014.

[31] M. Bramer,"Logic programming with prolog", Department of computer science and software Engineering, University of Portsmouth, United Kingdom, 2005.

[32] P. Blackburn, J., Bos and K., Striegnitz, "Learn Prolog Now! ", Available at: http://www.coli.uni-sb.de/kris/learn-prolog-now, Accessed date: Jan 25, 2014.

[33] J. F. Sowa,"Semantic Networks", Encyclopedia of Artificial Intelligence, 2nd ed , C.Shapiro and Wiley, 1992.

[34] E. Turban, J. E. Aronson and Liang, "Decision Support Systems and Intelligent Systems", 7th ed., Prentice Hall, Upper Saddle River, 2001.

[35] M. Pantic," Introduction to Machine Learning and Case-Based Reasoning", Imperial College department of computing, London, 2003.

[36] JM & Co/AJRA," The Basics of Expert (Knowledge Based) Systems", 1997.

[37] A. Bullinaria, 2005" iai : expert systems", Available At: www.cs.bham.ac.uk/~jxb/**IAI**/w9.pdf, Accessed Date: Feb 03, 2014.

[38] K. Tripathi," A Review on Knowledge-based Expert System: Concept and Architecture", IJCA Special Issue on "Artificial Intelligence Techniques - Novel Approaches & Practical Applications", Bharati Vidyapeeth Deemed University Institute of Management Kolhapur, India, AIT, 2011.

[39] Shalfield, R.," LPA WIN prolog user guides.": Logic Programming Associates, England,2002.

[40] Ghan, K. ,"Human judgment in diagnosing problem behavior in horses" Using knowledge based system application, University of Nottingham, United Kingdom: B.A.(Hons), 2004.

[41] Pfenning F. ,"Logic Programming", Carnegie Mellon University, 2007.

[42] Covington M.," *Prolog Programming in Depth*", Artificial Intelligence Programs The University of Georgia,U.S.A, 1995.

[43] Berry D. and Hart E., "A Review of Expert Systems Evaluation Techniques", 1993.

[44] A., C.J., and Scott, D.," Performance evaluation of a knowledge-based system for subsidence management". Journal of Structural Survey, Vol.19, No. 5, pp. 222-232.

[45] Burkle, T., Ammenwerth, E., Prokosch, H. and Dudeck, J.,"Evaluation of Clinical Information Systems": What Can Be Evaluated and What Cannot? Journal of Evaluation in Clinical Practice, Vol. 7, No. 4, Pp. 373–385.

[46] Speel, P.H., Schreiber, A.T., Joolingen, W.V., Heijst, G.V. and Beijer, G.J. ,"Conceptual odelling for knowledge-Based Systems", In:Encyclopaedia of Computer Science and Technology, Vol. 44, versionII. New York: Marce Dekker Inc. pp. 107–132, 2001.

[47] Pomykalski, J.J., Truszkowski, W.F. and Brown, D.E. ,"Expert Systems", in Wiley encyclopedia. USA: J. Webster. Pp. 1-66, 1999.

[48] Tony Polito , Rik Berry and Kevin Watson "Recent Applications of Knowledge Based System (KBS) Technologies", Available At: www.tonypolito.com/wri_kbs.doc, Accessed Date: May 20, 2014.

[49] J. Singh Thankur, "Intelligence & Expert System in: Business Competitiveness", Gian Jyotie, vol. I ,www.gjimt.com/GianJyotiE-Journal.htm., Jan-May 2012.

[50] Y. Shao and C., Oppenheim, "Expert System in Banking : The British Scene" A Preliminary Report, Department of Information Science, Strathclyde Business School, University of Strathclyde, 26 Richmond Street, United Kingdom.

[51] Desalegn K., "Designing a knowledge based system for VAT Administration", MSc Thesis, Addis Ababa University School of Information Science, Ethiopia, 2009.

[52] Wondimagegnehu N., "Determinants of nonperforming Loans: The case of Ethiopian Banks", MA Thesis, University of south Africa(UNISA),School of Business Leadership, South Africa 2012.

[53] Martin O., "credit assessment process and repayment of bank loans in barclays bank uganda ltd", MBA Thesis, Makerere University Business School (MUBS),Uganda, June 2007.

[54] Sagheb, "conceptual model of Knowledge Acquisition using Hierarchical Cluster Analysis", International Arab Conference of e-Technology, IACe-T., Egypt, PP. 1-14, 2009.

[55] Biazen G., "Application of Recommender System in field of Study Selection", Msc Thesis, Addis Ababa University, School of Information Science, Ethiopia, 2013.

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

[57] Monetary Authority of Singapore, credit risk, February 2006.

[58] A. Mihaela Dima , "**Credit Analysis"** AcademyPublish.org – Risk Assessment and Management, Available At:
www.academypublish.org/papers/pdf/447.pd. Accessed Date: Feb 22, 2014

[59] H. Talebzadeh, S. Mandutianu, and Ch. F. Winner" Countrywide Loan-Underwriting Expert System", AI Magazine Vol. 16, No. 1 ,PP.52-64,1995.

[60] G. Kalfopoulos," ESCAPE: Expert system development through code generation", University of Crete Department of Computer Science, Stochholm, Sweden, August, 2000.

[61] Artificial Intelligence and Expert Systems, university of York, Available At:-
www.cse.**yorku**.ca/~mack/1010/1010-Chapter11.ppt,Accessed *Date, Aug. 2014.*

[62 R. Lakner "Knowledge-based systems",Engineering Application of AI-PhD Course, Department of Computer Science, University of Veszprém, Hungary, 2001.

[63] Introduction to Knowledge Engineering," What is Knowledge Engineering?History & Terminology", available at: www.commonkads.uva.nl/INFO/course-slides/01-intro.ppt, *accessed date: Oct29,2014.*

[64] A. Arab Maki and N. Shariat Zadeh," Design and Development of a Maintenance Knowledge-Base System Based on CommonKADS Methodology", Master Thesis, Royal Institute of Technology, Department Production Engineering and Management, School of Industrial Engineering and Management, SE-10044 Stockholm, Sweden,June 2010.

APPENDIX

Appendix I

Interview questions for domain experts

The following interview questionnaires are used to extract tacit and explicit knowledge from domain experts.

1. What are the main points to focus on for credit evaluation?
2. What are credit services provided by commercial bank of Ethiopia?
3. What are the main criteria for each types of credit expected from a loan applicant?
4. Which are the priority loan types of the bank?
5. How can credit evaluated?
6. What are the acceptable criteria's to approve loan application for each types of credit?
7. What are the problems/challenges faced during credit evaluation?
8. Are there any advices services for the customer loan before credit process?
9. What mechanism used for credit application evaluated?
10. What is the role of the customer relationship manager?
11. Are all applications' request subjected to criteria? / is there any exception?
12. Do evaluators/ domain experts have any factor on credit evaluation?

Appendix II

General Eligibility Criteria for every credit production

The Bank offers a wide-range of credit products supposed to fit with the existing or future demands of the economy and its customers. CBE extends short, medium and long terms loans and advances to borrowers who are engaged in commercial and non-commercial activities. The redesigned Credit Process is customer focused service rendering, and team based credit processing.

General Eligibility Criteria

All customers applying for any type of loan/facility must fulfill the following general eligibility criteria:

- All persons engaged in lawful trading activities and creditworthy businesses (es) are/ are eligible to borrow business loans.

- The business credit applicant should present renewed trade license for the current fiscal year or investment license and principal registration certificate for new projects.
- All applicants who are engaged in business must present a tax identification number (TIN).
- The applicant and/or any of its shareholders/subsidiaries shall have no record of previous loss to the Bank. To that effect, internal records shall be thoroughly checked. The applicant's shareholders shall represent all shareholders in case of Private Limited Company (PLC) while major shareholders /top ten/ in case of Share Company.
- The applicant must have never been engaged in tax evasion, or in a breach of exchange and control regulations, or in any other illegal/unlawful dealings, if the information is available/the circulated record is available.
- The applicant must not have any record of mal-operation of the checking account in the banking system until the rehabilitation period is expired.
- The applicant shall fulfill at least the required minimum equity contribution but not from debt financing.
- The applicant and/or any of its major shareholders/subsidiaries must not have any non-performing loans in any bank.
- The applicant has to present all the documents/information demanded by the Bank.
- The applicant's business must be legally acceptable, financially viable, technically feasible and marketable.
- The applicant must be classified as Grade 1 or 2 or 3. However, in exceptional cases, new or additional credit may be considered for other Grades.
- The customer has to fulfill the specific eligibility criteria for each loans and advances indicated in the credit product line.

Appendix III

Sample program code

```
start:- consult('best2.pl'),nl,consult('pep3.pl'),nl,

nl,write('Welcome To a Self-learning Knowledge Based System For Credit Evaluation!'),nl,nl,

write('written by Wesenu Bekele  Appril,2014!!'),nl,nl,

write('Please Enter customer name::'),nl,read(Name),nl,answer1(Name).

 answer1(Name):- request(Name,Type),nl,  write('customer  is existing'),nl,

   learning(Name,Type).

answer1(Name):- \+ request(Name,_),nl,

 write('customer  is  new  for  a  bank!'),nl,   write('Do  you  want  to  see  some  requirements  of  Loan
'),write(Name),write('?'),nl,write('Answer by writing(yes/no):'),nl,read(Answer3),

    ((Answer3=='yes',advising(Name,Answer2));(Answer3=='no',noadvising(Name,Type))).

 advising(Name,Answer2):-  write('! Are  you a new or existing customer for

 the Bank  '),write(Name),write('?'),nl,write('Answer by writing (new/exist):'),read(Answer2),

          ((Answer2=='new',advicenew);(Answer2=='exist',adviceexist)).
 %%assertz(answer(Name,Answer2)),tell('best.pl'),write(':-
 dynamic(answer/2).'),listing%%(answer),told.

    noadvising(Name,Type):-

    write('Wellcome to credit evaluation!'),nl,   write('Enter '),write(Name),write('s'),write(' request from
 the following credit production type please!! or'),nl,

    write('classify credit customer'),nl,nl,

                write('<<customer classification>>'),nl,

                write('<< Overdraft Credit>>'),nl,
```

```
write('<< importletter of credit>>'),nl,

write('<< preshipment Export>>'),nl,

write('<< Merchandise>>'),nl,

write('<< Revolving Export>>'),nl,read(Type),nl,

((Type=='overdraft',overdratf(Name,Type));(Type=='importletter',import(Name,Type));(Type=='preshi
pment',preshipmentt(Name,Type));

(Type=='revolvingexport',export(Name,Type));(Type=='merchandise',merch(Name,Type));(Type=='cu
stomer',customerclassification));get_ok(C).

get_ok(C) :- repeat,write('PLEASE RETYPE  CORRECTLY!:

'),read(Type),ok(C),((Type=='overdraft',overdratf(Name,Type));(Type=='importletter',

import(Name,Type));(Type=='preshipment',preshipmentt(Name,Type));(Type=='revolvingexport',expo
rt(Name,Type));(Type=='merchandise',merch(Name,Type));(Type==customer,customerclassification))
,!.

ok(overdraft).

ok(importletter).

ok(preshipment).

ok(preshipment).

ok(revolvingexport).

ok(merchandise).

ok(customer).

advicenew:-nl,nl,

write('===To be eligible for the loan, you must come up with the following things=====!'),nl,nl,
```

```
write('A feasibility study, Lease agreement and certificate,land holding-certificate and'),nl,
write('bill of quantity and specification (if the project involves construction'),nl,
write(' A business license from authorized government bodies'),nl,
write(' Memorandum and Articles of Association Proforma invoice'),nl,
write(' (not exceeding two months)Equity contribution by the customer'),nl,
write('Curriculum vitae of the management group'),nl,nl,
write('Do you want to see the priority sector?( yes/no).'),nl,read(Yesno),
((Yesno=='yes',priorsect);(Yesno=='no',write('Good Bye'),nl,break)).

priorsect:-nl,
write('THE PRIORITY SECTORS THAT BANK GIVE PRIORITIES FOR THE SERVICES ARE:'),nl,nl,
        write('agricultural loan,'),nl,
        write('Export credit facililty,'),nl,
        write('preshipment  credit facility,'),nl,
        write('merchandise loan'),nl,
        write('Loan for manufacturing  and'),nl,
        write('import letter of credit').

adviceexist:-nl,nl, write('===To be eligible for the loan, you must come up with the following things==!!'),nl,nl, write(' A feasibility study, Audited financial statements,
a list of fixed assets which include their book value and market value,
A list of the market value of fixed assets to be purchased ,
Projected financial statements;without project expansion and
```

```
with project expansion'),nl,nl,

 write('IF you want to see the proirity sector'),nl,write('type yes or  no to exit'),nl,read(Prior),

((Prior=='yes',priorsect);(Prior=='no',write('Good bye!!'),nl,break)).

 overdratf(Name,Type):-

 write('Please Answer the Following Question inorder to check '),nl,

 write('the Eligibility of the '),write(Name),write(' Loan  request !'),nl,nl,

write('How long does the customer  business operated?:'),read(B),nl,

write('How loang does customers cuurent account ?:'),read(C),nl,

write('For how many applicant advanced a term loan?:'),read(L),nl,

write('Does the customer has good repayment record on term loan?(yes/no): '),read(A),nl,

write('Does the customer currently blacklisted by CBE or any other?(yes/no): '),read(A1),nl,

write('Does applicant need money for seasonal or temporary?(yes/no): '),read(A2),nl,

write('Collateral offerred by applicant?(acceptable/unacceptable): '),read(A3),nl,

write('Documents Required from the applicant?(completed/incompleted): '),read(A4),nl,

 evaluation(Name,Type,B,C,L,A,A1,A2,A3,A4).

overdraftcredit(Name,Type,B,C,L,A,A1,A2,A3,A4):-

      (B>=2),(C>=1),(L >=1),(A=='yes'),(A1=='no'),

(A2 =='no'), (A3=='acceptable'),(A4=='completed').

 evaluation(Name,Type,B,C,L,A,A1,A2,A3,A4):-

    overdraftcredit(Name,Type,B,C,L,A,A1,A2,A3,A4),

 write(Name),write('is eligible For' ),write(Type),nl,write('
```

```
Then the next step is Credit Analysis!'),

assertz(request(Name,Type)),tell('best2.pl'),write(':-dynamic(request/2).'),listing(request),told;
write('MESSAGE:!'), write(Name),write('  is Ineligible For '),write(Type),nl,write(' why?'),nl,write('
Type why if you want to know the reason'),nl,read(Why),

  (Why=='why'),nl,write(Name),write('  is  not fulfill one or more requirements

of  '),write(Type),nl,write('Tell to him to complete and come back again').

  import(Name,Type) :-nl,nl,

  write('Answer the following questions inorder'),nl,

write('to check Eligibility of  '),write('applicant loan Request'),nl,nl,

write('Does the request for one time?(yes/no):'),nl,read(P),nl,

((P=='yes',nl,check(Name,Type));(P=='no',nl,check2(Name,Type))).

check(Name,Type):-

write('Does the customer have investment certificate or'),nl,

write('appropriate license or invoice ?(yes/no):'),nl,read(Y),nl,

((Y=='yes',nl,write('The applicant  is  eligible for the request')),write(':: Then the next  step is Credit
Analysis!'),assertz(request(Name,Type)),tell('best2.pl'),write(':-
dynamic(request/2).'),listing(request),told

  ;(Y=='no',nl,write('The cust are not eligible!!'))).

  check2(Name,Type) :-

  write('Does the customer have import trade licenses?(yes/no)'),read(License),nl,

  ((License=='yes',nl,write('The cust are eligible')),

  assertz(request(Name,Type)),tell('best2.pl'),write(':-dynamic(request/2).'),listing(request),told
```

```
;(License=='no',nl,write('The cust are ineligible'))).

preshipmentt(Name,Type):-

write('Answer the following question to check validity of the application'),nl,nl,

write('Does the application for pre-shipment without the NBE?(yes/no):'),read(P),nl,

((P=='yes',nl,without(Name,Type));(P=='no',agaist(Name,Type))).

without(Name,Type) :-

write('Does the customer engaged in any export business?(yes/no):'),nl,read(P),nl,

write('Does an applicant  is business or corporate class ?(yes/no):'),nl,read(C),nl,

write('Does customer risk grade related as grade 1 or 2?(yes/no)::'),nl,read(R),nl,

write('Does an applicant present valid sales contract from foreign buyer(yes/no):'),nl,read(S),nl,

write('Does the export item selling price within acceptable range?(yes/no):'),nl,read(Pr),nl,

prevaluation(P,C,R,S,Pr),

    write(Name),write('s  request is eligble:::

The next step is credit analysis.'),

assertz(request(Name,Type)),tell('best2.pl'),write(':-dynamic(request/2).'),listing(request),told

 ;write('not eligible').

prevaluation(P,C,R,S,Pr):-(P=='yes'),(C=='yes'),(R=='yes'),(S=='yes'),(Pr=='yes').

agaist(Name,Type):-

write('the Eligibility is set per

the NBE directive'),assertz(request(Name,Type)),

tell('best.pl'),write(':-dynamic(request/2).'),listing(request),told.
```

```
export(Name,Type):-

write('"Welcome to Revolving Export Credit evaluation!"'),nl,write('Please interact with the following
question  in order to evaluate  '),write(Type),nl,nl,

write('Does the customer has clean track record in the export business?(yes/no):'),nl,read(Cl),nl,

write('Does the customer submit permanent Letter of Credit?(yes/no):'),nl,read(Pe),nl,

write('Does the customer submit Waybills such as truck way,

railway ?(yes/no):'),nl,read(Way),nl,

write('Does customer submit Insurance contract?(yes/no):'),nl,read(Insur),nl,

write('Does a customer have acceptable certificate from appropriate organization ?(yes/no):'),nl,

read(Cer),nl,exportevaluation(Cl,Pe,Way,Insur,Cer),nl,

write('The customer is Eligible for revolving export loan '),

assertz(request(Name,Type)),tell('best.pl'),write(':-dynamic(request/2).'),listing(request),told

 ;write('Sorry!'),write(Name),write(' is ineligible for revolving export loan!').

exportevaluation(Cl,Pe,Way,Insur,Cer):-

(Cl=='yes'),(Pe=='yes'),(Way=='yes'),(Insur=='yes'),(Cer=='yes').

merch(Name,Type):-

        write('can applicant  submit financial statement >=1 year?(yes/no):'),read(F),nl,

        write('Does the customer open account at the branch where they request loan?(yes/no):'),

read(Ac),nl,  write('Does  customer  submit  plan  that  justify  the  purpose  and  utilization  of  the
loan?(yes/no):'),

read(Plan),nl, write(' Does applicant prepare temporary
```

```
financial statement as request by bank?(yes/no):'),read(B),nl, write('Does customer present customs
declaration for  imported goods?(yes/no):'),read(Dc),nl, write('Does customer present internal
production report

for manufactured goods?(yes/no):'),read(Pro),nl,merchevaluation(F,Ac,Plan,B,Dc,Pro),nl,

      write('An applicant is Eligible for merchandise loan' ),

assertz(request(Name,Type)),tell('best2.pl'),write(':-dynamic(request/2).'),listing(request),told
;write(Name), write('  is Not Eligible for merchandise loan'),

assertz(request(Name,Type)),tell('best2.pl'),write(':-dynamic(request/2).'),listing(request),told.

merchevaluation(F,Ac,Plan,B,Dc,Pro):-

(F=='yes'),(Ac=='yes'),(Plan=='yes'),(B=='yes'),(Dc=='yes'),(Pro=='yes').

learning(Name,Type):-nl,

write(' Last Time'),write(' '),write(Name),write(' is Eligible For'),write(' '),write(Type),write(' Credit
Type'),nl,nl,write('Does the customer wants to reapply or request for another

Credit? write(yes/no).'),nl,read(Re),nl,

((Re=='yes',noadvising(Name,Type));(Re=='no',write('good bye'),nl,break)).

   customerclassification:-

write('Please Enter Customer Name'),nl,nl,

read(Name),nl,answer12(Name).

answer12(Name) :- cust_clas(Name,Btype),

write(Name),write(' '),write('is existing credit customer'),nl,

businessclass(Name).

businessclass(Name):-nl,write('Do you want to reclassify'),write(' '),write(Name),
```

```
write('?(yes/no)::'),nl,read(Yesno),nl,
(Yesno=='yes',evaluation(Name,Btype));(Yesno=='no',write('Good Bye!'),nl,(break)).
  evaluation(Name,Btype):-write('Please Enter current Scored score sheet out of 100%:'),nl,
read(X),custevaluation2(Name,Btype,X).
 level11(X):-X>=80,X=<100.
 level12(X):-X>=60,X<80.
 level13(X):- X<60,X>=0.
 level14(X):- X>100;X<0.
custevaluation2(Name,Btype,X):-
level11(X),write(Name),write(' '),write(' is Reclassified as Business credit customer'),nl,
write('Please enter business class to insert in a fact base?'),nl,read(Btype),nl,
assertz(cust_clas(Name,Btype)),tell('pep3.pl'),
write(':- dynamic(cust_clas/2).'),nl,
listing(cust_clas),told,write('Good Bye, the customer is reclassified'),nl,(break);
level12(X),write(Name),write(' '),write('is Reclassified as Corporate credit customer'),nl,
nl,write('please enter business class to save in fact base'),nl,
read(Btype),nl,assertz(cust_clas(Name,Btype)),tell('pep3.pl'),
write(':- dynamic(cust_clas/2).'),nl,
listing(cust_clas),told,write('Good Bye, the customer is reclassified'),nl,(break);
level13(X),write(Name),write(' '),write('is Reclassified as commercial credit customer'),nl,
nl,write('please enter business class to save in fact base'),nl,read(Btype),nl,
```

```
assertz(cust_clas(Name,Btype)),tell('pep3.pl'),

write(':- dynamic(cust_clas/2).'),nl,

listing(cust_clas),told,write('Good Bye, the customer is reclassified'),nl,(break);

level14(X),write('Please Reenter the number From "0-100"'),nl,write('Good Bye!!'),nl,(break).

answer12(Name) :- \+ cust_clas(Name,_),

write(Name),write('  '),write('is a new credit Customer for bank'),nl,nl,

write('Retype a customer name to insert in a fact base!'),nl,

read(Name),nl,assertz(cust_clas(Name,Btype)),

businessclass1(Name,Btype).

businessclass1(Name,Btype):-

write('Do you want to classfy Customer to Business Class?(yes/no).'),nl,read(Yesno),nl,

((Yesno=='yes',criteria(Name,Btype));(Yesno=='no',write('Good by'),break)).

criteria(Name,Btype):-

write('Please Enter Score sheet out of 70%'),nl,

read(S),custevaluation(Name,Btype,S).

level1(S):-S>=55,S=<70.

level2(S):- S>=35,S<55.

level3(S):- S<35,S>=0.

level4(S):- S>71;S<0.

custevaluation(Name,Btype,S):-

level1(S),write(Name),write(''),write(' is classified as business credit customer'),nl,
```

```
write('please Retype busines class to insert in a fact base'),nl,read(Btype),nl,
assertz(cust_clas(Name,Btype)),tell('pep3.pl'),
write(':- dynamic(cust_clas/2).'),nl,
listing(cust_clas),told,
write('Good Bye,'),write(Name),write(''),write('is classified as business'),nl,(break);
level2(S),write(Name),write(' '),write('is categorized as corporate credit customer'),nl,
write('please Retype  busines class to save in a fact base'),nl,read(Btype),nl,
assertz(cust_clas(Name,Btype)),tell('pep3.pl'),
write(':- dynamic(cust_clas/2).'),nl,
listing(cust_clas),told;
level3(S),write(Name),write(''),write(' is classified as commercail credit customer'),nl,
write('please Retype  busines class to insert in a fact base'),nl,read(Btype),nl,
assertz(cust_clas(Name,Btype)),tell('pep3.pl'),write(':- dynamic(cust_clas/2).'),nl,
listing(cust_clas),told;
level4(S),write('Please Reenter the Number From"0-70!'"),nl,nl,
write('Good Bye'),nl,(break).
```

Appendix IV

Prototype system Evaluation questions for the Domain Experts

Description of the parameter values are as follows

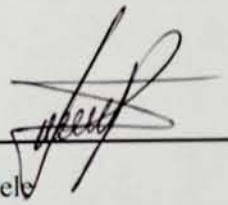
Excellent=5, very good=4, Good=3, Fair=2, P=1.

Instruction: please put(X) on the appropriate value of the corresponding parameter of evaluation questions of the prototype self-learning knowledge based system in credit evaluation of applicant requests.

No.	**Parameters of evaluation criteria**	Poor	Fair	good	Very good	Excellent
1	Simplicity to use and interactive with prototype system					
2	Attractiveness of the prototype system/user interface					
3	Does the prototype system Efficient in a time?					
4	The accuracy of the prototype system in reaching a decision to evaluate requests or application					
5	Does the system include adequate knowledge to evaluate requests?					
6	The ability of the prototype system to remember the customer information					
7	Usefulness of the prototype system					
8	Contribution of the developed prototype system in domain areas					

DECLARATION

This thesis is my original work and has not been submitted as a partial requirement for a degree of master in any other university.



Wosenu Bekele

October, 2014

Advisor: Solomon Teferra (PhD)