

ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES
DEPARTMENT OF INFORMATION SCIENCE

**DESIGNING A KNOWLEDGEBASE SYSTEM FOR VAT
ADMINISTRATION**

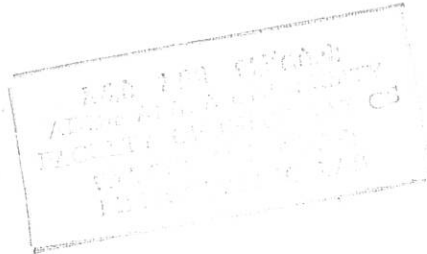
BY
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**A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE
REQUIREMENT FOR
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SCHOOL OF GRADUATE STUDIES
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BY
DESALEGN KIDANE BASHA

Signature of the Board of Examiners for Approval

DECLARATION

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

Desalegn Kidane Basha
September, 2009

The thesis has been submitted for examination with our approval as university advisors.

Dr. Million Meshesha

Ato Yehenew

DEDICATION

This thesis is dedicated to all my family, especially to my father

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List of Acronyms

AA	Addis Ababa
AAU	Addis Ababa University
ADB	African Development Bank
AI	Artificial Intelligence
ETB	Ethiopian Birr
ERCA	Ethiopian Revenue and Customs Authority
FBE	Faculty of Business and Economics
FDRE	Federal Democratic Republic of Ethiopia
FIRA	Federal Inland Revenue Authority
FNG	Federal Negarit Gazeta
FSR	Financial Statement Report
GDP	Gross Domestic Product
IMF	International Monetary Fund
IT	Information Technology
KA	Knowledge acquisition
KBS	Knowledge Base System
MIS	Management Information System
MoR	Ministry of Revenue
MoFED	Ministry of Finance and Economic Development
NBE	National Bank of Ethiopia
SIGTAS	Standard Integrated Tax Administration System
UK	United Kingdom
UN	United Nations
VAT	Value Added Tax
VPN	Virtual Private Network
WB	World Bank

ABSTRACT

Value Added Tax (VAT) has become a major tax instrument worldwide. In Ethiopia, it is a new tax system introduced since Jan. 2003 and an essential component of the tax reform programs which are currently undertaken. The existing VAT systems do not provide a simplified access to and clarification on information of the tax laws, tax payers lack awareness on tax rules and regulations. These problems have a great impact on the practicability of the regulations.

This paper examines VAT administration in Ethiopia and identifies key problems including lack of public awareness, efficiency, effectiveness, performance and gaps in the administration of VAT refunding, fraud and invoice. It is worth clarifying the Ethiopian VAT system and the rationales behind for the business owners through easy, effective and accessible systems using the KBS technology.

In this research work, a KBS is design in support of VAT administration in order to solve the problems identified specially in the area of VAT refunding. Both tacit and explicit knowledge for the KBS is acquired through interviewing domain experts and document analysis. The knowledge is modeled in a hierarchical tree structure. The knowledge representation is done using a rule based system.

For the prototype development Prolog preprogramming language has been used. The performance of the prototype system is evaluated by implementing continual as well as summative evaluation techniques on qualitative basis. The result is encouraging to design a practical a KBS for VAT administration. The finding in terms of accuracy, efficiency and effectiveness is discussed and further research areas are recommended.

CHAPTER ONE

INTRODUCTION

1.1. Background of the Study

One of the mechanisms in which countries raise revenue to finance government spending on the goods and services that most citizens demand is taxation (Abraham, 2003). A tax system can contribute not only for sustainable development but also for ethical and political success. That is why it is seen as one of the key issues raised during presidential election in most countries ranging from developing to industrialized once (James, 2005).

“The best tax system for any country reflects its economic structure, its capacity to administer taxes, its public service needs, and its access to other sources of revenue like aid. In addition it must also take in to account imprecise but important factor as tax morality, tax culture and above all the level of trust existing between people and their government” (Richard, 2008).

Value Added Tax (VAT), one type of tax, is a broad-based consumption commodity tax that is charged at multiple stage of production (Lepheto, 2003). It is an indirect tax that is charged as a percentage of prices, which means that the actual tax burden is visible at each stage in the production and distribution chain. It is collected fractionally, via a system of deductions whereby taxable persons (i.e., VAT -registered businesses) can deduct amount of VAT they have paid to other taxable persons on purchases of products/services for their business activities from their VAT liability (Bekure, 2004).

VAT is now becoming a universal form of consumption tax operational in around 150 International Monetary Fund (IMF) member countries (David, 2007). The VAT revenue averages 27% of the total tax revenue or 1%-10% of the Gross Domestic Product (GDP). The standard rate of charge varies from 3% to 25% of the price in different countries (Christophe, 2003).

In Ethiopia, VAT proclamation No 285/2002 which has replaced the sales and excise tax proclamation No. 68/1993 (as amended) has come into effect as of January 1st, 2003 (Bekure, 2004). The VAT law contains two VAT rates. One is the standard 15% rate and the other is at 0% (zero rate). Taxable transactions such as the export of goods and services are charged with VAT at a rate of zero. It means no VAT has to be charged, however, you

are permitted to reclaim the VAT on all the goods and services purchased to produce the good or service (FNG, 2002).

Following the tax proclamation No. 285/2002, the tax reform program is designed to refurbish the tax system and improve the legacy tax administration by introducing a new computerized information system (FNG, 2002). This attempt made by the revenue authority to use Information Technology (IT) for the financial activity and data management has paramount importance in delivering better service for the tax payers as well as making the tax collecting activity efficient, effective and relatively corruption free (MoR, 2005).

Among the tax reform programs, one of the first attempts is the introduction of computerized taxpayers' registration system. For the purpose, the Federal Inland Revenue Authority (FIRA) has designed a database called Taxpayers Identification Number (TIN). Currently further modifications that identify tax payer with photograph picture and finger prints are integrated in this system. The other is Standard Integrated Government Tax Administration System (SIGTAS). These databases are limited to registration of tax payers to produce unique identifications called TIN and VAT ID, monthly declaration of VAT, assessment of VAT, VAT audit, payment and reports' generation (MoR, 2005). Some more specific purpose databases that support the collection of different tax types are also designed and implemented by Addis Ababa city administration tax authority independently.

Artificial intelligence (AI) can be integrated into a variety of software in order to make the software more responsive to user needs (Harold, 1990). For instance, one of the major benefits of KBSs is increasing capabilities of other application systems. Integration of KBS with other systems makes the systems more effective; they cover more applications work faster and produce high quality result. More specifically, "if there is a mess of rules (e.g. tax and auditing), then the KBSs can "unravel" the mess." (Carol and Daniel, 1995)

KBSs specially developed for auditing and taxation purposes have become an integral part of the accounting profession's decision making armory (Porter, 1994). For instance, ExperTAX, AOD, Audit Risk, FlowEval, TAXMAN I and II, TAXADVISOR are now used to tackle such diverse problems as audit risk analysis, tax planning, business control, audit-opinion assistance and tax accruals (Carol, 1995).

1.2. Problem Statement and Justification

Although the contribution to the total government expenditure and GDP varies from time to time and from country to country, tax is considered to be the back bone of the economy (James, 2005). However, most developing countries including Ethiopia are currently dependent on external financial resources to fund their development activities (Bekure, 2004). For a country to be developed (Richard, 2008) it needs to collect 25-30% of the GDP in taxes. Similarly, the UN millennium project (2005) was advising developing countries to mobilize on an average for an additional 4% GDP in tax revenue per annum beyond their current average level of 18%.

The case in our country is different from the recommendations above. Tax contributes only 14.3 % to the GDP, which is below the average of developing countries by 3.7% (NBE, 2004/05); and the growth rate is below 2% nearly for the last two decades (Girma, 2006).

Prior studies conducted on the performance of the tax system of Ethiopia are widely argued to be unsatisfactory, inefficient and not effective (Esubalew, 1998; Yoseph, 1998; Abraham, 2003; Girma, 2006; Getu, 2007; Wollela, 2008). The cause mentioned for its weakness as all the researchers agreed include¹: narrow tax base, tax evasion and tax avoidance, deterioration in tax administration, low public awareness about tax and corruption among others.

The preliminary discussion made with tax officers at the revenue authority Mexico main branch, Arada and Lafto sub city offices of Addis Ababa and Awassa regional office has also strengthen the above point as well. In addition, the periodical reports (annual, semi-annual and quarterly) also show that the main problems of the tax system in Ethiopia for the last several years include:

- Tax avoidance,
- Inadequate tax administration,
- Low tax culture²
- Low public awareness about tax

¹ Tax evasion is a fraudulent activity made on taxation, and tax avoidance is an attempt to escape from tax net.

² The Concept of Tax Culture emphasis on interaction of the actors and the cultural values like: honesty, justice, sense of duty, and tax mentality that consists of tax moral and tax discipline (Birger, 2001).

These problems are interrelated problems. The spread of tax avoidance is because of inadequacy of the tax system to overcome the problem. The need and an attempt to escape from the tax net is because of the diminished public awareness about the importance of paying tax to the overall development. A long history of low public awareness regarding the importance of paying tax honestly makes the tax culture lower.

The manifestation of these problems is evident on omitting the occasional sales from their accounting to systematic supervision of sales and falsification of invoice, creation of fake invoice for purchases never made, usage of two types of invoices, underreporting sales amount, creation of short-lived enterprises, traders that are liable to VAT but do not register, deliberate changing of business names and addresses to escape from the tax net (Getu, 2007).

As we can observe, one of the problems arise from lack of proper knowledge about the importance of tax for the development. The other problem is that the tax system lacks the capacity to give access to tax payers to, learn, know, ask questions and get consistent answers, get adequate and consistent advices. Creating clear awareness on the importance of tax obviously encourages the voluntary submission of all the tax required honestly. This is evident in developed countries where citizens are relatively more voluntary and responsible to pay tax on time than developing countries (Hancock, 1995).

This study is, therefore, intended to explore and develop a KBS that support the VAT administration of the country.

In this work, an attempt is made to answer the following research questions:

- Can we design a KBS capable of creating awareness, giving guidance and counseling on tax law, rules, procedures and directives?
- Can we integrate KBS with the existing systems to best serve the stakeholders³ of tax carry out their share efficiently with minimal confusion, anxiety, conflict and unwanted penalties than the usual?
- Can KBS assist tax payers in matters related to tax and encourage the voluntary submission of accurate tax returns and payments?

³ Stockholders of tax include: the tax payers, the VAT officers, the managers, the policy makers, the tax, the appealing committees

- Can KBS enhance the performance of the existing systems and enable effective use of the existing systems and infrastructures even to outreach the taxpayer more easily and in a cost effective way?

1.3. Objectives of the Study

The following objectives are targeted to achieve in this research work.

1.3.1 General Objective

The general objective of this research is to explore and design an applicable knowledge base system that support the stakeholders of tax by giving appropriate VAT related advice based on the tax law of the country (Ethiopia) and working procedures of the concerned bodies.

1.3.2. Specific Objectives

The specific objectives of the research are:

1. To review documents so as to understand various laws, rules, procedures and directives those are now active in VAT administration. In addition, literature is reviewed to have conceptual understanding about KBS and suitable prototype development tools.
2. To acquire the appropriate domain knowledge through interviews and discussion with experts in the area and personal observation of the existing system.
3. To represent the acquired knowledge using a rule based knowledge representation technique.
4. To develop a prototype VAT advising KBS that can work in collaboration with the existing systems.
5. To test the prototype system and evaluate its reliability and performance in the real context.
6. To forward further research direction in the area of KBS for tax administration.

1.4. Scope and Limitations of the Study

There are three broad categories of tax payers in the context of Ethiopia tax law. The first that contain the majority is category C. This category includes all tax payers that have a total annual sale of less than 100,000 ETB. The second category, category B, includes those tax payers that have a total annual sale between 100,000 and 500,000 ETB. The third category, category A, is the one that contain large tax payers where their total annual sale exceeds 500,000ETB (FNG, 2002).

The scope of this research work is the category A tax payers. Within the category A tax payers, the case of VAT refunding has got special focus. The rules applicable in this study cover only those laws, rules and directives applicable for both federal and regional states in common. The research does not consider the laws, rules and directives adopted by the regional states.

Moreover, this study has only gone as far as designing the prototype Knowledge base system that can show the case at a glance. This includes Knowledge acquisition, knowledge representation, system development and a simple explanation interface designed using SWI prolog.

There are limitations in the study. The first one is access to the necessary data directly because of the privacy of tax data. If there is a full and direct access to all the necessary data and information, the knowledge acquired would be better. The other limitation is the non availability and affordability of commercial prototype development shells, as a result, using the free programming languages lack some important features that help a lot in prototype development. If these limitations were not the case the result of the study would be better.

1.5. Beneficiaries of the Study

The output of this study can benefit all the stakeholders compounded around VAT collecting activity by lifting up their awareness, giving guidance and counseling on tax law, rules, procedures and directives. These include:

- The tax payers- any individual or institution supposed to pay tax from the income earned according to the tax law of the country.

- The VAT officers- a personnel in charge of VAT assessment, audit, payment and related jobs in the tax offices.
- The managers at different level, especially low level managers.
- The policy makers that have connection with VAT
- The committees in charge of investigating VAT claims and of course accounting firms and other companies.

There are several advantages in using knowledge base systems for tax administration. First a tax knowledge base system preserves the knowledge captured in the system's knowledge base. The system supplies the correct answer to any difficult tax issue for which the knowledge base system is developed. In case when the laws change, the rules in the knowledge base can be modified to reflect those changes.

The second use of the proposed tax knowledge base system is the capacity to distribution of the tax expertise stored in the system. It could also quickly and inexpensively provide the tax payers with the necessary information to respond to the unusual tax problem. The tax knowledge base systems of the proposed type can also benefit businesses and individuals as well by determining the tax consequences of their transactions.

1.6. Methodology of the Study

In order to achieve the objectives of the study and address the stated problems successfully, methods suitable for gathering information, knowledge acquisition, knowledge representation, KBS development tools selection and system evaluation are identified. Hereunder the detail is presented.

1.6.1. Literature Review

For the purpose of understanding the concepts/principles of KBS and identifying tools, techniques and detail problem areas of VAT administration books, articles, related research works done by local and international scholars, and other relevant publications have been reviewed in detail.

1.6.2. Knowledge Gathering

The information and knowledge for the study is collected and acquired from various sources. Interviews, discussions and personal observations are made with the intention of getting the tacit knowledge of the experts. Besides literature, the information use for the

input of the proposed system is gathered using interview, discussion and personal observations made. The validity of this instruments will be checked by making a cross comparison of ideas raised, answers for the questions and comments with one another. Using observations, unstructured interviews, brainstorming and discussions held with a sample group of stockholders the knowledge acquired is refined.

Detail reference on VAT law of the country, rules and directives set by the concerned bodies for the implementation of VAT, research works by international organizations like IMF, documents prepared for different nationwide and continental proceedings on VAT and periodical reports of the tax authority are also used to acquire the explicit knowledge. Other literatures related with tax, audit and accounting related documents are also used.

Most importantly, information and knowledge of experienced human experts are used through continual feed backing mechanisms, visual interaction and cross validation of the comments and answers. Nine senior and well experienced professionals on tax from federal office, regional authority, regional branch and Addis Ababa sub cities are participated. This makes the participants more representative of the whole and the knowledge acquired comprehensive.

1.6.3. KBS Design

A prototype KBS on VAT administration is developed by exploring the existing VAT auditors' expertise, rules and procedures used in VAT administration as a source of knowledge. This approach is chosen because it is suitable to code knowledge base that can be tested with a lesser risk. It is a most common approach in KBS researches (Graham, 1989). This research work uses production rule or rule based approach to get advantage of its modularity, simplicity, good performance and convenience for the case under discussion (Saleem and Abba, 1992).

The production rule is put in the form of condition-action pair. Rules are created by conversion from the hierarchical tree used to modeling knowledge acquired during knowledge acquisition phase. It is chosen for its ease of implementation and the capacity to extract rule-based knowledge from previous cases is faster. To learn more rules, the Predictive Apriori algorithm is used to generate rules using some 4067 records of data that have 12 attributes. In this approach the algorithm is responsible for reasoning and consistency checking. However the redundancy checking and completeness of the rules are

evaluated in consultation with the domain experts and compared the rules with the one found from the hierarchical tree conversion.

1.6.4. Implementation Tools and Techniques

The prototype system is developed using a programming language Known as SWI prolog. It is used for its suitability for the production rule and the capacity to minimize the complexity of the problem (max, 2005). Based on production rule, the knowledge acquired from all the sources is materialized to the prototype KBS using the prolog programming language. The inferring technique used for the prototype development is a backward chaining because the goals are identified and set prior to the inferring process. Prolog is also use a backward chaining inference mechanism.

1.6.5. Sampling Technique

The study area is selected based on the sampling technique that is appropriate to the study and manageable with time and budget allocated for the study. The sample contains Addis Ababa and SNNP regional state among the regions in the country. Among federal branches Addis Ababa and Awassa federal branches are considered and among sub cities of Addis Ababa Arada, Kolfe Keranio and Lafto are considered. Stratifying data based on the type and states of businesses that pay VAT is also used for testing the system.

1.6.6. Testing and Experimentation

The reliability and performance of the proposed system is tested using 40 test cases. The testing is conducted with the advice/counseling/guidance services and visual interaction that can be undertaken by personnel in tax offices for the cases usually happen in connection with VAT. The test data is collected and refined for the test based on four parameters: specific case, frequent case, historical case and arbitrary cases. Nine from each of the first three types of cases and thirteen arbitrary cases. The cases are examined and evaluated in manual bases first and then in the new system next, then the comparison or the match is observed. The performance is measured by the accuracy measure of the KBS against the manual.

CHAPTER TWO

LITERATURE REVIEW

2.1. Introduction

This chapter has got three important parts. The first part presents a brief review of literature on taxation in general, the tax system of Ethiopia and the VAT introduction and administration of Ethiopia. The second part made a review on Artificial intelligence (AI), Knowledge base system (KBS) and Expert System (ES) - definitions, evolution, their relationships in meaning, component parts, and benefits of KBS and the application of KBS in the fields of taxation. The third part review on related research works.

2.2. Taxation System

Tax is among the major sources of government income for a country (Richard M., 2008). As compared to developing countries, developed countries have been able to generate substantial revenue through imposing of taxes (Wollela, 2008). One of the reasons for this has been the efficient tax system operating in the developed countries unlike the developing economies which are characterized by weak monetization and the low development of the formal sectors. In other words, developed countries have employed a tax system that has one or a combination of the following desirable characteristics as economic efficiency, administrative simplicity, flexibility, political accountability and fairness (Abraham, 2003).

In principle, a tax system need to be economically efficient meaning it should not have an impact on the allocation of resources (Richard, 2008). Its adoption should be easy and inexpensive to administer, fair in its impact on all individuals and should also be able to respond to changing economic circumstances (Yoseph, 1998). It follows that optimality in a tax system requires absence of distortion in any economic activity (Hancock, 1995). Taxpayers should also be able to determine what they are actually paying so that the political system can more accurately reflect the preferences of individuals.

It is expected that people's tax payments is in line with their income and they are required to pay a tax in proportion to their level of income (Tanzi, 2001). On the side of tax collectors, collection of tax should be time conscious and convenient and the cost of collecting the taxes should not be high to discourage business. Alternatively, this means that the ideal tax system in developing countries should raise essential revenue without

excessive government borrowing and should do so without discouraging economic activity and without deviating too much from tax system in other countries (Tanzi, 2001).

A good tax system should run in harmony with important national objectives and if possible, should assist the society in achieving them (Bahitia, 1998). It should try to accommodate the attitudes and problems of the taxpayers and should not lose sight of the administrative practicability or the goods of social and economic justice and should also yield adequate revenue for the treasury and should be flexible enough to move with the changing requirements of the state and the economy. The dynamism of the tax system is all the more relevant for a developing economy where the structure and rates of taxes have to be constantly reviewed (Abraham, 2003).

2.3. An Overview of Tax System of Ethiopia

The first major change in Ethiopia's tax system was initiated in the years 1947-52 (Alemayehu and Abebe, 2005). These changes were generally optional, including amendments to property taxes (land and cattle). Broad-based taxes on goods and services were also introduced in the mid 1950s. Later in the decade and in the early 1960s, changes were also made in the rate and structure of taxes, especially on income (Esubalew, 1998).

In 1976-79, significant changes on the rate and structure of all types of taxes were made. These involved widening the land tax base, introducing capital and surplus transfers from nationalized firms, as well as certain minor arrangements on other taxes (Wogene, 1994).

Following the 1991/92 tax reform, the taxing system in Ethiopia divided into three broad categories (Alemayehu and Abebe, 2005): taxes on income and profits, taxes on goods and services and taxes on international trade.

- ***Taxes on income and profits:*** This category include tax on employment income, rural land and agricultural income tax, rental income tax, taxes on business and other profits, tax on income from mining activities, capital gains tax, and taxes on other sources of income such as chance wining.
- ***Taxes on goods and services:*** This category includes tax on textiles, television sets, alcohol, perfumes and automobile. Many basic goods such as bread, milk, petroleum gas, transport are exempt from taxation.
- ***Taxes on international trade:*** International trade relates to levies on imports (customs duty, import excise tax, import sales tax) and tax on exports.

In the last decade, following the general 1992's policy reform, most of these taxes have been reformed and amended. Some institutional reforms aimed at enhancing the government's capacity to raise tax revenue have also been made (Alemayehu and Abebe, 2005).

The recent tax reform, implemented since 2001/02, includes changing policies to address insufficient revenue, to correct distortions that reduce economic welfare and growth, or measures to reduce inequities (Abraham, 2003). The reform program has two components: overhauling of the tax legislation and improving the tax administration. This research work has connection with the latter component.

The focus of the reforms includes improving the efficiency, modernizing tax administration by enhancing technical capacities and reforming indirect taxation. The main reform to indirect taxation, hence, was the introduction of a Valued-added tax (VAT) which is made operational beginning January 1, 2003 (Abraham, 2003; Alemayehu and Abebe, 2005; Wollela, 2008). VAT is a category of good and service taxes defined above.

After a long history of manual tax administration system, Federal Inland Revenue Authority (FIRA) has exploited the power of information technologies in performing its various activities. Following the new tax proclamation of 2002, the tax reform program is designed to fix up the system, improve the legacy tax administration and develop modern tax administration programs by improving the human resource management and introducing a new computerized information system (MoR, 2005).

The major activities in VAT administration are identifying taxpayers, processing returns, controlling collections, making refunds, auditing taxpayers and levying penalties (MoR, 2005). On the part of administration, it is a prior tax to identify the taxpayers. In connection with this (FNG, 2002), preparation of a single master file, based on unique Tax Identification Number (TIN) is crucial and this ensures that each taxpayer's account contains all the relevant tax and payment data for that taxpayer alone. For this purpose, FIRA introduces a computerized national TIN system to support the strengthening of the tax administration as major priority areas of the current tax reform (Abraham, 2003).

The TIN system is a registration mechanism in which a taxpayer is given a single identification number to be used in administering all taxes. It encompasses personal and business profiles of the taxpayers including full name, address, capital installed, bank

account, the number of branches contain, contact address and related information (FNG, 2002). Taxpayer identification numbering is a well-designed numbering system, which consists of numbers generated randomly and that have a self check digit that is a number calculated from the digits forming the basic part of the TIN. It has a power to hold tax information in nationwide (MoR, 2005).

For the other activities of VAT listed above i.e. processing returns, controlling collections, making refunds, auditing taxpayers and levying penalties, FIRA has been implemented a database system called SIGTAS, which stands for Standard Integrated Government Tax Administration System (MoR, 2005). Based on certain modules of SIGTAS software, which has been installed in different countries to date, the VAT software manages the transactions inherent in the tax, including assessment, verification, recovery and receipt. Currently, this software was installed in Addis Ababa and other regions of Ethiopia since 24 February 2004 (Alemayehu and Abebe, 2005).

2.4. AI, KBS and ES

2.4.1. Evolution of AI, KBS and ES

Even though there were a number of early attempts that can be characterized as AI, it was Alan Turing who first articulated a complete vision of AI in 1950 (Russell and Norvig, 2006). They introduced the Turing test, machine learning, genetic algorithms, and reinforcement learning.

In the late 1950s, special programming languages that facilitate symbol manipulation were invented and the first attempts were game playing, theorem proving and general problem solving (Carol and Daniel, 1995). The most prominent, at that time, was called LISP (LIST Processing). Because of its simple elegance and flexibility, most AI research programs are written in LISP, but commercial applications have moved away from LISP (Robert and Edward, 1993).

In the early 1970s another AI programming language was invented in France. It is called PROLOG (PROgramming in LOGic) (Max, 2005). It is based on research by computer scientists in Europe in the 1960s and 1970s, notably at the Universities of Marseilles, London and Edinburgh. The first implementation of PROLOG was at the University of Marseilles in the early 1970s. Programs written in PROLOG have had behavior similar to rule-based systems written in LISP.

The 1970's was a decade in the history of AI when emphasis was placed on expert system with the objective of matching the performance of human expert on tasks that are narrowly defined (Russell and Norvig, 2006). The first knowledge intensive system, DENDRAL, which was developed in the mid 1960's for the purpose of solving the problem of inferring a structure of molecules from the information provided by a mass spectrometer, became a convincing concept for the research community in artificial intelligence.

Following this pioneer work on expert systems, various expert systems were developed in diverse fields of study. Taxman I and II are examples in the field of accounting and taxation (Porter, 1994). In the field of medicine, within a decade from the development of DENDRAL, such systems as MYCLN, INTERNIST, PUFF, and QMR were applied in medical problems as bacterial blood infections, internal medicine, pulmonary disorder and medical diagnosis respectively (Russell and Norvig, 2006).

In the early 1980's, variety of logic-based programming languages have arisen; and PROLOG, which did not immediately become a language of choice for AI programmers has become generic (Robert and Edward, 1993).

2.4.2. Meanings of AI, KBS and ES

Artificial intelligence (AI) is simply the discipline of building intelligence into computers (Carol and Daniel, 1995). Various scholars define AI from different perspectives with varying emphasis (Russell and Norvig, 2006):

- *From the perspective of intelligence:* AI is making computers "intelligent" enabling them act as we would expect people to act.
- *From a research perspective:* AI is the study of how to make computers do things which, at the moment, people do better.
- *From a business perspective:* AI is a set of very powerful tools, and methodologies for using those tools to solve business problems.
- *From a programming perspective:* AI includes the study of symbolic programming, problem solving, and searching.

Marvin Minsky, the pioneer in AI, probed the science of making machines do things that would require intelligence if done by human being (Harold and Anna, 1990). They contrast

the word “artificial” with the word “real”. He explains artificial lake as “a body of water made by man but it is a lake serving the same purpose as real lakes!”

The term intelligence covers many cognitive skills, including the ability to solve problems, learn, and understand language (Robert and Edward, 1993). Similarly, intelligence is explained by Ronald and Hector (2004) as one of the most complex and mysterious phenomena that clearly conditioned by knowledge for a very wide range of activities. According to Ronald, we make decision about what to do based on what we know or believe about the world. Putting these terms together Ronald defines AI as *a study of intelligence behavior achieved through computational means*.

KBSs are primary subdivisions of AI that allow large reasoning steps and can more easily handle typically occurring cases in narrow domain specific knowledge (Russell and Norvig, 2006). These systems are being used in problem diagnosis, planning, information interpretation, design, monitoring, debugging, prediction and instruction (Harold and Anna, 1990). KBS ability drives partly from reasoning over explicitly represented knowledge (Ronald and Hector, 2004). The author also tries to distinguish between KBS and KB using Knowledge representation hypothesis. The hypothesis implies that “*We will want to construct system for which our intentional stance is grounded by design in symbolic representations. We call such system a KBS and the symbolic representation involved there a KB.*” Various scholars also define KB simply as a collection of facts and rules in the KBS (Bessie, 1990; Tadele, 2005).

More often than not, ES and KBS are used synonymously. Taken together, they represent the most widespread type of AI application (Robert and Edward, 1993). However, some research works made a distinction between KBS and ES (Rediet, 2006). They see ES as system that contains a human expert tacit knowledge, whereas KBS as that contain both tacit and explicit knowledge. “...Knowledge is often derived from experts in a particular field”. As Bessie (1990) notes

“...ES is more modestly described as programs which incorporate expertise in to its knowledge base. Any seemingly intelligent behavior is a result of human experts who create a program, not a machine learning facts and creating new Knowledge”

Ronald and Hactor (2003) call ESs as a very clear case of KBS. However, ESs may be defined from different perspective with various emphases as follows:

- ES is a computer programs that are derived from a branch of computer science research called Artificial Intelligence (Robert and Edward, 1993).
- ES is a computerized, problem solving process which emulates human decision making and furnishes expert consultations in a well-defined domain of expertise based on the experts' experiences and heuristics (Russell and Norvig, 2006).
- ES is a computerized inference/intuition aid for humans, differing from conventional computing in that it usually deals with 'knowledge' in addition to data and information (Harold and Anna, 1990).
- ES is a computer program which is designed to solve problems and make decisions in bounded and well-defined knowledge in a specific application area (Frank, 1994).

As Sallem and Abba (1992) points out ESs are computer programs that mimic the behavior of human experts with in some specific domain of Knowledge.

Lakner (2001) sumerizes the relationship of the three terms, AI, KBS and ES by drawing a model shown in figure 2.1.

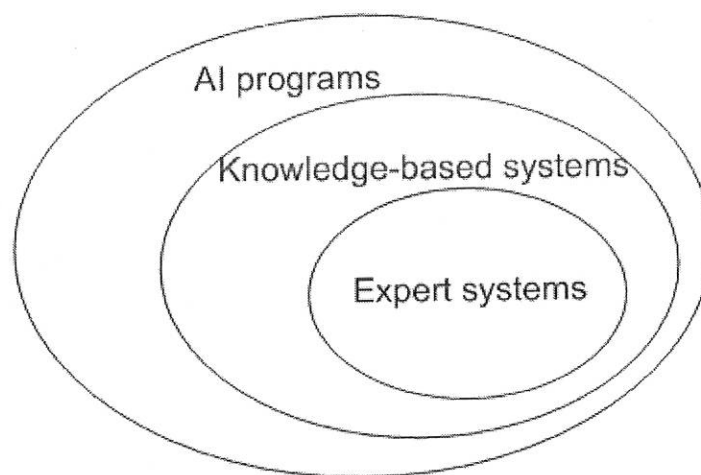


Figure 2.1: The relationship between AI, KBSs and ESs.

According to Lakner (2001), the basic difference between the three terms is scope and he describes the terms as:

- Artificial Intelligence programs are Intelligent problem solving tools that encompass knowledge base system and expert system.

- Knowledge Base Systems are Artificial Intelligence programs with special program structure separated knowledge base.
- Expert Systems are Knowledge Base Systems applied in a specific narrow field.

In simple terms, expert system is a subset of knowledge based system and knowledge based system is a subset of Artificial Intelligence. This is description is one and the same with the idea discussed above.

As we can understand from the above discussion and definitions of ES, the basic, if not the only, difference between AI, KBS and ES is the domain of problem and the scope of a field they cover. Domain here refers to the area within which the task is being performed. A thorough analysis shows that one is the subdivision of the other i.e., ES is a sub division of KBS and KBS in turn is the subdivision of AI. Bessie (1990), strengthening this idea, says that an expert system, which deals with a quite finite and bounded scope in a given field, uses programming techniques which grew out of the field of artificial intelligence.

2.4.3. 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." (Pan and Scarbrough, 1999). Knowledge is also defined by Scarborough, Swan and Preston (1999) as information that changes something or somebody either by becoming grounds for actions, or by making an individual (or an institution) capable of different or more effective action.

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 systems. These typologies have been adopted by knowledge engineers when analyzing texts and constructing knowledge models (Bechhofer, 2006; Robert and Edward, 1993). These are:

i. Declarative vs. Procedural Knowledge

One well-known distinction is 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 are often referred to as object knowledge and process or task knowledge.

ii. Tacit vs. Explicit Knowledge

Another well-known classification 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 acquire.

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 Robert and Edward (1993), knowledge is classified as factual and heuristic. Factual knowledge: is that knowledge of the task domain that is widely shared, typically found in textbooks or journals, and commonly agreed upon by those knowledgeable in the particular field. Heuristic knowledge: is the less rigorous, more experiential and judgmental knowledge of performance. In contrast to factual knowledge, heuristic knowledge is rarely discussed, and is largely individualistic. It is the knowledge of good practice, good judgment, and plausible reasoning in the field. It is the knowledge that underlies the "art of good guessing".

2.4.4. KBS Building Components

Figure 2.2 shows the building blocks of a general KBS. The main components of the KBSs are user interface, knowledge base, inference engine, that help the system to interact with users, accumulate knowledge and accordingly reason out to generate new facts or solve a given problem. The details of these components are presented as follows.

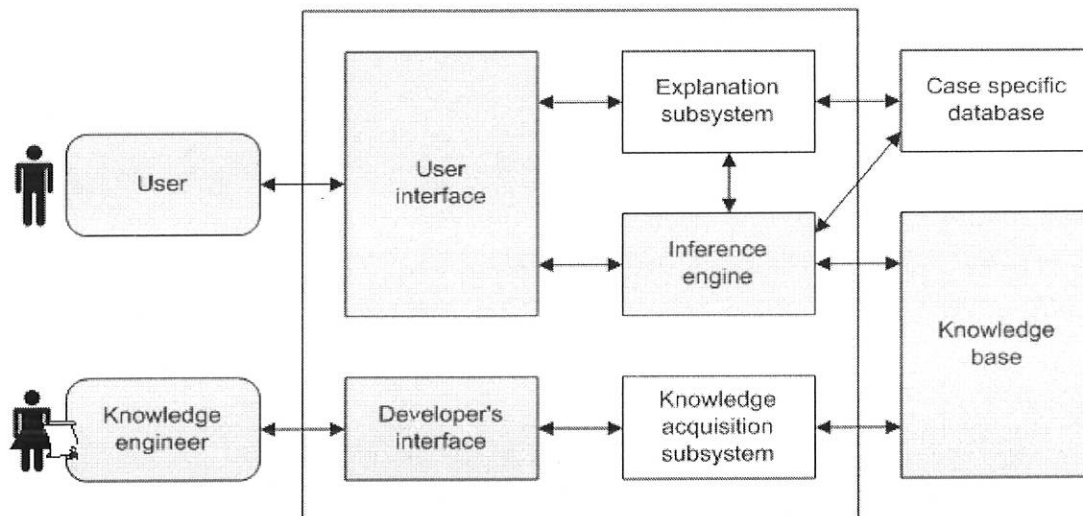


Figure 2.2: Components of KBS architecture, Lakner (2001).

User interface is the component that allows the user to query the system and receive the results of those queries (Graham, 1989). The User interface component of an ES facilitates communication between a user and the ES. An important feature of this interface is, one it allows the system to explain why specific information is being sought from the user; in other words it explains relevance of this information in reaching an intermediate or final conclusion. The other is it allows the system to explain the line of reasoning, rule or algorithm that it in reaching conclusion (Saleem and Abba, 1992).

Knowledge base is the heart of the KBS, contains the specific knowledge about the system area of expertise in the form of facts and rule. The rules use the facts in driving the conclusion (Saleem and Abba, 1992). There are different methods for representing knowledge in an ES: production rule, first order predicate logic, frame and semantic network (Marek, 2003). Detailed discussion of knowledge representation techniques presented in section 2.4.5.4.

Inference engine is a program which manipulates the knowledge base to reach goal of the query (Bessie, 1992). This component of an ES is responsible for search and pattern matching operations (Saleem and Abba, 1992). It examines the rules with the knowledge base in a particular sequence to seek matches to the contents in the database which consists of information provided by the user as well as intelligent results derived by the system. As the rules matching facts in the database are found, the rules are fired. A fired rule may reference another rule and for an inference chain. Also, a fired rule may add new facts to

the database that may trigger firing of another rule. This process continues until a conclusion is reached.

There are three known methods for efficient inference mechanisms in KB: forward chaining, backward chaining and combination of the two (Graham, 1989; Saleem and Abba, 1992).

i. Forward chaining

Forward chaining, a data-driven, method is used when data is the starting point. Here, the system does not start with a pre-defined goal; rather, it attempts to match the existing data with the condition part of the rules in the knowledge base. If one or more such rule found, the system formulates the rules. The conclusion thus derived then become part of the database. This process continues until either of the rules halts the process and makes some recommendation or the system becomes unable to reach any conclusion. A drawback of this method is that the system would drive every possible intermediate conclusion regardless of the need for it.

ii. Backward chaining

Backward chaining, a goal driven method starts with a pre defined goal as the starting point and looks for a rule that has that particular goal in its conclusion part. Once such a rule is defined the system searches the existing database for a match with the conclusions in the If part of the rule under consideration. If a match is found, the database is updated with the conclusion derived. This matching may also result in firing of some other rules to validate some sub-goals, and thus trigger an inference chain. This process continues until the goal is achieved. A drawback of this method is that a condition of sub- goal may result in explosion of possibilities.

iii. The combined methods

The combined methods strategy employs both the forward and the back ward chaining search approaches. This strategy is usually employed to analyze complex problems. It is worth nothing that in practice the strategy used by an ES is transparent to the user.

In addition to the above core components the ES contain the following component knowledge types and subsystems:

2.4.5. KBS Development Issues

The major issues raised in connection with development of a KBS includes: Knowledge acquisition, knowledge engineering, knowledge models, knowledge representation, controlling reasoning and explaining solution among others. Hereunder a detailed review is made on each of them.

2.4.5.1. Knowledge Acquisition

Knowledge acquisition refers to the task of giving knowledge to expert systems. It is a task performed by knowledge engineers (Robert and Edward, 1993). The power of an expert system lies in its store of knowledge about the task domain -- the more knowledge a system is given, the more competent it becomes. The sources of knowledge may be human experts or other sources (e.g. books, manuals ...etc). Tadele (2005) defines Knowledge elicitation as the activity of extracting and capturing knowledge from a human expert and any other sources (Tadele, 2005). Some people use the term knowledge elicitation interchangeably with knowledge acquisition.

Many techniques have been developed to help elicit knowledge from an expert. These are referred to as knowledge acquisition (KA) techniques. The following list gives a brief introduction to the types of techniques used for acquiring, analyzing and modeling knowledge (Yang, 1995):

- interviews (unstructured, semi-structured and structured),
- reporting techniques (such as self-report and investigation) and observational techniques
- Transcripts of interviews or other text-based information to identify various types of knowledge, such as goals, decisions, relationships and attributes.
- Hierarchy-generation techniques, such as tree, are used to build taxonomies or other hierarchical structures such as goal trees and decision networks.
- The construction of grids indicating such things as problems encountered against possible solutions. Important types include the use of frames for representing the properties of concepts

- Capturing the way people compare and order concepts, and can lead to the revelation of knowledge about classes, properties and priorities.
- Generation and use of concept maps, state transition networks, event diagrams and process maps.

A well-known classification of knowledge is that of tacit knowledge -cannot be articulated easily and explicit knowledge-can be articulated easily (Robert and Edward, 1993). 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 acquire.

Some of the most important issues in knowledge acquisition are presented as follows:

- Most knowledge is in the minds of experts
- Experts have vast amounts of knowledge
- Experts have a lot of tacit knowledge
 - They don't know all that they know and use
 - Tacit knowledge is hard (impossible) to describe
- Experts are very busy and valuable people
- Each expert doesn't know everything

2.4.5.2. Knowledge Engineering

Knowledge engineering is a field within artificial intelligence that develops knowledge-based systems. Such systems are computer programs that contain large amounts of knowledge, rules and reasoning mechanisms to provide solutions to real-world problems (Robert and Edward, 1993).

A major form of knowledge-based system is the one designed to emulate the reasoning processes of an expert practitioner (i.e. one having performed in a professional role for very many years). Since the mid-1980s, knowledge engineers have developed a number of principles, methods and tools that have considerably improved the process of knowledge acquisition. Some of the key principles are summarized as follows:

- Knowledge engineers acknowledge that there are different types of knowledge, and that the right approach and technique should be used for the knowledge required.
- Knowledge engineers acknowledge that there are different types of experts and expertise, such that methods should be chosen appropriately.

- Knowledge engineers recognize that there are different ways of representing knowledge, which can aid the acquisition, validation and re-use of knowledge.
- Knowledge engineers recognize that there are different ways of using knowledge, so that the acquisition process can be guided by the project aims.
- Knowledge engineers use structured methods to increase the efficiency of the acquisition process.

2.4.5.3. Knowledge Models

Knowledge models are views of knowledge base using diagram and other structured representation such as trees, maps, matrices and annotation pages (Robert and Edward, 1993). Structured knowledge is easy to find and understand by the user, easy to use by software's and easier for maintenance, management and re-use (Bechhofer, 2006). They are structured representations of knowledge using symbols to represent pieces of knowledge and relationships between them. They include: symbolic character-based languages, such as logic; diagrammatic representations, such as networks and ladders; tabular representations, such as matrices; and structured text, such as hypertext.

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 benefit during knowledge elicitation from an expert, validation with the same expert, cross-validation with another expert, knowledge publication, maintenance and updating of the knowledge (Robert and Edward, 1993).

2.4.5.4. Knowledge Representation

Knowledge representation is the process of encoding formalizing and organizing the knowledge acquired into rules or cases or patterns for use by the expert system (Robert and Edward, 1993). Common knowledge representation methods include first order predicate logic, production rule, frame semantic network and ontology. One widely used representation is the production rule, or simply rule. Expert systems whose knowledge is represented in rule form are called rule-based systems.

i. Production Rule: - is one of the most popular and widely used knowledge representation languages. Early expert systems used production rule as their main knowledge

representation language. For instance, MYCIN, which is also considered one of the first research works in medical informatics, has production rules as its knowledge representation language. TAXADVISOR, TAXMAN I and TAXMAN II are among the rule based systems in the area of taxation (James, 1993)

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 often 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 (Marek, 2003).

Example for rule based knowledge representation as adopted from John (1992) and Penny (1993).

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

ii. Logic-Based Knowledge Representation: Logic can be defined as the study of correct inference, of what follows from what. Logic usually consists of syntaxes, semantics and proof theory (Russell and Norvig, 2006). The syntax of logic defines a formal language of the logic. The semantics of logic specifies the meanings of the well-formed expressions of the logical language. The proof theory of logic provides a purely formal specification of the notion of correct inference.

The basic notion of logic has been known already to old Greeks. It is a system that defines a framework for representing relational knowledge and reasoning about it. Unlike rule-based systems, logic is a very suitable tool for representing real world models. It can represent very complex relationships among objects, it can represent hierarchies, and it is very extensible. The main problem of reasoning with logic is that inference is usually an NP-complete problem, and there have not been many successful methods of expressing heuristic knowledge using logics. The reasoning is performed according to strictly defined rules of inference. The various types of logic are: propositional logic, first-order-predicate logic and modal logics (Max, 2005).

Equivalent knowledge representation of the example given above for production rule using logic based knowledge representation is given as follows (John, 1992; Penny 1993):

Green(light_color)

Red(light_color)

Green(Traffic_light) → Action(Go)

Red(Traffic_light) → Action(Stop)

iii. Semantic Networks: Semantic network or net is a graphic notation for representing knowledge in patterns of interconnected nodes and arcs (John, 1992). 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. As (Max, 2005), these classes then may be hierarchically ordered to represent the knowledge. Every semantic network can be represented by the language of first order logic.

Again equivalent representation of the example above using semantic network based knowledge representation looks like the figure below (John, 1992; Penny 1993):

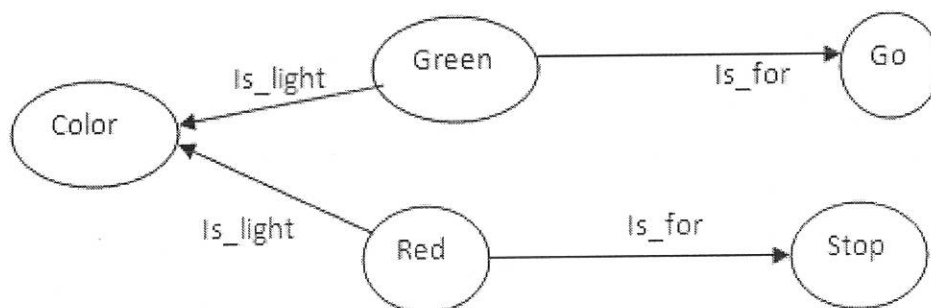


Figure 2.3: Sample semantic net compiled by Sowa (1992).

iv. Frame-Based Representation Languages: Frames are structures that represent knowledge about a limited aspect of the world (Carol, 1995). The principle of frames has been further enhanced and refined in Object Oriented Programming paradigm. Like the concepts in semantic network representations, frames are descriptions of objects. The descriptions in a frame are called slots (Max, 2005). Many knowledge representation languages have been developed based on this concept. In medical informatics, some high quality medical vocabularies use frames as their knowledge representation languages.

Similarly, an equivalent frame based knowledge representation for the example above is shown in table 2.1 (John, 1992; Penny 1993).

Traffic Light Frame	
Light_Is	Traffic Light
Is_for	Go, Stop
Light_Color_Is	Green, Red

Table 2.1: Sample frame based knowledge representation

2.4.5.5. Controlling Reasoning

Controlling reasoning simply means planning and controlling what questions to ask and what test to perform. Designing KBS involves paying close attention to the details of how knowledge is accessed and applied during the search for a solution (Bessie, 1992). This has been done using the algorithms integrated in the inference engine of the ES tool.

Rule-based and case-based reasoning are two popular approaches used for problem solving in intelligent systems. They are natural alternatives in knowledge representation. Rules usually represent general knowledge, whereas cases encompass knowledge accumulated from specific or specialized situations (Jim, Ioannis, 2003). Case based reasoning processes to combine the solutions of identical training cases in order to propose a solution to the new cases. If incompatibility arises with the individual solutions, then back tracking to search for other solutions may be necessary. Rule based reasoning processes to relate the facts given in the condition part with the facts in the action part for the set of rules given in the rule base (Jiawei and Micheline, 2001).

Each approach has advantages and disadvantages. Case-based reasoning (CBR) was introduced as an alternative to rule-based reasoning (RBR), but there is a growing interest in integrating it with other reasoning paradigms, including RBR; which we call it a hybrid approaches (Jim, Ioannis, 2003).

2.4.5.6. Explaining Solution

Explanation facility is one of the strong features of an expert system used to communicate with the users in natural language (Fiore, 1989). It can explain the logic it is using and ask questions whenever the needed information is missing. Each question asked by the system is the consequence of its attempt to apply a particular rule (Graham, 1989). The user provides single word answers including unknown when no information is available. The

user may also respond with a number of commands including why/how command. Explanation facility exposes the program's line of reasoning in a way user can understand and critique. The transparency of the program makes for a more accountable and credible system (Saleem and Abba, 1992).

2.5. Benefits of KBS

The benefit of KBSs to users as it is pointed out by Robert S. E. and Edward F (1993) is briefly summarized as:

- A speed-up of human professional or semi-professional work -- typically by a factor of ten and sometimes by a factor of a hundred or more.
- Within companies, major internal cost savings. For small systems, savings are sometimes in the tens or hundreds of thousands of dollars; but for large systems, often in the tens of millions of dollars and as high as hundreds of millions of dollars. These cost savings are a result of quality improvement, a major motivation for employing expert system technology.
- Improved quality of decision making. In some cases, the quality or correctness of decisions evaluated after the fact show a ten-fold improvement.
- Preservation of scarce expertise. KBSs are used to preserve scarce know-how in organizations, to capture the expertise of individuals who are retiring, and to preserve corporate know-how so that it can be widely distributed to other factories, offices or plants of the company.

2.6. Prolog Programming Language

Prolog is an abbreviation for PROgramming in LOGic. It is designed basically to handle/manipulate knowledge representation using First Order Predicate Logic (FOPL) (Max, 2005). The expressiveness of Prolog is due to three major features of the language: rule-based programming, built-in pattern matching, and backtracking execution. 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 (Patrick, Johan and Kristina, 2001).

Prolog allows a program to be read either declaratively or procedurally. This dual semantics is attractive. Procedural programming requires that the programmer tell the computer what to do. That is, how to get the output for the range of required inputs. The Programmer must know an appropriate algorithm. Declarative programming requires a more descriptive style. The programmer must know what relationships hold between various entities (Paul, 2001).

There are also arguments in favor of using conventional languages, such as C languages, for building KBSs. Usually these arguments center around issues of portability, performance, and developer experience. As newer versions of commercial Prologs have increased sophistication, portability, and performance, the advantages of C languages over Prolog decrease (Patrick, Johan and Kristina, 2001).

2.7. Application of KBS on Taxation

There are several major application areas of knowledge based systems such as agriculture, education, environment, law, manufacturing, medicine, power systems, geology, telephone cable maintenance,...etc. (Sallem and Abba, 1992).

Business organizations on the cutting edge have pursued KBS as a matter of strategy; others have been willing to embrace innovation only when necessary for survival (Harold, 1990). He identifies the possible business application areas of KBS in decision making. The areas include: engineering, management consulting, execute buy-sell-hold orders, retraining, reviewing law applications, coaching lawyers, and judges, monitoring and evaluation, banking and accounts, tax and investment advising and insurance underwriting. Hereunder the application of KBS for taxation purpose is briefly reviewed.

FinancialAdvisor, a KBS developed in 1985, was the first commercially successful system to be used by tax consultants (Porter, 1994). However a number of other ESs that supports tax administration has been developed before and after FinancialAdvisor (James, 1993, Porter, 1994, Carol, 1995, and Harold, 1992).

In 1977, Taxman I was developed to test the consequences of certain corporate reorganization transactions. This KBS was able to represent a complete set of facts in a

corporate tax case and also was able to represent the full set of statutory rules and concepts which classified the various tax cases (James, 1993, Porter, 1994). Further, in 1979, Taxman II was developed to solve problems involving legal concepts and to produce human like patterns of cognitive theory for information processing of arguments (James, 1993, Porter, 1994).

In 1982, the expert system, TAXADVISOR was developed to solve problems dealing with income and transfer tax planning for individuals. The system was designed to make recommendations, based upon projected future events, for tax-related actions which would maximize the wealth that an individual transferred at death (James, 1993).

World Tax Planner, which is developed by International Tax Planning Expert System Deloitte & Touche (Touche Ross), is in use since 1985. It is used by international tax experts, 500 people in over 65 offices in 30 countries.

Since 1986 ExperTAX developed by Coopers & Lybrand is in use for Corporate Tax Planning, it is used for gathering and data review for corporate tax planning and auditing the deferred tax accrual. In use since 1986 started with 2000 rules – the rules grown to over 3000 rules.

In 1987, a KBS called Investor was constructed, which assisted in the selection of real estate or oil and gas tax shelters (Porter, 1994). The system recommended the first acceptable choice for an individual.

In addition, Harold (1992) reviewed as several ESs were developed in this area since 1970's. Most, if not all, of them are dependent on use of shell. These include AUDITOR and CFILE (bad debts allowance applications used for banking), ExperTAX (tax accruals and planning application and AOD (an audit-opinion assistance application).

2.8. Related Research Works

In this section, among research works on the tax system of Ethiopia those that are closely related with the VAT administration of Ethiopia are briefly reviewed.

The first to be reviewed is a working paper conducted by Abraham Tesfaye, who is a senior economic and market research officer of NBE, prepared for second international conference on the Ethiopian economy held in 2003 in Addis Ababa. The study is on problems and prospects of implementing VAT in Ethiopia. The paper attempts to discuss

the problems and prospects of implementing VAT in Ethiopia. The study is made mainly based on literature survey and comparison of good practices of other countries that implement VAT successfully. It makes a discussion on VAT developments including the tax system, the need for VAT, VAT administration and problems in implementation of VAT.

Finally, the paper highlights the following problems of VAT implementation of Ethiopia:

- The problems of introducing a VAT depend in large measure on effectiveness of the tax administration, the lead in time and the structural features of the VAT (rates, exemptions and treatment of small tax payers).
- Most of the exempt goods and services are disproportionately consumed by the relatively well to do, so the exemptions cannot be justified on equity grounds.
- The taxpayers refuse to honor their debt obligations to the VAT service while others submit their VAT returns without payments.
- There is also deliberate submission of nil returns, non-issuance of VAT invoices and refuse to use the VAT coupons.
- Insufficiency of material and human resources leads administrations to concentrate their enforcement efforts only on large taxpayers, which can encourage noncompliance among other taxpayers.

The author forwarded the following two important recommendations for a bright prospect for effective implementation of VAT in the country among others.

- A publicity campaign aimed at both taxpayers and consumers is necessary for the successful introduction of a VAT. Where such efforts have been made, as they were in Argentina, Korea, and Mexico, for example, the VAT has been introduced without great difficulty.
- The tax authority should carefully prepare regulations, return forms and systems for registering taxpayers and processing VAT returns and payments.

The second related research work is the one conducted by Wollela Abehodie in 2008, who is a PhD candidate in the Australian School of Taxation at the University of New South Wales and a lecturer at the Addis Ababa University, Ethiopia. The study is on VAT administration of Ethiopia. It focuses on reflection of major problems.

The methodology followed is in-depth interviews with tax officials and surveys were used. Specifically, in-depth interviews were held with tax officials at different times. The surveys were conducted using semi-structured questionnaires designed to elicit both quantitative and qualitative data on compliance costs and problems in the VAT system. Both surveys were conducted using face-to-face interview method.

The findings of the analyses suggested that in Ethiopia there is divergence between the effective VAT taxation and the legislation. The main areas where there are gaps and problems include taxpayers identification and registration, VAT filing and payment, VAT refunds, VAT audits, penalties and VAT invoicing. In addition, the outcomes of the surveys showed a lack of tax awareness among the society and strong education programs as well as lack of trust between taxpayers and administrators as major challenges to the VAT system in the country. The gaps and problems identified in the study were partly because of under staffing of the tax authority. This, in turn, is attributable to limited tax administration resources.

As a recommendation for this, the author suggested that the government would better look at the possibility of making sufficient skilled man power and material resources available for the administration of VAT.

Moreover, this paper examined the decentralization of VAT administration following the assignment of VAT revenue to regional governments. The Ethiopian government has assigned VAT revenue to regional governments without clearly envisaging. Following the assignment of VAT revenue, the administration has been partly delegated to regional governments. Both the decentralization of VAT revenue and the administration do not appear to be with thorough consideration of the distortions, the inherent administrative difficulty of the tax and weaknesses in the tax administrations, especially, at regional governments' level.

In this regard, it is suggested that before the tax has further consequences in the form of revenue losses and undesirable inter-governmental relationships it is worth to reassess the decentralization. That is, the assignment of VAT revenue and the decentralization of its administration ought to be re-examined in light of the design features of the tax, the constitutional inter-governmental fiscal relationships, the experiences in other developing countries and the capacity of the country in implementing sub-national VATs.

The other related research work is also the one conducted by Getu Minaye (2007). It is on VAT practices and problems in Federal Inland Revenue Authority of Ethiopia. It is a thesis submitted to school of graduate studies AAU in partial fulfillment of the requirement for the degree of M.Sc. in public administration in the department of public admin and management.

The study attempts to find answers of the following research questions:

1. Do the business communities know the VAT rules and regulations properly?
2. Do the business communities perform their business activity on the basis of the current VAT laws?
3. Does the administration capacity of FIRA strong enough to control those non compliance and delinquent taxpayers?
4. Have the implementation of VAT in Ethiopia met its objectives properly and encourages for the growth of investment and export?
5. What are the problems that hinder for the smooth implementation of VAT in Ethiopia?
6. Does FIRA have taken some measures to alleviate the problems of those obstacles for the smooth implementation of VAT?

The technique used to approach the problems is through analysis of primary and secondary data. Primary data is collected from employees and tax payers using questionnaire and face to face interviews with government officials and the business community and secondary data is collected through the review of existing publications and unpublished materials, proclamations, manuals, journals, and magazines, company reports, guides and regulations, books and research and working papers with their findings. The major sources of secondary data were FIRA VAT dept, MoR, MoFED, and statistical bulletins.

One of the finding is that VAT in Ethiopia has faced various problems such as tax evasions and fraud. It is evident through enterprises starts to propose their own false invoice, some enterprises collected VAT for themselves, some are sold their product as two kinds of VAT inclusive and VAT exclusive, some are understated financial statement and some are making business under threshold. In this regard, the author recommended the following measures to be taken to sustain the VAT system tackle the problems

- Train tax payers about the rules and regulations of VAT continually
- Recruit new employers and give continual training for the existing ones
- Delegate the tax authority to the regional and city administration
- Increase follow up and investigation to control non compliance enterprise
- The business community should also obey the current VAT rules and regulations and they perform their activities according to the VAT laws

The other Finding highlights shortage of qualified man power and low public awareness as among the major problems that lead to failure to control non compliance VAT payers. Again he recommends FIRA to recruit more qualified employers for controlling of non VAT compliance VAT payers. This recommendation is similar with the one forwarded by Wollela (2008).

The tax system of Ethiopia, as it is seen in section 2.3 of this review, is supported by the databases; namely, TIN Application and SIGTAS. AI can be integrated into a variety of software in order to make the software more responsive to user needs (Harold and Anna, 1990). One of the major benefits of KBSs is increasing capabilities of other application systems. Integration of KBS with other systems makes the systems more effective; they cover more applications, work faster and produce high quality result. More specifically, "if there is a mess of rules (e.g. tax and auditing), then the Knowledge based systems can "unravel" the mess." (Carol, 1995).

As it is mentioned in chapter one section 1.2 and other research works reviewed, the core problems of Ethiopian tax system is inefficiency, ineffectiveness, poor performance and lack of public awareness. Therefore, this research work is intended to design a prototype KBS that support the tax administration of Ethiopia by looking in to the way that the already existing systems can be best integrated to optimize the performance of tax administration and encourage awareness creation with the special focus on VAT.

Form the review made, one can understand that there is no research conducted to come up with a KBS for the tax administration in Ethiopia to date. This research work is the first attempt to integrate a KBS technology in the aim of supporting the VAT administration of the country. The foundation of this research is therefore the existing problems of tax system and the need to integrate a KBS for tax administration, which can hopefully close the technological gap.

CHAPTER THREE

KNOWLEDGE ACQUISITION AND MODELING

3.1. Introduction

Knowledge required for designing KBS for tax administration is acquired through interviews, discussions and personal observations. In this chapter conceptual modeling of the knowledge acquired using hierarchical tree structure is presented. This modeling technique clearly shows the flow of knowledge in the course of decision making.

3.2. Knowledge Acquisition

Knowledge acquisition is the activity of capturing, structuring and modeling knowledge from any source for the purpose of storing, sharing and implementing the knowledge (Milton, 2008). It is the act of knowledge engineering in the field of AI that develops KBS, which include knowledge elicitation, analyzing, and structuring. In KBS development, knowledge acquisition is a stage in which the knowledge engineer captures both tacit and explicit knowledge in the domain so as to knowledge to build a KB. Before we begin to design and implement our KBS, the process of knowledge elicitation has to be undertaken. Knowledge elicitation can be described as acquiring knowledge from human experts and learning from data.

The most important issues rise in connection with knowledge acquisition are (Yang, 1995) the following:

The first one is how to acquire knowledge available as tacit in the minds of experts. The second one is how to screen out the most valuable knowledge from vast amounts of knowledge. The third one is how to describe tacit knowledge and the final one is how to develop the culture of knowledge sharing. Because of these issues, the following techniques are often proposed to simplify the task of getting valuable knowledge from experts (Bechhofer, 2006):

- Take experts off the job for short time periods
- Allow non-experts to understand the knowledge
- Focus on the essential knowledge
- Capture tacit knowledge
- Allow knowledge to be collate from different experts

- Allow knowledge to be validated and maintained

To obtain sufficient information that enable to develop complete KB, the researcher has examined unstructured interviews conducted with two MIS officers, three tax officers (experts) at ERCA⁴ head office, two VAT auditors at Arada and kolfe keranio sub city branch each and held a comprehensive discussions with VAT and IT officers at SNNP regional tax authority and ERCA Awassa branch office.

Moreover, additional information is collected using personal observation in one hand to cross check the validity of the information collected by the interview and discussion with the one collected with the observation on the other hand to gather additional information to cover those areas that are not covered by interview and discussion. Thus, the study is based on unstructured interviewee questions, comprehensive group discussions and frequent personal observation at the course of action.

In this study, interviews, discussions and personal observations are techniques mainly used to draw out and validate the experts' knowledge. To model the knowledge, the hierarchical tree is used. The hierarchical tree is chosen for knowledge modeling because of its simplicity to model the intended knowledge. After having concepts discovered through interviews, discussions, personal observations and document analysis, the acquired Knowledge is structured and the model is built using a hierarchical tree structure. In this model, a goal is located at the bottom of the hierarchy and the factors at the top lead to the goal at the bottom.

Nine senior and well experienced professionals on tax from federal office, regional authority, regional branch and Addis Ababa sub cities have participated. This makes the participants more representative of the whole and the knowledge acquired comprehensive. Two managerial level personnel's are also interviewed with the intention of knowing the cross sector link with other organization they are working with and their future plans. Profiles of experts who participated in knowledge elicitation process are presented in the table 3.1 below.

⁴ ERCA is the name used for FIRA after the merging of the revenue authority with the customs authority

Quantity in number	Educational qualification	Field of study	Experience in the tax sector	Position
1	M.A.	Management	14years	VAT department Head
1	M.A.	Accounting	8 years	Office Head for large tax payers
1	M.A.	Accounting and finance	7 years	Tax Officer
4	B.A.	Accounting	All more than 8 years	VAT auditors
1	B.SC.	Economics	3 years	Tax Officer
1	B.A.	Business Administration	6 years	Tax Officer
1	B.A.	Management Information System	2 years	System administrator
1	B.Sc.	Applied mathematics	4 years	Database administrator

Table 3.1: Profiles of the experts participated in interviews and discussions.

3.3. Knowledge Modeling

3.3.1. Extracted Concepts of VAT Administration

A wide range of concepts are found in the function of tax administration because tax has a direct and indirect link with all economic structure. VAT is a type of tax that has a direct relationship with consumers, consumption commodities, and business types; foreign trade (import/export), inflation, GDP, exchange rate, invoice, exemption, declaration, assessment and many more. All of these relations have got interesting research ideas both for scholars from the field of information science as well as economics, finance and accounting.

These concepts may appear in various forms in principle of taxation. However, the discussion hereunder is based on the analysis of the interviews conducted, discussion held with the domain experts; and personal observation made at the offices in the course of this research work.

The knowledge elicitation activity for this study mainly concentrate on: VAT registration, VAT refund, VAT invoices, VAT credit, VAT on foreign trade, accounting for VAT and concept of VAT fraud/evasion. However, the conceptual model is built comprehensively for the VAT refund. This concept is also the one used to the task of knowledge representation and prototype design in the next chapter in order to avoid complexity of modeling and designing all the concepts at a time.

In VAT design of Ethiopia, registration for VAT can be compulsory or voluntary. Compulsory registration is required when at the end of any period of 12 months the person made, taxable transactions that have the total value which exceeded 500,000 ETB; or at the beginning of any period of 12 calendar months there are reasonable grounds to expect that the total value of taxable transactions to be made by the person will exceed 500,000 ETB. In addition, the following are obligated to register for VAT regardless of the volume of their annual turnover.

- Share companies, private limited companies and state owned enterprises;
- Contractors from category 1 to 9;
- Leather and leather product manufacturers;
- Computer and computer related devices suppliers
- Importers and exporters;
- Flour factories;
- Shoes, plastic and plastic products manufacturing factories;

Voluntary registration is made at the judgment of the authority. However, a tax payer which carried on taxable activity and is not registered for VAT may voluntary apply to the authority for such registration if regularly supplying or rendering at least 75% of its goods and services to registered persons. The authority can also refuse to register taxpayers who:-

- has no fixed address of business;
- does not keep proper accounting records,
- has no bank account; and
- has previously been registered for VAT purposes but failed to perform his duties under the VAT law.

Refund is the key feature of VAT. There are two main provisions in the legislation concerning VAT refunds. The first provision is for registered taxpayers who have at least

25 per cent of the value of their taxable transactions for the accounting period, other than zero rating of the disposal of a going concern, taxed at zero per cent. For these taxpayers the VAT law obliges the tax authority to make a cash refund of the amount of VAT applied as a credit in excess of the amount of VAT charged for the accounting period within a period of two months after the registered person files an application for refund, accompanied by documentary proof of payment of the excess amount.

The second provision is for other registered taxpayers. For these taxpayers, the amount of VAT applied as a credit in excess of the amount of VAT charged for the accounting period is to be carried forward to the next five accounting periods and credited against payments for these periods. Any unused excess remaining after the end of this five month period is legislated to be refunded in cash within two months after the registered person files an application for refund, accompanied by documentary proof of payment of the excess amounts.

In both of the above cases, when the tax authority is satisfied that a person who made an application for refund has overpaid VAT, the authority is allowed first to apply the amount of the excess in the reduction of any tax, levy, interest or penalty payable by the person under the VAT proclamation, the customs proclamation, income tax proclamation, or the sales and excise tax proclamation. After applying the credit in reducing the VAT payer's debt under the income tax, VAT, customs, sales and excise taxes proclamations, the tax authority is required to repay any amount remaining to the person if the amount to be refunded is more than ETB 50.

However, the authorities require the following conditions to be fulfilled and documents to be submitted:

1. The applicant has to be registered for VAT;
2. Monthly financial statements (FSS) presented at the right time. These are shown in the models below.

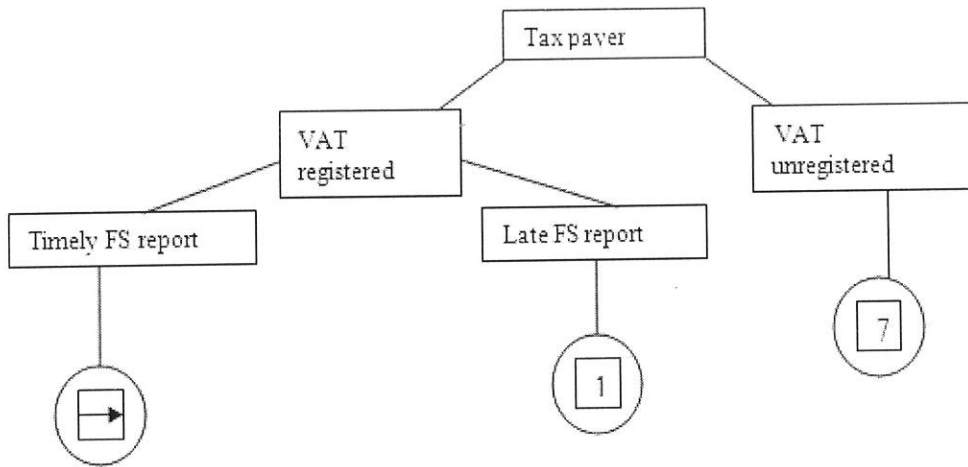


Figure 3.1: A Model for checking the registration and FS report conditions.

The numbers 1, 2, 3... 9 in a circles at the leafs of all the models here and following refers to goal1, goal2, goal3,...goal9 described in a sub-section 3.3.3 of this chapter respectively and the arrows in the circle indicate the continuation of the case to one of the figure following it and starts with similar label. A VAT registered tax payer that makes monthly financial reports on time can have a right to claim VAT refund. The concept that describes this idea is presented in the figure 3.2 below.

3. The amount of VAT refund claimed by the applicant has to also be included in a monthly financial statement report.

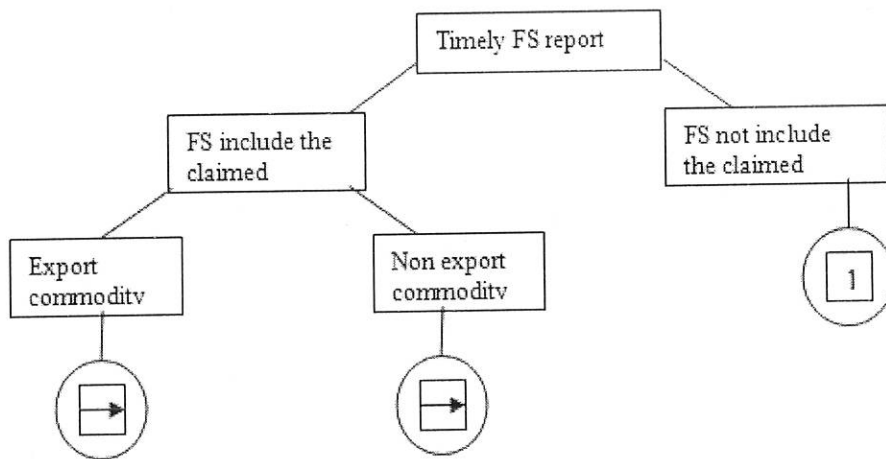


Figure 3.2: A Model used to check the inclusion of the reclaimed amount in the financial reports.

4. Documents that assured products or goods are exported

This document is required to include the following important components:

- Custom's declaration, Bill of lodging/air way bill, Bank permit invoice, Bank credit advice for gained foreign currency
- VAT invoice paid for different expenses. Moreover, to get fast service, the taxpayer should assure that whether the invoices have direct relation with export products or goods and any invoices paid for VAT which have a direct relation with field task has been reported on time in monthly financial statement.
- Contractual agreement with the buyer who is a recipient of the service at the mentioned accounting period;
- Part of VAT paid on input of export goods and a report done with a table shows the calculation of this must be submitted;
- Bank credit advice for gained foreign currency. These are presented using the model presented in the figure 3.3 below.

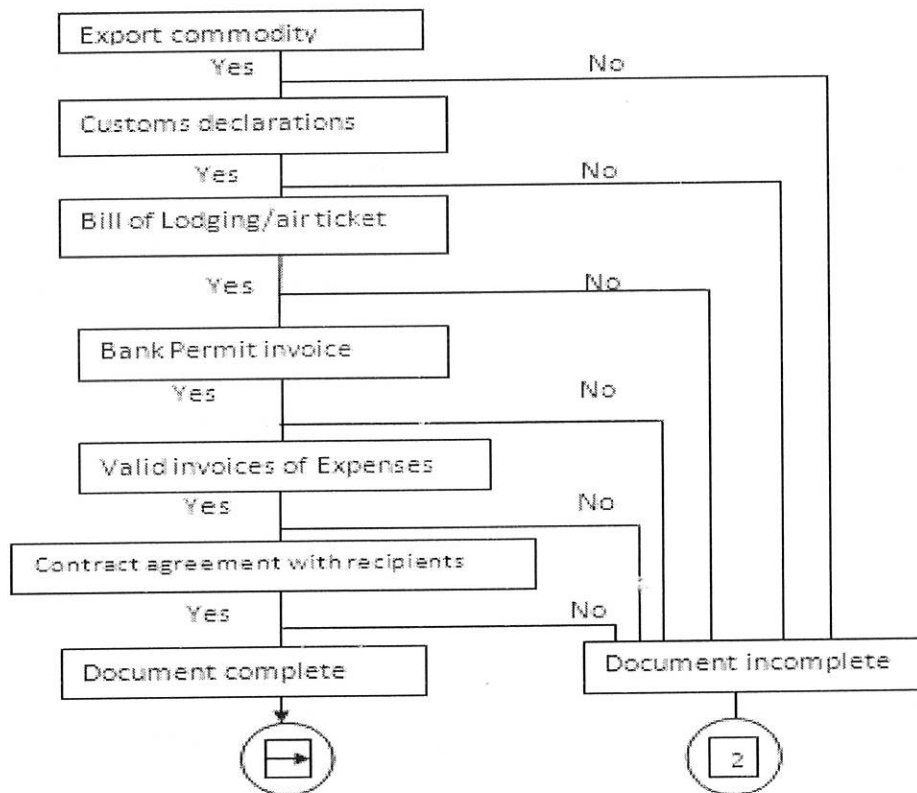


Figure 3.3: A Model used to check the necessary condition to refund VAT on export transactions

This model is unique to transaction including export commodities. After the accomplishment of checking the above conditions the model used to handle both export and non export transaction will become the same. In both cases the subsequent procedure is filing an application with two copies. Fulfilling all the above conditions a tax payer is expected to get response within two months time. Once the completeness of the all the necessary documents for export is made, the steps followed for both export and non export commodities is identical and it is shown in figure 3.4 below.

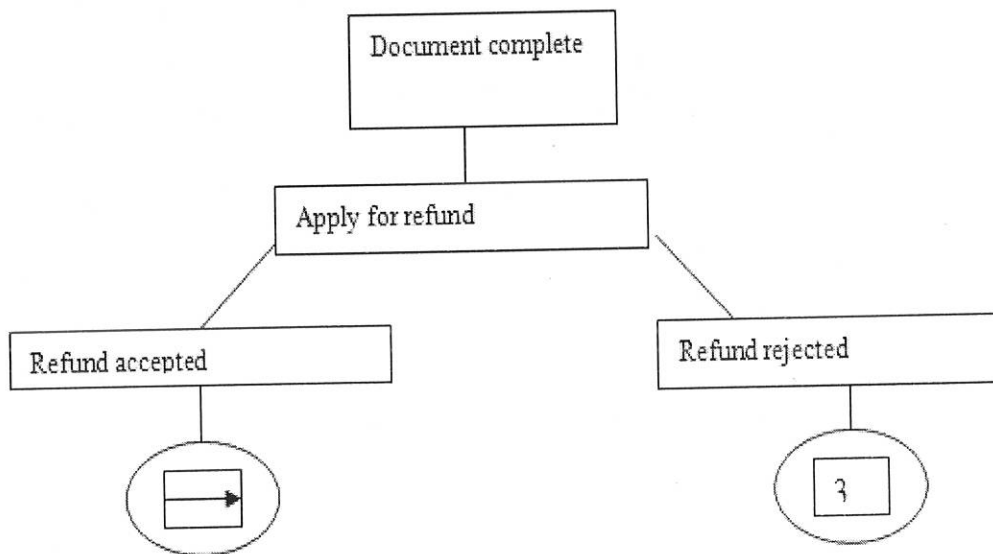


Figure 3.4: Application for export VAT refund

To get the refund amount in cash within two months, for any accepted application, at least 25% of taxable transactions have to be a sector taxed at zero rates in order to get the refund in cash otherwise offset with other tax liability. However, the Authority is not obliged to refund excess credits if the amount to be refunded is not more than 50 Birr. If the amount eligible for refund is 50 birr or less, this amount can be carried forward and credited against tax due in the subsequent five accounting periods. Figure 3.5 below models the refund process after the application is accepted.

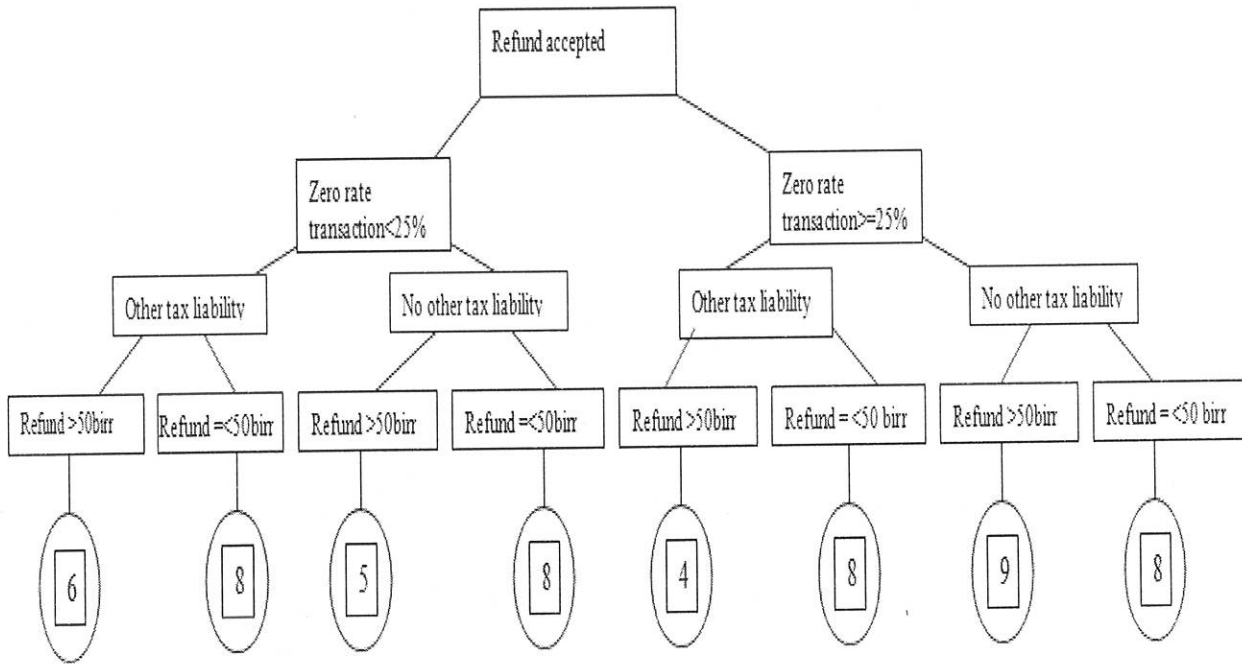


Figure 3.5: A Model that shows the process after the refund application gets accepted.

VAT fraud or evasion is simply a noncompliance that has criminal implication. As pointed by Christophe (2003), tax evasion is a common phenomenon in all countries. Fraud/evasion comes in many forms ranging from traders omitting the occasional sales from their accounting to systematic supervision of sales and falsification of invoice. The main types of fraud/evasion are summarized below (Christophe, 2003).

i. Inflated refund claim. The simple method to inflate refund happen by creating fake invoice for purchases never made. In this type, organized crime networks have been known to establish business solely to fabricate invoices for sale to those wishing to defraud the revenue.

ii. Underreported sales. This is the most usual way of evading VAT. By concealing sales to the domestic market, traders may not only evade their own obligation to charge VAT on their output, but also generate excess credits to be refunded.

iii. Fictitious traders. This involves creation of short-lived enterprises that register for VAT and create the illusion of trading in goods and services. A common ploy is to invent fake export invoices on nonexistent goods and claim VAT refunds.

iv. Domestic sales disguised as exports. Traders sell goods on the domestic market but claim a refund using a fake export invoice.

Other forms of evasion and fraud include:

- Traders that are liable to VAT but do not register
- Credit claimed for taxable supplies used in exempt activities, and credit claimed on private purchases
- Credit claims from unregistered suppliers
- Goods imported illegally and the sold with VAT added but not remitted to the tax authorities; and
- Exchange arrangements hidden from the authority

From the above mentioned fraud types, we can easily observe the extent at which VAT refund is interrelated with VAT fraud. Most of them have a target of fake refund claim which is one among the very serious crimes that could be committed on taxation.

3.3.2. Conceptual Model Building

To build a model for the knowledge that has been acquired so far, a thorough analysis and understanding of the concepts is made. Building the conceptual model requires well understanding of each and every input and output parameters or attributes identified during knowledge acquisition. Each of the parameters has their own broad and in-depth concepts that need a thorough analysis to build a model. Some of the input/output parameters are:

<p>The input parameters:</p> <ul style="list-style-type: none"> • Value annual turn over • Type of business • Audit reports/histories • Custom information • Licensing center information • Audit reports • Refund claim • Record keeping • Invoice usage • Bank information • Contracted agreement with recipient (for exporters) 	<p>The output parameters:</p> <ul style="list-style-type: none"> • Inflated refund claim • Under reported sales • Fictitious traders • Domestic sales disguised as exports • Traders that are liable to VAT but do not register • Credit claimed for taxable supplies used in exempt activities, and credit claimed on private purchases • Credit claims from unregistered suppliers • Goods imported illegally and the sold with VAT added but not remitted to the tax authorities
--	--

Table 3.2: Input and output parameters to the whole VAT administration

Not only concept diversity but also interrelation of the parameter makes conceptual model building more complex. Any of the input and the output mentioned above can have a relation with one or more of the other. Considering all the concepts at a time to build a model creates complexity, as it is mentioned earlier. To simplify the complexity, in this study, the concept of VAT refund is focused and the parameters are reduced to:

<p>The input parameters:</p> <ul style="list-style-type: none"> • Custom information • Licensing center information • Audit reports • Monthly Financial Statement Report • Record keeping • Commodity type • Invoice usage • Bank information • Contracted agreements • Net Refund Required 	<p>Output parameters:</p> <ul style="list-style-type: none"> • Refund paid within two months • Refund rejected • Refund offset against other tax liabilities • Refund carried forward to the next five months • Refund doesn't concern
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Table 3.3: Input and output parameters to VAT refund claim handling

The reason to choose the concept VAT refund than the others is not only to avoid the complexity of building a conceptual model to all the acquired Knowledge in the area of VAT but also the close connection of the concept VAT refund with fraud and evasion gets

priority. In this study, therefore, the concept of VAT refund is discussed in a more detail than the other concepts.

3.3.2.1. Goals for Refund Claim

From the analysis of knowledge extracted and captured through interviews, discussions and observations, the concept VAT refund is identified to target one of the goals described below:

- Goal 1: *Refund cannot be claimed***-this is the goal that tells tax payer having no right to claim for VAT refund because of failure to fulfill the preconditions or the necessary documents.
- Goal 2: *Documents are not complete***-this is the goal that tells the rejection of the refund claim because of incomplete document attached with the application regarding their export related transactions.
- Goal 3: *File a charge to the court or committee in charge of tax claim***-this goal tells the taxpayer right to file a charge to the court or anybody in charge of handling tax related objections.
- Goal 4: *Refund offset to other tax liabilities and Net refund will be paid***-this tells that the refund claim gets acceptance but it is subjected to counterbalance with other tax liabilities or penalties that the taxpayer have. The net amount will be paid within 2 months time from the application for refund.
- Goal 5: *Refund carried forward to the next 5 months and then the net will be paid***- this tells that the refund claim gets acceptance but it is carried forward to be considered on the payments made on VAT for the next consecutive five accounting periods (months)
- Goal 6: *Refund offset and net refund carried forward to the next 5 months and then it will be paid***- this tells that the refund claim gets acceptance but it is carried forward to be considered on the payments made on VAT for the next consecutive five accounting periods (months) after all other tax liabilities are counterbalanced.
- Goal 7: *Refund does not concern***- this tells the case is out of the concern of the VAT refund claim

Goal 8: *Refund may not be paid but only offset*-it is similar to goal 4 above but the authority cannot be forced to pay because of the threshold value to refund. It is usually considered as if it is rejected.

Goal 9: *Net refund will be paid in cash*-the net amount of VAT refund will be paid within 2 months time from the application of the refund

However these goals are condensed to five top goals and the remaining four are sub goals during the inference process of the backward chaining that will be discussed in the next chapter.

3.3.2.2. Conceptual Model for Refund Claim

Figure 3.6 shows the conceptual model for VAT refund claim. The figure tries to summarize, consolidate and refines all the models presented earlier by removing redundant and unnecessary labels such as inclusion of claimed amount in the FS report as it is obviously checked when the invoice is validated. Goal 4 and goal 9, goal 5 and goal 6 and also goal 8 and goal 7 can be seen as identical goals in the conceptual model.

In the next chapter the KBS development that includes knowledge representation, prototype development, testing the system and performance evaluation is presented.

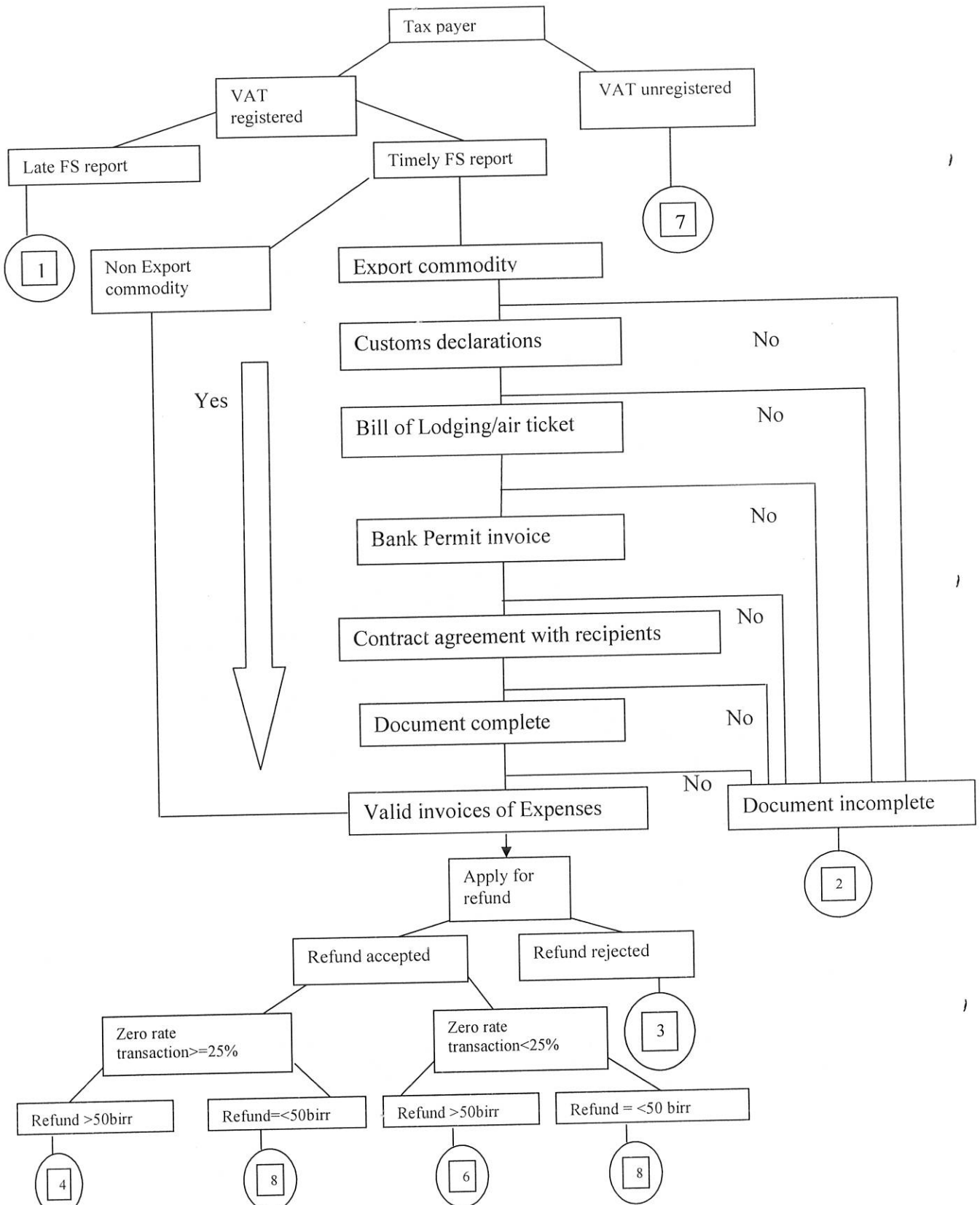


Figure 3.6: Conceptual model for VAT refunding system

CHAPTER FOUR

THE KBS DEVELOPMENT AND EVALUATION

4.1. Introduction

In the previous chapter, the knowledge acquisition and modeling the acquired knowledge using hierarchical tree structures is presented. In this chapter, the prototype system development together with the knowledge representation and system evaluation is discussed.

4.2. KBS Development

The development of the KBS focuses specifically on VAT refund. The KBS designed for the VAT refund here made a thorough investigation on the existing system, even though the existing system is manual. The system consider not only taking the advantage of a computer based system but also incorporate what is not in the existing system that have a lot to do with preventing fraud specially by fabrication of fake documents and invoice. The system also consider enhancement of the service delivery.

The other important feature of the new system, what I preferred to call VATReAdv (VAT Refund Advisor), is that it is designed in such a way that the available IT infrastructure is utilized effectively without any additional cost required for implementation. In other word, the new system is cost effective to implement and efficient in fraud detection. Unlike the existing system which only give attention to the tax payer of a given tax office or branch, the new system can consider the transactions performed at every offices or branches of the authority nationwide using the already available IT network infrastructure called revenue network to optimize the fraud detection capability. In this framework the KBS is designed to support the efficiency, effectiveness and performance that are raised as major problems of the tax system of the country.

Providing adequate and consistent advice is also among the feature incorporated in the new system with the intention of raising the awareness of the tax payers. The comparison made on the conceptual schema of the existing and the new system is shown in figures 4.1 and 4.2 below.

4.2.1. Contrast of the Legacy and the Proposed System

The VAT refund process currently practiced is modeled as in the figure 4.1 below

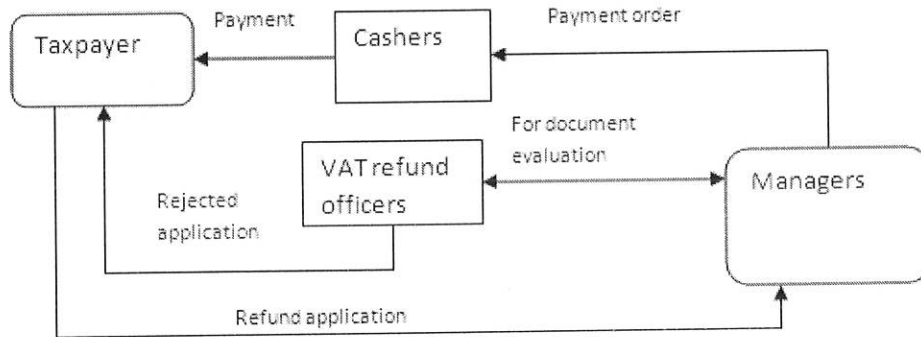


Figure 4.1: Model of the legacy system for VAT refunding

In this process model, refund application is filed to the authority by the tax payer. The application is forwarded to VAT officers for investigation and document evaluation. The evaluated and approved documents forwarded back to the managerial level decision and confirmation. The confirmed document together with the payment order is sent to the cashers. Otherwise the rejected application is sent back to the taxpayer together with the briefing of the reason for rejection. Similarly, the new system is modeled as shown in the figure 4.2 below.

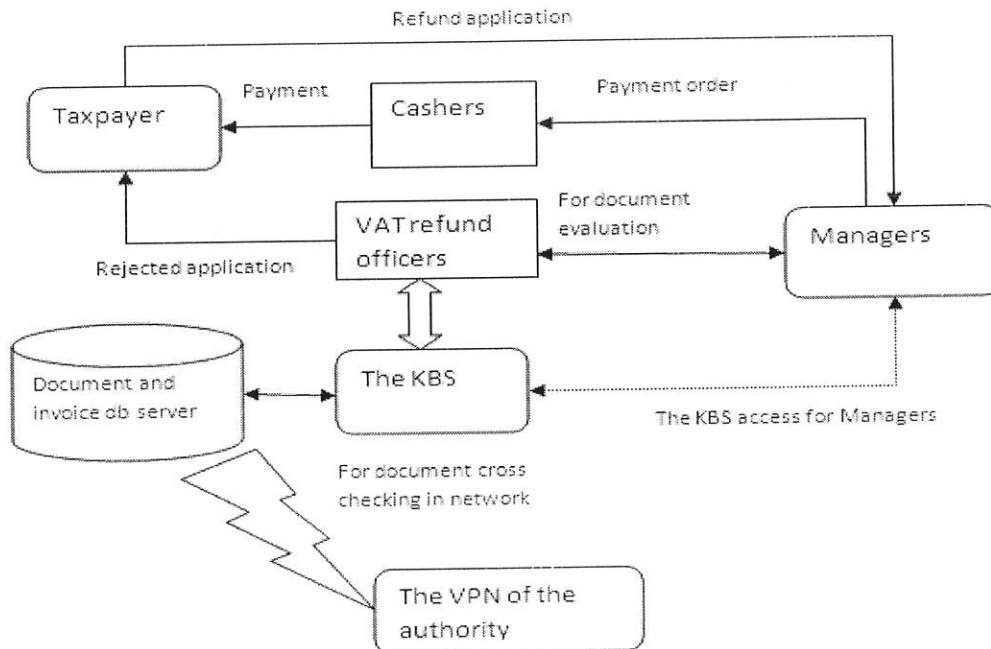


Figure 4.2: Model of the new system for VAT refunding

The proposed system considers all the necessary steps and cut out or simplifies the difficulties in the existing system. Besides, it is powerful in checking documents and invoices nationwide through the network available that cannot have access to the human experts on the manual bases. This is done by adding all the valid document numbers and invoice numbers found in to the network to the facts of the KBS (the structure of the network is discussed in section 4.2.2). This capability has a great importance on fraud detection by providing fake invoices and documents. The collection of all the invoice and document numbers of all the branches and regional offices are accessed for document evaluation. It also smoothen the controversies exist between experts and decision makers by using consistent knowledge and giving confidential solution for a given case on the bases of the rules and facts in the knowledge base.

4.2.2. Virtual Private Network (VPN) Architecture of the Authority

The revenue authority has a VPN in use for accessing data from remote offices. The VPN is a secure and more affordable network that runs over a private IP network which is obtained from the Ethiopian telecommunication corporation (the state monopoly ISP). The revenue authority VPN gives remote access to data in branch offices and regional offices and vice versa. A way to access the intranet is securely by dialing through the Ethiopian Telecommunication Corporation remote access VPNs with telephone numbers in many cities. The general revenue network architecture which has been installed by the revenue authority of Ethiopia is shown in the figure 4.3 below. It can be considered as a big opportunity to implement any newly coming systems using this available infrastructure.

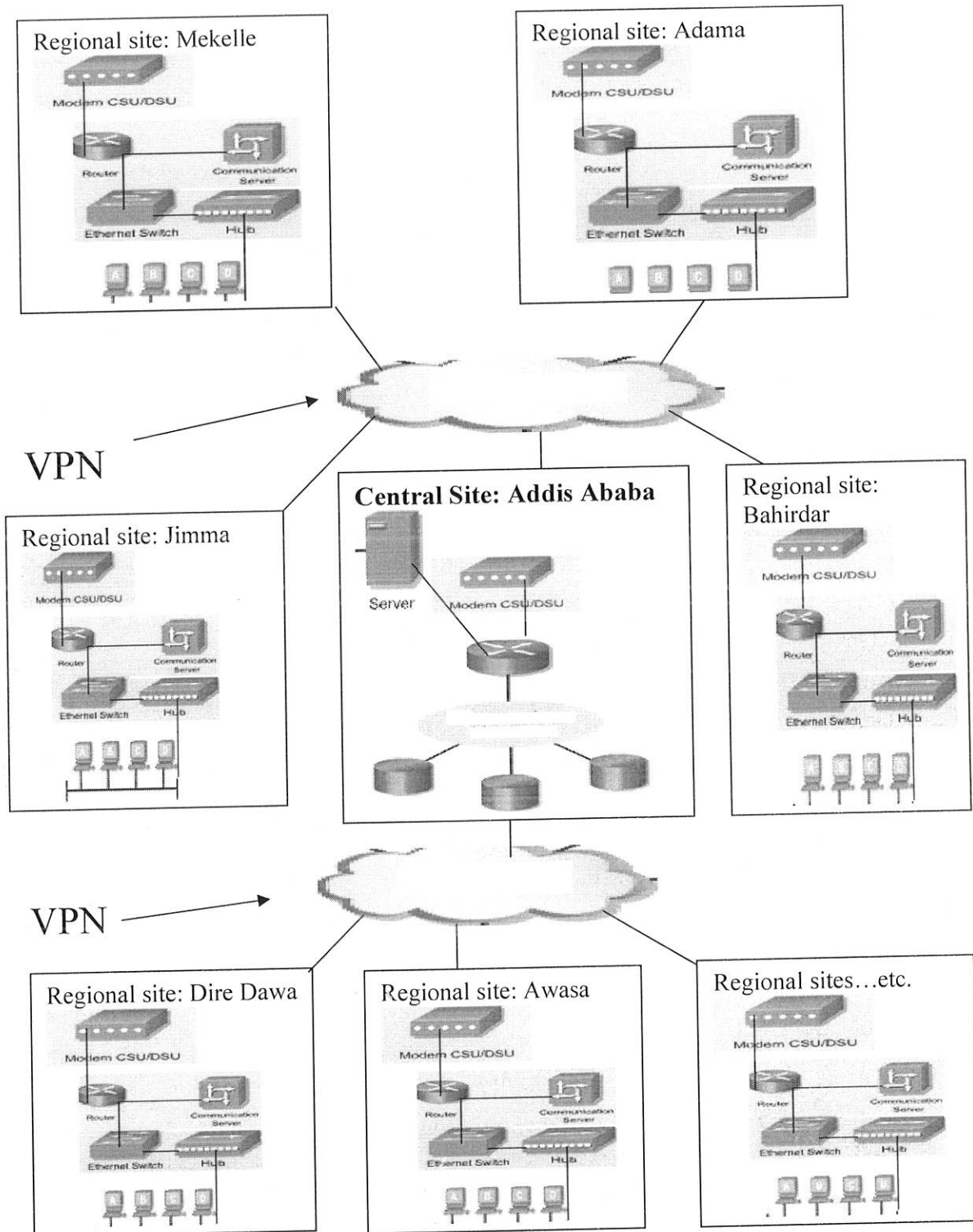


Figure 4.3: The existing nationwide revenue network architecture.

***Remark:** only some sample branches and regional offices are included here. All other are connected likewise.

4.2.3. The System Design

In the KBS, the domain knowledge is represented by a set of IF-THEN production rules and data is represented by a set of facts for situations at hand. The Prolog inference engine compares each rule stored in the knowledge base with facts given or contained in the databases. When the IF (condition) part of the rule matches a fact, the rule is fired and its THEN (action) part is executed. The matching of the rule IF parts to the facts produce inference chains. The inference chain indicates how the KBS applies the rules to reach a conclusion.

4.2.3.1. Knowledge Representation

Knowledge representation is the process of encoding formalizing and organizing the knowledge acquired into rules or cases or patterns for use by the expert system (Robert and Edward, 1993). It is also defined as the process of describing and mapping expert knowledge using a set of symbols and attaching meaning to the syntax. There are a number of various available 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 research is the production rule or rule based. The first reason is that rules are relatively easy to understand and create from the acquired knowledge or generate them from decision tables using machine learning tools like WEKA. The other reason is that rule base representation is convenient to translate from the knowledge acquired and modeled using hierarchical tree.

The term production rule in AI, which is the most commonly used type of knowledge representation (Graham, 1989), can also be defined as an IF-THEN structure that relates the given information or facts in IF part to some action in the THEN part. The IF part is called the antecedent (premise or condition); and the THEN part is called the consequent (conclusion or action). Rule provides some description of how to solve a problem in relatively easy and understandable manner. Sample prolog representation of the rule base used for this study is shown in sub section 4.2.3.4.

The rules for this study are created from the knowledge acquired through the knowledge elicitation techniques used in chapter three. In other words rules are created through the transformation of hierarchical tree modeled in the previous chapter to the if-then rules. In addition to this, the dataset for VAT refund which has twelve attributes and 4067 records are used to generate rules using the machine learning tool called WEKA employing the algorithm called predictive A priori association. It is chosen because of its capability to model relationships that are found between objects and help to formulate rules.

The rules created from the hierarchical tree of the previous chapter are evaluated in consultation with the domain expert. The total number of rules after continual evaluation is found to be 28. Likewise the rules created using the above mentioned tool is 100 best rules that show association of 12 attributes (see appendix IV). These 100 best rules are evaluated for their redundancy, consistency, completeness and exhaustiveness again in consultation with the domain experts; and finally after continual refinements the working rules are found to be 33. The additional five rules are obtained after refining the 100 rules found from WEKA.

4.2.3.2. The Attributes of the Dataset

The dataset used for rule generation in WEKA is derived from five different tables used for different purposes that have a link with VAT refunding in anyway. The tables are used for VAT registration, VAT declaration, VAT assessment VAT audit and VAT refund claim itself. The need for finding data in an indirect means than direct is the difficulty behind the privacy of data.

Tax proclamation (proclamation no 286/2002) of Ethiopia declare tax information to be closed confidentially. Any one in need of tax information for any purpose except for the court evidence and central statistical authority consumption⁵ has to come with a written and signed commandment by the director for screened and clearly specified information. Therefore, following indirect way is the preferred method though it was very time consuming and tiresome task. The attributes and values set of the dataset is presented in the table 4.1 below.

⁵ Tax data is allowed for the two institutions using an official letter of request only.

Attribute	Values set
VAT_registration	{yes, no}
Monthly_FS_report	{late,timely}
Claimed_amount	{include,not include}
Commodity_type	{export,non export}
custom_declaration	{valid,invalid}
bill_of_lodging	{valid,invalid}
Bank_permit_invoice	{valid,invalid}
foreign_currency_earned	{valid,invalid}
contract_agreement	{valid,invalid}
liability_deducted_refund_amount_requested	{above50ETB,below50ETB}
zero_rate_transaction	{aboveaforth,belowafourth}
refund_statuses	{offset,carried_forward,paid_in_2month,rejected,doesnot_concern,no_obligation_to_refund}

Table 4.1: Attributes and value sets of the dataset used for rule generation in Weka

4.2.3.3. Knowledge base Construction

The knowledge base of the system contains the domain knowledge useful for solving VAT refund related problems. 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. When the condition part of a rule is satisfied, the rule is said to fire and the action part is executed. Sample rules and facts are shown below.

Sample Rules and Facts of the KBS.

Rules

Rule1. IF a taxpayer is registered for VAT

THEN a tax payer should report monthly financial statement.

Rule2. IF monthly FS report is late THEN tax payer is subjected to penalty.

Rule3. IF a taxpayer is registered for VAT

AND report monthly FS on time

AND the amount of VAT paid exceeded the amount of VAT collected

AND the FS include the report of the collected amount of VAT

THEN tax payer can apply for VAT refund

Rule4 IF a taxpayer is registered for VAT

AND report monthly FS on time

AND the amount of VAT paid exceeded the amount of VAT collected

AND the FS include the report of the collected amount of VAT

AND all the transactions are non export

THEN VAT refund claim is accepted

Rule5 IF a taxpayer applies for VAT refund is exporter
THEN all export documents are required

Rule6 IF a taxpayer is registered for VAT
AND report monthly FS on time
AND the amount of VAT paid exceeded the amount of VAT collected
AND the FS include the claimed amount of VAR in the report
AND the transactions include export commodities
AND valid export documents are attached
THEN VAT refund claim is accepted

Rule7 IF the VAT refund is accepted AND zero rate transaction exceeds 25%
AND refund amount >50ETB
AND no other tax liability
THEN refund will be paid within two months.

Rule8. IF the VAT refund is accepted AND zero rate transaction exceeds 25%
AND refund amount >50ETB
AND other tax liability expected
THEN refund will be offset with the liability and the net will be paid within two months.

Rule9 IF refund amount is less than 50ETB THEN it is offset to other liability

Rule10 IF refund amount is less than 50ETB THEN cannot be paid in cash.

Facts

VAT refund is a concern of registered tax payer.

Any tax expected is tax liability.

Commodity can be export or non export.

A valid custom declaration is an export document.

A valid Bill of lodging is a valid export document.

A valid Air plane ticket is a valid export document.

A valid Bank permit invoice is a valid export document.

A valid Contractual agreement with recipient of the time is a valid export document.

These rules and facts are added to the knowledge base using prolog programming language. The detail is presented in appendix VI, based on which the system is applying reasoning.

During knowledge base construction considering situational analysis in the rule base is a challenging task. For instance, government deliberately favors not to pay VAT refund because of the cash shortage available for refund even though the rule clearly declares to refund on time. Contrary to this some special favor also made to VAT refund in order to promote export that is capable of earning foreign currency. This controversies and special cases are the challenges during knowledge base construction.

4.2.3.4. Reasoning Mechanisms

During inference, rules are linked into chains of reasoning by the KBS which can use either backward chaining or forward chaining. Forward chaining is data-driven and investigates the consequences of the knowledge and finds the rules whose conditions are satisfied by the knowledge; whereas backward chaining is the goal-driven reasoning tries to prove a hypothesis by finding rules with the hypothesis result in its conclusion. In case where an expert first needs to gather some information and then tries to infer from it whatever can be inferred, the forward chaining inference engine is chosen. Whereas, incase when expert begins with a hypothetical solution and then attempts to find facts to prove it, the backward chaining inference engine is chosen.

The reasoning mechanism used for this research is the backward chaining because the goals are predetermined as specified in chapter three and refined in the following subsection. Backward chaining systems are good for solving structured selection types of problems and don't require all the rules to be fired but only the rules that have connection with the specified goal or sub goals. Moreover the PROLOG programming language used in this research infers using backward chaining.

In backward chaining, the KBS has the goal (a hypothetical solution) and the inference engine attempts to find the evidence to prove it. First, the knowledge base is searched to find rules that might have the desired solution. Such rules must have the goal in their THEN (action) parts. If such a rule is found and it's IF (condition) part matches data in the database, then the rule is fired and the goal is proven. If this is not the case, the inference engine puts aside the rule it is working with and sets up a new goal, a sub goal, to prove the IF part of this rule. Then the knowledge base is searched again for rules that can prove the sub goal. The inference engine repeats the process of stacking the rules until no rules are

found in the knowledge base to prove the current sub goal. This is the way how the system reasons out.

4.2.3.5. The Goals

The goals listed in chapter three sections 3.3.3 include all the intermediate and the final outputs of the VAT refunding process. During inference five top goals are used. The remaining intermediates are seen as sub goals during inference. The five top goals are:

Goal 1: *Refund offset to other tax liabilities and Net refund will be paid*-this tells that the refund claim gets acceptance but it is subjected to counterbalance with other tax liabilities or penalties that the taxpayer have. The net amount will be paid within 2 months time from the application of refund.

Goal 2: *Refund carried forward to the next 5 months and then the net will be paid*- this tells that the refund claim gets acceptance but it is carried forward to be considered on the payments made on VAT for the next consecutive five accounting periods.⁶

Goal 3: *Refund first offset and net refund carried forward to the next 5 months and then the net will be paid*- this tells that the refund claim gets acceptance but it is carried forward to be considered on the payments made on VAT for the next consecutive five accounting periods after all other tax liabilities are counterbalanced.

Goal 4: *Refund does not concern*- this tells the case is out of the concern of the VAT refund claim

Goal 5: *Net refund will be paid in cash*-the net amount of VAT refund will be paid within 2 months time from the application of the refund.

Goals such as document complete, document incomplete are sub goals as they are lead to either the refund application followed by other top goals or refund rejection.

4.2.3.6. The User Interface

The user interface of the system is directly used from the interface of the SWI prolog window. The facts are asked to be answered using the “yes” or “no” options or to be selected and written from the menu alternatives.

⁶ VAT accounting period means one month of Ethiopian calendar.

The first page of the user interface welcomes the user by displaying “Welcome to VATReAdv Knowledge based system.” As shown in figure 4.4 and invite the users to write **go** followed by full stop and press enter key. To start the consultation invite the user to write **continue** followed by full stop and press enter key and then follow the instruction. To get explanation for the conclusions made invite the user to write **how** followed by full stop and press enter key. To know why some question is asked invite the user to write **why** followed by full stop and press enter key. To exit from the prolog window invite the user to write **halt** followed by full stop and press enter key. To stop consulting VATReAdv invite the user to write **quit** followed by full stop and press enter key. To know more about VATReAdv invite the user to write **help_VAT** followed by full stop and press enter key.

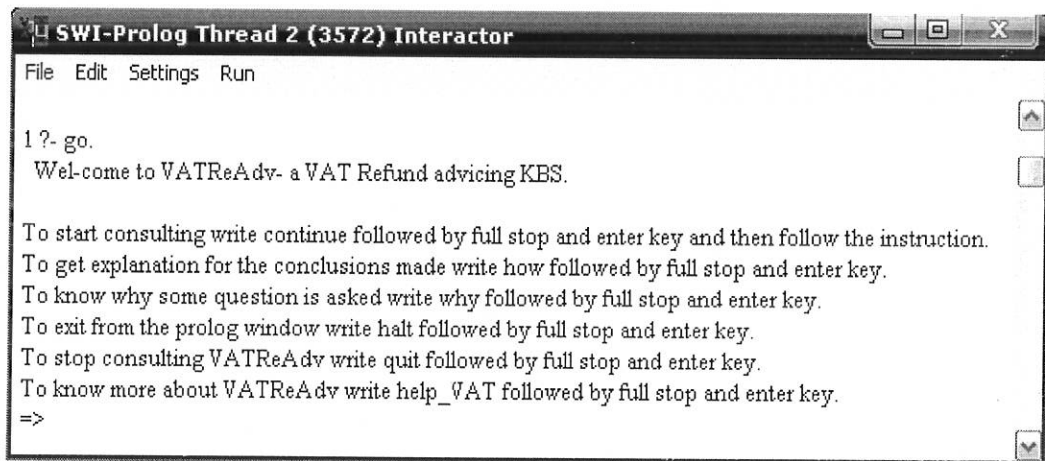


Figure 4.4: The welcoming window of the VATReAdv.

4.2.3.7. Explanation Facility

The explanation facility enables the system to review its own reasoning and explain its decisions. That means it enables the user to ask the system how a particular conclusion is reached and why a specific fact is needed. The system is able to explain its reasoning and provide the necessary advice that is in line with the output of the case under consideration. The system can also provide an advice even in the intermediate results of the refunding process whenever necessary without the interference of the user.

The explanation facility is among the important parts of the VATReAdv. The system is capable to explain how the conclusions arrived. This means the user can ask the system for justification of conclusions or explanation why some question is asked. At any point in a consultation the VATReAdv responds with the rules that is used for the conclusion, or the rules being considered which led to a question to the user.

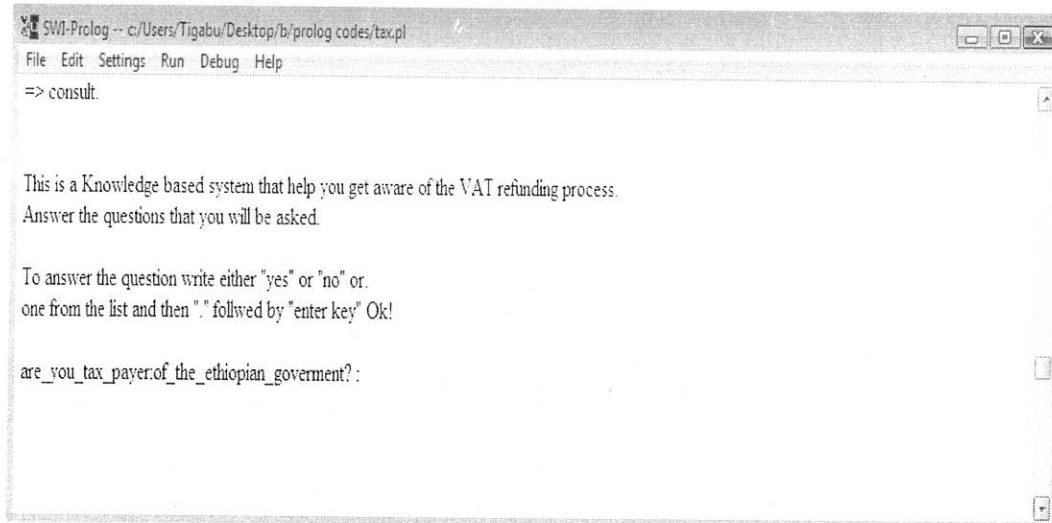


Figure 4.5: The VATReAdv window asking the tax payer.

“Are you tax payer of Ethiopian government?” is the first question asked by the system. This question is asked to tell that the system is only the concern of the taxpayer of Ethiopia but any one in need of the consultation can proceed. In case where the response is yes the system continue to ask more questions so that the appropriate conclusion is made. In the meantime or at the end of the consultation the system provides the necessary advices when ever appropriate.

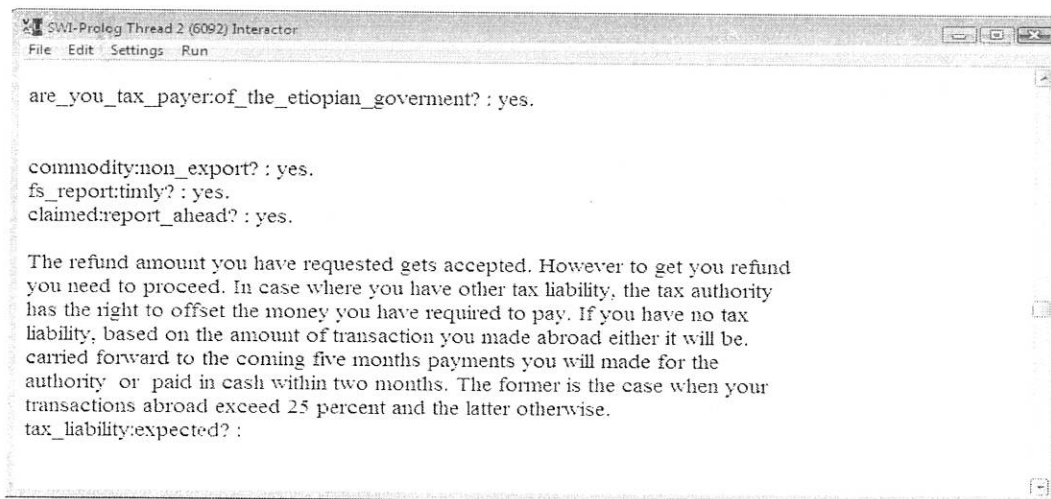


Figure 4.6: The window that give advice for the accepted VAT refund claim.

As shown in figure 4.6 above, the system asks questions and collects the answers. It gives intermediate advices that tells the user how he/she can proceed and what could be the results following this step. The application proceeds likewise.

4.3. Testing and Evaluation

There are different techniques that are employed to systems testing and evaluation. Based on the time of evaluation made, we can classify evaluation as continual and summative (Anumba and Scott, 2001). The former is the evaluation of the system during and throughout the development process and the later is the evaluation of a system after the development task is completed.

For this research the two above mentioned methods are used in combination. The evaluation process tries to answer the questions like: are the knowledge acquisition and knowledge representation schemes adequate or do they need to be extended or modified? Is the system coming up with the right answers for the right reasons? Is the embedded knowledge consistent with the experts? Is it easy for users to interact with the system? What facilities and capabilities do the users need?

In addition to these, the quality of the system's decision and advice, the correctness of the reasoning techniques, the system's efficiency, and its cost effectiveness. The evaluation activity also involves exploring the code, examining the reasoning processes, examining intermediate results and conclusions of the system, to help detect errors as early as possible in the development.

The evaluation process adopted has involved the domain experts from beginning to end of the process. The experts interacted with various sections of the system by inputting several variables to check its performance and providing feedbacks on different cases. These are useful in identifying areas of knowledge missing from the system; areas of the system which are not being covered; and whether the knowledge was consistent with that of the experts and so on.

As the aim of the summative evaluation is to test VATReAdv ability against various cases of VAT refund, the sample data used to test the system contain four different types of cases so that these varieties make the sampling of test data more adequate and comprehensive. The test data types include:

- i) *Specific cases* – to test whether specific situations are handled properly;
- ii) *Frequent cases* –to test whether the system could cope with day-to-day cases;

- iii) *Historical cases* – to compare the standards of the past with that of the system and the experts;
- iv) *Arbitrary cases* – used to test the breadth of situations that the system is able to handle.

Within the types mentioned above, the test cases selected are also very different in terms of the business type, address, and date they are exhibited so that no bias would be introduced into the evaluation process and enables us to work with the case sensitivity analysis. The cases are entered into the system with the visual interaction of the expert evaluators. 40 test cases which are chosen by the experts on the basis of the above mentioned four parameters are used to evaluate VATReAdv during the summative evaluation phase. Experts are allowed to make comments while testing the system, altering parameters as desired.

Four sample cases (one for each type) are briefly described below:

Case 1: (Sample Specific Case data)

Profile of the case: This case involved a VAT refund request of business X⁷ which is a private limited company established in 02/04/2007 in Addis Ababa and engaged in production of house and office equipments with the license number Y1. It is registered for VAT at kolfe-karanio sub city tax authority and the VAT certificate is issued on 25/04/2007. There is no previous tax history recorded and available in the database as well as in manual basis regarding this business. The VAT refund application for the transaction performed in the month of July 2007 which amounts 56,452ETB is filed on 02/09/2007 by the legal representative of the company. However, no monthly financial reports were filed to the tax office since the registration for VAT to the application for The VAT refund. There are no evidences that the transaction include commodities exported throughout the month-July 2006.

Decision made: The system, after having asked the user for the following question, conclude the refund request is rejected. The questions asked and the answers provided by the system are:

are_you_tax_payer:of_the_ethiopian_goverment? : yes.

commodity:non_export? : yes.

⁷ The business name and license number are not disclosed for the privacy purpose

fs_report:timly? : no.

commodity:export? : no.

fs_report:late? : yes.

The final output is “*The refund is rejected.*” This decision is identical to the one made and reason out by the human expert. Following the decision the system advice the taxpayer by telling the reason for the rejection of the refund request as:

“Your refund request is rejected because of your failure to report your financial statement reports on time. For the future you don’t forget to report your financial statement report on time. The financial report submitting time of a given months is 30 days after the end of the month. However the authority may revise this accordingly. Therefore you are always being alert to new information regarding your tax.”

Among 9 similar specific case test data, the system decision of 7 of them matches with the decision of the human experts. That means, for this data types alone the accuracy is 78%

Case 2: (Sample Frequent Case data)

Profile of the case: This case involved a VAT refund request of taxpayer X⁸ which is a sole proprietorship established in 18/06/2005 in Arbaminch and engaged in general construction with the license number Y2. It is registered for VAT at SNNP regional tax authority-Awasa. The VAT certificate is issued on 25/09/2005. The tax assessment report of the tax auditors for this taxpayer shows a sum total of 29,453.55ETB is expected to be paid for the previous Ethiopian fiscal year⁹ (1997) by the taxpayer. On the other hand, The VAT refund application for the transaction performed in the month of December 2006 which amounts 34,299.06ETB is filed on 02/09/2007 by the taxpayer. The tax payer had been submitted all his monthly financial reports on time since registration to the refund application. Moreover, all the invoices attached with the application are within the ranges of invoice numbers reported to the tax offices from the legal invoice publishers. However, no evidence attached to show any service delivered abroad.

⁸ Again the business name and license number are not disclosed for the privacy purpose

⁹ Ethiopian fiscal year is from September 11 of the year to September 10 of the following year

Decision made: The system, after having asked the user for the following question, conclude the refund request is accepted and offset to the tax liability expected. The difference from the offset is decided as it is carried forward to tax liabilities in the coming five accounting period and then it will be paid.

The questions asked and the answers provided by the system are:

are_you_tax_payer:of_the_ethiopian_goverment? : yes.

commodity:non_export? : yes.

fs_report:timly? : yes.

claimed:report_ahead? : yes.

The system advices meanwhile for his getting acceptance as:

“The refund amount you have requested gets accepted. However, to get your refund you need to proceed. In case where you have other tax liability, the tax authority has the right to offset the money you have required to pay. If you have no tax liability, based on the amount of transaction you made abroad either it will be carried forward to the coming five months payments you will made for the authority or paid in cash within two months. The former is the case when your transactions abroad exceed 25 percent and the latter otherwise.”

and continue to ask. (See figure 4.6)

tax_liability:expected? :

”.....” tax_liability:expected? : yes.

And the final output was “The refund is subject to offset.” This is identical to the decision made by the human experts at the time. Following the decision the system advice the taxpayer for the procedure of refund offset.

Again, among 9 similar frequent case test data, the system decision of 7 of them matches with the decision of the human experts. That means for this data types the accuracy is 78%

Case 3: (Sample Historical Case data)

Profile of the case: This case involved a VAT refund request of a government owned enterprise called X¹⁰ which is established in 02/04/1998 in Addis Ababa and engaged in leather and leather products with the license number Y3. It is registered for VAT at head office of the authority and the VAT certificate is issued on 25/07/2003. For the year 2002 and before, the tax authority had imposed tax which amount a sum total of 2,001,041.78ETB. More than 86% of their sales transactions were made abroad. Besides the year long contractual agreement with the recipient companies, the customs declarations, lodging tickets, bank permit invoices, bank credit invoice for earned foreign currency and invoices for the paid VAT on purchase were attached. The VAT refund application for the transaction performed in the month of Dec. 2003 which amounts 3,156,452.37ETB was filed on 12/01/2004 with a covering business letter of the enterprises. The enterprise had been submitted his monthly financial reports on time since registration to the refund application

Decision made: The system, after having asked the user for the following question, conclude the refund request is accepted; and out of the requested refund amount 3,156,452.37ETB 2,001,041.78ETB is offset to the tax liability and the remaining 1,155,410.59 is paid within two months since the application had been made. The comment given by the experts regarding this case is that the case delayed six months practically by the human experts processing. The delay was not because of the legal procedure rather it might be because of the bureaucratic and processing bottle necks exist at the beginning of the VAT operation since that time.

The questions asked and the answers provided by the system are:

are_you_tax_payer:of_the_etiopian_goverment? : yes.

commodity:non_export? : no.

commodity:export? : yes.

custom_declaration:valid? : yes.

bill_of_lodging:valid? : yes.

bank_permit_invoice:valid? : yes.

contractual_agreement:valid? : yes.

¹⁰ still the business name and license number are not disclosed for the privacy purpose

vat_invoice:valid? : yes.

bank_credit_advice:valid? : yes.

fs_report:timly? : yes.

claimed:report_ahead? : yes.

The system advises the tax payer meanwhile for his getting acceptance as it is shown in case 2 above and continues to ask

tax_liability:expected? : yes.

And the final output was “The refund is offset and the remaining should be paid within two months.” This is also identical to the decision made by the experts regardless of the delay in the process of the human expert at the time. Following the decision the system advice the taxpayer for the way how the cash is collected.

Still, among 9 similar historical case test data, the system decision of 8 of them matches with the decision of the human experts. That means for this data types the accuracy is 88%

Case 4: (Sample Arbitrary Case)

Profile of the case: This case involved a VAT refund request of a coffee exporting enterprise called X¹¹ which is established in 02/04/1989 in Addis Ababa and engaged in exporting coffee with the license number Y4. It was registered for VAT at head office of the authority and the VAT certificate was issued on 11/03/2003. For the year 2002 and before, the tax authority had imposed a profit tax which amount a sum total of 1,780.045.36ETB. Almost 100% of their sales transactions were made abroad. Besides, the yearlong contractual agreement with the recipient companies, the customs declarations, lodging tickets, bank permit invoices, bank credit invoice for earned foreign currency and invoices for the paid VAT on purchase are carefully attached. The VAT refund application for the transaction performed in the month of Sep. 2003 which amounts 2,302.046.27ETB is filed on 23/11/2003 with a covering business letter of the enterprises. The enterprise had been submitted his monthly financial reports on time since registration to the refund application

¹¹ still the business name and license number are not disclosed for the privacy purpose

Decision made: The system, after having asked the user for the following question, conclude the refund request is accepted; and out of the requested refund amount 2,302.046.27ETB 1,780.045.36ETB was offset to the tax liability and the remaining 522,000.91 is paid within two months since the application had been made. The comment given by the experts regarding this case is also delayed for a year. Again, the delay was not because of the legal procedure rather it might be because of the bureaucratic and processing bottle necks exist at the beginning of the VAT operation since that time.

The questions asked and the answers provided are:

are_you_tax_payer:of_the_ethiopian_goverment? : yes.

commodity:non_export? : no.

commodity:export? : yes.

custom_declaration:valid? : yes.

bill_of_lodging:valid? : yes.

bank_permit_invoice:valid? : yes.

contractual_agreement:valid? : yes.

vat_invoice:valid? : yes.

bank_credit_advice:valid? : yes.

fs_report:timly? : yes.

claimed:report_ahead? : yes.

Decision: The refund is offset

The system advices the tax payer meanwhile for his getting acceptance as it is shown in case 2 and 3 above and continues to ask

tax_liability:expected? : yes.

And the final output is “The refund is offset and the remaining should be paid within two months.” This is also identical to the decision made by the experts regardless of the delay in the process of the human expert at the time. Following the decision the system advice the taxpayer for the way how the cash is collected.

Still, among 13 arbitrary test data, the system decision of 11 of them matches with the decision of the human experts. That means for this data types the accuracy is 84.6%

Accordingly, a sum total of 40 cases are tested. Finally, we can come up with the agreement of the exhaustiveness of the test not only for the type of data specified above but also to the type and of data they are supposed to be tested.

In addition to the continual vs. summative evaluation, KBS evaluation techniques can also be split into two broad types (Anumba and Scott, 2001), which are: *qualitative* – employing subjective comparisons of performance; and *quantitative*- employing statistical techniques to compare KBS performance against either test cases or human experts.

Most developers employ the use of qualitative techniques such as the common process of running test cases through the proposed system and comparing the system’s output with known results (Moore and Miles, 1991). Quantitative techniques are rarely used and are considered inappropriate for the evaluation of a KBS (Moore and Miles, 1991). This is mainly because these approaches would not normally be used for the evaluation of human expertise.

Predictive validation is one of the most commonly employed qualitative techniques to evaluate KBSs (O’Keefe *et al.*, 1987, Hayes-Roth *et al.*, 1983). The test involves the use of historic test cases. The KBS is driven by past data to obtain a set of conclusions. These conclusions are compared with that of the historic case or with expert performance; and then the performance is judged. This is what we follow in the evaluation process of this research. The summery of the whole evaluation is presented in the confusion matrix shown in the table 4.2 below. The details of the test cases are presented in the table at appendix V.

4.4. The Confusion Matrix

The confusion matrix is a simple square matrix that compares the relative performance of the human and the new system- the match and mismatch. The columns of the matrix correspond to the number of instances by human and the rows correspond to the number of instances by the system as a particular value. For example, using the output presented in table 4.2 we see 3 instances have the result refund rejected (C) by the human whereas they have the result refund paid (D) by the system. The values in the diagonal are the number of instances that are match and those that deviate from the diagonal is the number of instances that are mismatch.

		OUTPUT BY HUMAN EXPERTS					
		A	B	C	D	E	sum
OUTPUT BY VATReAdv	A	7	0	2	0	0	9
	B	0	8	2	0	0	10
	C	0	0	11	0	0	11
	D	0	0	3	7	0	10
	E	0	0	0	0	0	0
	sum	7	8	18	7	0	40

Table 4.2: Confusion matrix that show the result of the experiment

*Key: A=Refund offset, B= Refund carried forward, C= Refund rejected, D= Refund paid, E=Refund Doesn't concern.

From the table 4.2, the performance of the system is computed using the following equation.

The accuracy = No. of matching instances/ Total No. of instances

$$= (AA+BB+CC+DD+EE)/40$$

$$= (7+8+11+7+0)/40=33/40=0.825$$

$$=82.5\%$$

The result shows the system has an accuracy of 82.5%. The remaining 17.5% is the variation between the system and the human experts. Out of the 17.5% the output of the human expert is found to be only '*refund rejected*' whereas the output using the system contain outputs, '*refund offset*', '*refund carried forward*' and '*refund paid*'. The variation happened because of two main reasons. The first one is the trend in the revenue authority regarding VAT refunding is that the experts as well as managers favor for rejection than that of the other results in case where there is some complications or misunderstandings or vague ideas to process a refund.

The other is the new system couldn't work with situation analysis while the human can do. The system narrows down this gap by considering case based reasoning that enable it to learn from past human practices which is not covered in this research.

The system can be maintained and updated only through manual basis by adding new or relevant rules and facts in the knowledge base of the system and by deleting unnecessary or changed rules from the knowledge base. An automatic updating is not considered in this research.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

This study has verified the applicability of KBSs to support VAT administration and the results obtained are promising. In this chapter, a summary of the problems addressed together with preliminary results found and recommendation for future improvements are presented.

5.1. Conclusions

As we can see from result of the experimentation, the performance of the system in terms of explaining result, shortening processes, providing advices and making decision easier is interesting. It is also efficient in terms response time and in using system resources. The system can effectively work with any form of VAT refunding cases specified in the scope of the study. The accuracy with reference to the human expert is shown to be 82.5% which is encouraging.

The intention of the revenue authority in computerizing tax administration and the tax collection procedure focuses mainly on the satisfaction of the tax payers' requirements. This requires changing the administration in such a way that computerizing tax administration system satisfies the two parties by making the work of the authority effective and efficient; and providing fairness, better service and justice to the taxpayer.

The aim of this study is to exploit the applicability of knowledge base system so that it supports the two parties, the tax payer and tax collector, of VAT in counseling and advising based on the VAT law, rules, regulations and directives set by the concerned government bodies of the country. The system described in this study can assist tax payers in matters related to tax and encourage the voluntary submission of accurate tax returns and payments. Moreover it raises the awareness of existing tax payers as well as newly coming investors concerning VAT.

Though the magnitude is different, complaining about VAT is popular all over the globe. Implementation of VAT is highly confronted with resistance from the stakeholders in many countries mainly because of lack of awareness, misunderstanding and misinterpretation of the law (David, 2007). The case is also true in our country. These complaints, unless

clarified properly, may interrupt and discourage the business community. Above all, the level of trust existing between people and their government become painful. In this regard, the study has explored and suggested possible solution for these interrelated problems as tax evasion and avoidance of tax, inadequate tax administration, lack of belongingness (low tax culture) and low public awareness about tax in the best possible manner by making use of the KBS technology.

The system provides advice on requirements, procedures, and goals of VAT refunding in all sectors of the business that perform transactions abroad or at home. The system usability matters can be seen from the point of view of its capability to give solution at point in time when the tax payer or the officer needs a solution to a problem facing regarding VAT refunding.

Using the test data collected on the bases of specificity, frequency of happening, being historical and arbitrary; the results obtained are promising. Based on the results presented in the previous chapter, the following conclusions may be drawn:

- The tacit and explicit knowledge acquired from the various sources encompass essential elements that can be used for system development.
- The rule base knowledge representation is a working technique that enables easy conversion of the knowledge flow models to rules.
- In case when rules and procedures changed or new relevant rules are obtained in the course of action, the maintenance of the rule base is done manually through deleting, modifying and adding rule and facts so that the performance of the system can further be improved continually. However, it is better to investigate further as to how to automatically update the knowledge base.
- Making use of the available infrastructure enables the system reaches remote offices and enhances the effectiveness to consider cases that are not limited in a single branch office.
- The proposed system handles VAT refund related issues. An effective VAT administration system needs to handle challenges related to other VAT related issues like assessment, declaration, invoices management as well as other tax types like turnover tax.

5.2. Recommendations

Although the results of this study are promising, further work needs to be done in order to upgrade the prototype system to a real system. KBS is an appropriate area of studied to solve important problems in the fields of taxation. Using experiences of tax specialists' tacit knowledge, principles of taxation, procedures in taxation and collected cases in taxation as source of knowledge, solving problems and making reasonable decisions by implementing KBS is possible. In this regard, direction for research includes the following.

Development of case based reasoning on taxation is needed in order to take situational analysis in to consideration. Taxation ontology and its application in KBS need to be considered further so that it will ease the task of knowledge engineering. This is also enable the system automatically acquire the tacit and explicit knowledge.

Extending the scope of this research horizontally to other VAT administration issues like assessment, audit, custom cases of VAT, intelligence tasks of VAT; and also vertically to other tax types like turnover, sure tax, withholding tax can be taken as the continuation of this research.

The weakness of the performance of the tax system is because of the interconnected problems as evasion and tax avoidance, deterioration in tax administration, and corruption among others. The study has shown that the tax system is in general neither efficient nor effective. To solve this problem, primarily, tax stakeholders need to have access to information in readily and digestible form. Therefore, promoting further studies on and implementation of systems similar to the prototype shown in this study has the capability to fill the gap in the best possible way.

The usability of a system is well depend on its characteristics like ease of use, ease to learn and the way it encourages the user. The interface design is among the major point raised in connection with the usability. The interface design need to be studied in detail and the design need to integrate natural language processing in order to ease communication in local languages like Amharic, Afan Oromo, Tigrigna and others.

The MIS department of the revenue authority has got various divisions like system administration division, database administration division, software application division, data compilation division. But nowadays, knowledge has been identified as one of the most important resources that contribute to the competitive advantage of an organization.

Therefore, the authority has to pay attention to divisions for the knowledge engineering tasks as well so that the wider use of the knowledge resources has come to be realized and progressive knowledge engineering tasks can be done.

Providing appropriate continual training to make professionals familiar and alert to use the power and potential of KBS and ES technologies is also an important point to be considered ahead to expand systems of this type in the organization.

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Appendix II

Interview Questions that are used to collect information specific to VAT refund.

1. Does the VAT refund applicable in our country? What is the concept and operational procedure behind it?
2. What pre and post conditions are required to get the refunding services?
3. Is there a statutory dead line or and tax holyday or calendar that is applicable for VAT refunding purpose?
4. What are the concepts of the terms: offset, carried forwarded, accepted, rejected and minimum threshold in the context of VAT refunding?
5. Is there a mandatory carried forward period for VAT refund credit?
6. Could VAT refunds be offset against other tax liabilities?
7. Are VAT refunds paid from consolidated VAT revenues or from a budget expenditure items?
8. What risks are there in connection with VAT refund and how they are assessed and managed?
9. What verification schemes are employed prior to the application of refund payment?
10. What information exchanges are made between the tax authority and other institutions like customs centers, banks,...etc. to verify the validity of refunds?
11. How long does it take, in principle and in practice, to process refund claims?
12. What are the major outputs of refund claims in practice? What are their shares in terms of percent of the refund amount and in terms of the number of claims? What percent of the claims in corporate transactions made abroad?
13. How much does the total refund amount on average as a percentage of the gross VAT collected?

Appendix III

Discussion questions that are used to cross validate the information gathered through interview and personal observations. Some part of the discussion is also intended to assess the general structure of the tax authority, the type of links the authority have with other institutions, legal autonyms of the authority. This discussion includes not only experts but also top and middle level managers.

The core points of the discussion¹²

1. Explain the national structure of the tax authority?
2. List the major government, non governmental and private institutions that work together with the tax authority? Explain their work share, how legally they are linked with and their rights and responsibility?
3. How do you explain the procedure followed to process a VAT refund?
4. What major VAT frauds or evasions are frequently observed in the country?
5. What are the investigation, detection, and protecting mechanisms of VAT fraud now employed and/or proposed for the future? What, particularly, is employed for VAT refund related frauds?
6. What specific data's are used to process VAT refund claims?

¹² Questions 1 and 2 used to get additional information whereas questions 3 to 6 used for cross validation

Appendix IV

==== Run information ====

Scheme: weka.associations.PredictiveApriori -N 100 -c -1

Relation: VAT

Instances: 4096

Attributes: 11

Monthly_FS_report
Claimed_amount
Commodity_type
custom_declaration
bill_of_lodging
Bank_permit_invoice
foreign_currency_earned
contract_agreement
liability_deducted_refund_amount_requested
zero_rate_transaction
refund_statuses

==== Associator model (full training set) ====

PredictiveApriori

Best rules found:

1. Monthly_FS_report=timely Commodity_type=nonexport refund_statuses=rejected 256
==> Claimed_amount=notincluded 256 acc:(0.995)
2. Claimed_amount=include Commodity_type=nonexport refund_statuses=rejected 256
==> Monthly_FS_report=late 256 acc:(0.995)
3. Monthly_FS_report=timely Claimed_amount=include refund_statuses=rejected 248 ==>
Commodity_type=export 248 acc:(0.995)
4. refund_statuses=offset 128 ==> Monthly_FS_report=timely Claimed_amount=include
128 acc:(0.99498)
5. refund_statuses=offset 128 ==> Monthly_FS_report=timely
liability_deducted_refund_amount_requested=below50ETB 128 acc:(0.99498)
6. Monthly_FS_report=timely refund_statuses=offset 128 ==> Claimed_amount=include
liability_deducted_refund_amount_requested=below50ETB 128 acc:(0.99498)
7. Commodity_type=nonexport refund_statuses=offset 124 ==> Claimed_amount=include
liability_deducted_refund_amount_requested=below50ETB 124 acc:(0.99498)
8. refund_statuses=paid_in_2month 70 ==> Monthly_FS_report=timely
Claimed_amount=include 70 acc:(0.99492)
9. custom_declaration=valid refund_statuses=offset 68 ==> Claimed_amount=include
liability_deducted_refund_amount_requested=below50ETB 68 acc:(0.99492)
10. bill_of_lodging=valid refund_statuses=offset 68 ==> Claimed_amount=include
liability_deducted_refund_amount_requested=below50ETB 68 acc:(0.99492)
11. Bank_permit_invoice=valid refund_statuses=offset 67 ==> Claimed_amount=include
liability_deducted_refund_amount_requested=below50ETB 67 acc:(0.99492)

12. foreign_currency_earned=valid refund_statuses=offset 67 ==> Claimed_amount=include liability_deducted_refund_amount_requested=below50ETB 67 acc:(0.99492)

13. refund_statuses=carried_forward 66 ==> Monthly_FS_report=timely Claimed_amount=include 66 acc:(0.99491)

14. refund_statuses=carried_forward 66 ==> Monthly_FS_report=timely liability_deducted_refund_amount_requested=above50ETB 66 acc:(0.99491)

15. Monthly_FS_report=timely refund_statuses=carried_forward 66 ==> Claimed_amount=include liability_deducted_refund_amount_requested=above50ETB 66 acc:(0.99491)

16. Monthly_FS_report=timely refund_statuses=carried_forward 66 ==> Claimed_amount=include zero_rate_transaction=belowaforth 66 acc:(0.99491)

17. Claimed_amount=include refund_statuses=carried_forward 66 ==> Monthly_FS_report=timely zero_rate_transaction=belowaforth 66 acc:(0.99491)

18. Claimed_amount=include refund_statuses=carried_forward 66 ==> liability_deducted_refund_amount_requested=above50ETB zero_rate_transaction=belowaforth 66 acc:(0.99491)

19. contract_agreement=valid refund_statuses=offset 66 ==> Claimed_amount=include liability_deducted_refund_amount_requested=below50ETB 66 acc:(0.99491)

20. liability_deducted_refund_amount_requested=above50ETB refund_statuses=carried_forward 66 ==> Monthly_FS_report=timely zero_rate_transaction=belowaforth 66 acc:(0.99491)

21. liability_deducted_refund_amount_requested=above50ETB refund_statuses=carried_forward 66 ==> Claimed_amount=include zero_rate_transaction=belowaforth 66 acc:(0.99491)

22. liability_deducted_refund_amount_requested=above50ETB refund_statuses=paid_in_2month 66 ==> Monthly_FS_report=timely zero_rate_transaction=aboveaforth 66 acc:(0.99491)

23. liability_deducted_refund_amount_requested=above50ETB refund_statuses=paid_in_2month 66 ==> Claimed_amount=include zero_rate_transaction=aboveaforth 66 acc:(0.99491)

24. zero_rate_transaction=belowaforth refund_statuses=carried_forward 66 ==> Claimed_amount=include liability_deducted_refund_amount_requested=above50ETB 66 acc:(0.99491)

25. Commodity_type=nonexport refund_statuses=carried_forward 64 ==> Monthly_FS_report=timely zero_rate_transaction=belowaforth 64 acc:(0.99491)

26. Commodity_type=nonexport refund_statuses=carried_forward 64 ==> Claimed_amount=include liability_deducted_refund_amount_requested=above50ETB 64 acc:(0.99491)

27. zero_rate_transaction=aboveaforth refund_statuses=offset 64 ==> Claimed_amount=include liability_deducted_refund_amount_requested=below50ETB 64 acc:(0.99491)

28. zero_rate_transaction=belowaforth refund_statuses=offset 64 ==> Claimed_amount=include liability_deducted_refund_amount_requested=below50ETB 64 acc:(0.99491)

29. Monthly_FS_report=timely Commodity_type=nonexport refund_statuses=carried_forward 64 ==> liability_deducted_refund_amount_requested=above50ETB zero_rate_transaction=belowaforth 64 acc:(0.99491)

30. contract_agreement=invalid refund_statuses=offset 62 ==> Monthly_FS_report=timely Commodity_type=nonexport 62 acc:(0.99491)

31. contract_agreement=invalid refund_statuses=offset 62 ==> Claimed_amount=include
Commodity_type=nonexport 62 acc:(0.9949)

32. Monthly_FS_report=timely contract_agreement=invalid refund_statuses=offset 62 ==>
Commodity_type=nonexport liability_deducted_refund_amount_requested=below50ETB
62 acc:(0.9949)

33. Claimed_amount=include contract_agreement=invalid refund_statuses=offset 62 ==>
Commodity_type=nonexport liability_deducted_refund_amount_requested=below50ETB
62 acc:(0.9949)

34. Bank_permit_invoice=invalid refund_statuses=offset 61 ==>
Monthly_FS_report=timely Commodity_type=nonexport 61 acc:(0.9949)

35. Bank_permit_invoice=invalid refund_statuses=offset 61 ==> Claimed_amount=include
Commodity_type=nonexport 61 acc:(0.9949)

36. foreign_currency_earned=invalid refund_statuses=offset 61 ==>
Monthly_FS_report=timely Commodity_type=nonexport 61 acc:(0.9949)

37. foreign_currency_earned=invalid refund_statuses=offset 61 ==>
Claimed_amount=include Commodity_type=nonexport 61 acc:(0.9949)

38. Monthly_FS_report=timely Bank_permit_invoice=invalid refund_statuses=offset 61
==> Commodity_type=nonexport
liability_deducted_refund_amount_requested=below50ETB 61 acc:(0.9949)

39. Monthly_FS_report=timely foreign_currency_earned=invalid refund_statuses=offset 61
==> Commodity_type=nonexport
liability_deducted_refund_amount_requested=below50ETB 61 acc:(0.9949)

40. Claimed_amount=include Bank_permit_invoice=invalid refund_statuses=offset 61 ==>
Commodity_type=nonexport liability_deducted_refund_amount_requested=below50ETB
61 acc:(0.9949)

41. Claimed_amount=include foreign_currency_earned=invalid refund_statuses=offset 61
==> Commodity_type=nonexport
liability_deducted_refund_amount_requested=below50ETB 61 acc:(0.9949)

42. custom_declaration=invalid refund_statuses=offset 60 ==> Monthly_FS_report=timely
Commodity_type=nonexport 60 acc:(0.9949)

43. custom_declaration=invalid refund_statuses=offset 60 ==> Claimed_amount=include
Commodity_type=nonexport 60 acc:(0.9949)

44. bill_of_lodging=invalid refund_statuses=offset 60 ==> Monthly_FS_report=timely
Commodity_type=nonexport 60 acc:(0.9949)

45. bill_of_lodging=invalid refund_statuses=offset 60 ==> Claimed_amount=include
Commodity_type=nonexport 60 acc:(0.9949)

46. Monthly_FS_report=timely custom_declaration=invalid refund_statuses=offset 60 ==>
Commodity_type=nonexport liability_deducted_refund_amount_requested=below50ETB
60 acc:(0.9949)

47. Monthly_FS_report=timely bill_of_lodging=invalid refund_statuses=offset 60 ==>
Commodity_type=nonexport liability_deducted_refund_amount_requested=below50ETB
60 acc:(0.9949)

48. Claimed_amount=include custom_declaration=invalid refund_statuses=offset 60 ==>
Commodity_type=nonexport liability_deducted_refund_amount_requested=below50ETB
60 acc:(0.9949)

49. Claimed_amount=include bill_of_lodging=invalid refund_statuses=offset 60 ==>
Commodity_type=nonexport liability_deducted_refund_amount_requested=below50ETB
60 acc:(0.9949)

50. custom_declaration=invalid refund_statuses=paid_in_2month 36 ==>
Monthly_FS_report=timely Commodity_type=nonexport 36 acc:(0.99467)

51. custom_declaration=invalid refund_statuses=paid_in_2month 36 ==>
 Claimed_amount=include Commodity_type=nonexport 36 acc:(0.99467)

52. bill_of_lodging=invalid refund_statuses=paid_in_2month 36 ==>
 Monthly_FS_report=timely Commodity_type=nonexport 36 acc:(0.99467)

53. bill_of_lodging=invalid refund_statuses=paid_in_2month 36 ==>
 Claimed_amount=include Commodity_type=nonexport 36 acc:(0.99467)

54. Bank_permit_invoice=valid refund_statuses=paid_in_2month 35 ==>
 Monthly_FS_report=timely zero_rate_transaction=aboveaforth 35 acc:(0.99464)

55. Bank_permit_invoice=valid refund_statuses=paid_in_2month 35 ==>
 Claimed_amount=include zero_rate_transaction=aboveaforth 35 acc:(0.99464)

56. Bank_permit_invoice=invalid refund_statuses=paid_in_2month 35 ==>
 Monthly_FS_report=timely Commodity_type=nonexport 35 acc:(0.99464)

57. Bank_permit_invoice=invalid refund_statuses=paid_in_2month 35 ==>
 Claimed_amount=include Commodity_type=nonexport 35 acc:(0.99464)

58. forign_currency_earned=invalid refund_statuses=paid_in_2month 35 ==>
 Monthly_FS_report=timely Commodity_type=nonexport 35 acc:(0.99464)

59. forign_currency_earned=invalid refund_statuses=paid_in_2month 35 ==>
 Claimed_amount=include Commodity_type=nonexport 35 acc:(0.99464)

60. custom_declaration=valid refund_statuses=carried_forward 34 ==>
 Monthly_FS_report=timely zero_rate_transaction=belowaforth 34 acc:(0.99462)

61. custom_declaration=valid refund_statuses=carried_forward 34 ==>
 Claimed_amount=include liability_deducted_refund_amount_requested=above50ETB 34
 acc:(0.99462)

62. custom_declaration=valid refund_statuses=paid_in_2month 34 ==>
 Monthly_FS_report=timely zero_rate_transaction=aboveaforth 34 acc:(0.99462)

63. custom_declaration=valid refund_statuses=paid_in_2month 34 ==>
 Monthly_FS_report=timely liability_deducted_refund_amount_requested=above50ETB 34
 acc:(0.99462)

64. bill_of_lodging=valid refund_statuses=carried_forward 34 ==>
 Monthly_FS_report=timely zero_rate_transaction=belowaforth 34 acc:(0.99462)

65. bill_of_lodging=valid refund_statuses=carried_forward 34 ==>
 Claimed_amount=include liability_deducted_refund_amount_requested=above50ETB 34
 acc:(0.99462)

66. bill_of_lodging=valid refund_statuses=paid_in_2month 34 ==>
 Monthly_FS_report=timely zero_rate_transaction=aboveaforth 34 acc:(0.99462)

67. bill_of_lodging=valid refund_statuses=paid_in_2month 34 ==>
 Monthly_FS_report=timely liability_deducted_refund_amount_requested=above50ETB 34
 acc:(0.99462)

68. Bank_permit_invoice=valid refund_statuses=carried_forward 34 ==>
 Monthly_FS_report=timely zero_rate_transaction=belowaforth 34 acc:(0.99462)

69. Bank_permit_invoice=valid refund_statuses=carried_forward 34 ==>
 Claimed_amount=include liability_deducted_refund_amount_requested=above50ETB 34
 acc:(0.99462)

70. forign_currency_earned=valid refund_statuses=carried_forward 34 ==>
 Monthly_FS_report=timely zero_rate_transaction=belowaforth 34 acc:(0.99462)

71. forign_currency_earned=valid refund_statuses=carried_forward 34 ==>
 Claimed_amount=include liability_deducted_refund_amount_requested=above50ETB 34
 acc:(0.99462)

72. contract_agreement=valid refund_statuses=carried_forward 34 ==>
 Monthly_FS_report=timely zero_rate_transaction=belowaforth 34 acc:(0.99462)

73. contract_agreement=valid refund_statuses=carried_forward 34 ==>
 Claimed_amount=include liability_deducted_refund_amount_requested=above50ETB 34
 acc:(0.99462)

74. contract_agreement=invalid refund_statuses=paid_in_2month 34 ==>
 Monthly_FS_report=timely Commodity_type=nonexport 34 acc:(0.99462)

75. contract_agreement=invalid refund_statuses=paid_in_2month 34 ==>
 Claimed_amount=include Commodity_type=nonexport 34 acc:(0.99462)

76. Monthly_FS_report=timely custom_declaration=valid refund_statuses=carried_forward
 34 ==> liability_deducted_refund_amount_requested=above50ETB
 zero_rate_transaction=belowaforth 34 acc:(0.99462)

77. Monthly_FS_report=timely custom_declaration=valid refund_statuses=paid_in_2month
 34 ==> Claimed_amount=include
 liability_deducted_refund_amount_requested=above50ETB 34 acc:(0.99462)

78. Monthly_FS_report=timely custom_declaration=valid refund_statuses=paid_in_2month
 34 ==> Claimed_amount=include zero_rate_transaction=aboveaforth 34 acc:(0.99462)

79. Monthly_FS_report=timely bill_of_lodging=valid refund_statuses=carried_forward 34
 ==> liability_deducted_refund_amount_requested=above50ETB
 zero_rate_transaction=belowaforth 34 acc:(0.99462)

80. Monthly_FS_report=timely bill_of_lodging=valid refund_statuses=paid_in_2month 34
 ==> Claimed_amount=include liability_deducted_refund_amount_requested=above50ETB
 34 acc:(0.99462)

81. Monthly_FS_report=timely bill_of_lodging=valid refund_statuses=paid_in_2month 34
 ==> Claimed_amount=include zero_rate_transaction=aboveaforth 34 acc:(0.99462)

82. Monthly_FS_report=timely Bank_permit_invoice=valid
 refund_statuses=carried_forward 34 ==>
 liability_deducted_refund_amount_requested=above50ETB
 zero_rate_transaction=belowaforth 34 acc:(0.99462)

83. Monthly_FS_report=timely forign_currency_earned=valid
 refund_statuses=carried_forward 34 ==>
 liability_deducted_refund_amount_requested=above50ETB
 zero_rate_transaction=belowaforth 34 acc:(0.99462)

84. forign_currency_earned=valid zero_rate_transaction=aboveaforth
 refund_statuses=paid_in_2month 34 ==>
 liability_deducted_refund_amount_requested=above50ETB 34 acc:(0.99462)

85. custom_declaration=invalid refund_statuses=carried_forward 32 ==>
 Monthly_FS_report=timely zero_rate_transaction=belowaforth 32 acc:(0.99456)

86. custom_declaration=invalid refund_statuses=carried_forward 32 ==>
 Monthly_FS_report=timely Commodity_type=nonexport 32 acc:(0.99456)

87. bill_of_lodging=invalid refund_statuses=carried_forward 32 ==>
 Monthly_FS_report=timely zero_rate_transaction=belowaforth 32 acc:(0.99456)

88. bill_of_lodging=invalid refund_statuses=carried_forward 32 ==>
 Monthly_FS_report=timely Commodity_type=nonexport 32 acc:(0.99456)

89. Bank_permit_invoice=invalid refund_statuses=carried_forward 32 ==>
 Monthly_FS_report=timely zero_rate_transaction=belowaforth 32 acc:(0.99456)

90. Bank_permit_invoice=invalid refund_statuses=carried_forward 32 ==>
 Monthly_FS_report=timely Commodity_type=nonexport 32 acc:(0.99456)

91. forign_currency_earned=invalid refund_statuses=carried_forward 32 ==>
 Monthly_FS_report=timely zero_rate_transaction=belowaforth 32 acc:(0.99456)

92. forign_currency_earned=invalid refund_statuses=carried_forward 32 ==>
 Monthly_FS_report=timely Commodity_type=nonexport 32 acc:(0.99456)

93. contract_agreement=invalid refund_status=carried_forward 32 ==>
Monthly_FS_report=timely zero_rate_transaction=belowaforth 32 acc:(0.99456)
94. contract_agreement=invalid refund_status=carried_forward 32 ==>
Monthly_FS_report=timely Commodity_type=nonexport 32 acc:(0.99456)
95. Bank_permit_invoice=valid foreign_currency_earned=valid
refund_status=paid_in_2month 18 ==>
liability_deducted_refund_amount_requested=above50ETB 18 acc:(0.9934)
96. Bank_permit_invoice=valid contract_agreement=valid
refund_status=paid_in_2month 18 ==>
liability_deducted_refund_amount_requested=above50ETB 18 acc:(0.9934)
97. Monthly_FS_report=timely foreign_currency_earned=invalid contract_agreement=valid
refund_status=paid_in_2month 17 ==> zero_rate_transaction=aboveaforth 17
acc:(0.99319)
98. Claimed_amount=include foreign_currency_earned=invalid contract_agreement=valid
refund_status=paid_in_2month 17 ==> zero_rate_transaction=aboveaforth 17
acc:(0.99319)
99. Commodity_type=nonexport foreign_currency_earned=invalid
contract_agreement=valid refund_status=paid_in_2month 17 ==>
zero_rate_transaction=aboveaforth 17 acc:(0.99319)
100. Monthly_FS_report=timely Claimed_amount=include Commodity_type=nonexport
Bank_permit_invoice=valid zero_rate_transaction=aboveaforth
refund_status=paid_in_2month 33 ==>
liability_deducted_refund_amount_requested=above50ETB 32 acc:(0.98886)

Appendix V

Case no.	Business type ¹³	Address	System output	Human output	Match
1	Construction	Head office	offset	offset	√
2	Coffee	Head office	carried forward	carried forward	√
3	electronics	Head office	paid	rejected	×
4	Hotel	Head office	offset	offset	√
5	Jewelry	Head office	carried forward	carried forward	√
6	Leather	Head office	paid	paid	√
7	Coffee supply	Awassa	rejected	rejected	√
8	Whole sale	Awassa	carried forward	carried forward	√
9	Const. materials	Awassa	carried forward	rejected	×
10	Construction	Awassa	offset	offset	√
11	Spare part	Lafto	rejected	rejected	√
12	House & off. Eq.	Lafto	rejected	rejected	√
13	Garage	Lafto	carried forward	carried forward	√
14	Const. materials	Lafto	offset	rejected	×
15	Comp. & acc.	Bole	offset	offset	√
16	Restaurant	Bole	carried forward	carried forward	√
17	Hotel	Bole	rejected	rejected	√
18	House renting	Bole	offset	offset	√
19	Comp. & acc.	Bole	carried forward	carried forward	√
20	Const. materials	Kolfekeranio	paid	rejected	×
21	House & off. Eq.	Kolfekeranio	rejected	rejected	√
22	Whole sale	Kolfekeranio	carried forward	carried forward	√
23	Const. materials	Kolfekeranio	paid	paid	√
24	electronics	Arada	rejected	rejected	√
25	Jewelry	Arada	carried forward	rejected	×
26	House renting	Arada	carried forward	carried forward	√
27	Restaurant	Arada	rejected	rejected	√
28	Coffee supply	Awassa	paid	paid	√
29	Whole sale	Awassa	rejected	rejected	√
30	Const. materials	Awassa	carried forward	carried forward	√
31	Construction	Awassa	paid	rejected	×
32	Spare part	Lafto	offset	offset	√
33	House & off. Eq.	Lafto	rejected	rejected	√
34	Garage	Lafto	paid	paid	√
35	Hotel	Bole	offset	offset	√
36	House renting	Bole	rejected	rejected	√
37	Comp. & acc.	Bole	paid	paid	√
38	Const. materials	Kolfekeranio	rejected	rejected	√
39	House & off. Eq.	Kolfekeranio	offset	rejected	×
40	Whole sale	Kolfekeranio	paid	paid	√

***Key:** √ - mark show exact match whereas
 × - mark show discrepancy

¹³ Sole proprietor, PLC. and partnership combinations are their.

The confusion matrix

		OUTPUT BY HUMAN EXPERTS					
		A	B	C	D	E	sum
OUTPUT BY VATReAdv	A	7	0	2	0	0	9
	B	0	8	2	0	0	10
	C	0	0	11	0	0	11
	D	0	0	3	7	0	10
	E	0	0	0	0	0	0
	sum	7	8	18	7	0	40

Table 4.2: confusion matrix that show the result of the experiment

Key: A=Refund offset, B= Refund carried forward, C= Refund rejected, D= Refund paid, E=Refund Doesn't concern.

The accuracy = No. of matching instances/ Total No. of instances

$$= (AA+BB+CC+DD+EE)/40$$

$$= (7+8+11+7+0)/40=33/40=0.825$$

$$=82.5\%$$

Appendix VI

Sample Prolog Code

```
%.....
%greeting :-
%write(' Wel-come to VATReAdv-a VAT Refund advicing KBS %System. '),nl,nl.
%.....
top_goal(X),nl,nl,
write('The refund is '), write(X), nl.
solve :-nl,nl,
write('Well! come back any time when necessary. '),nl,nl.
top_goal(X):-nl,nl,tax_payer,nl,
write(' To answer for each question write only either "yes" or "no" then "." and press
"enter" Ok!'),nl,nl,
are_you_tax_payer(of_the_ethiopian_goverment),nl,nl,refund(X),nl.
top_goal(X):-are_you_in_need_of(vat_refund_awareness),refund(X),nl.
refund(offset):-
    refund1(accepted),
    tax_liability(expected),advice(offset).
refund(carried_forward):-
    refund1(accepted),
    does_your_refund(above_50ETB),
    zero_rate(below_a_forth),advice(carried_forward).
refund(in_2month):-refund1(accepted),
    does_your_refund(above_50ETB),
    zero_rate(above_a_forth),
    tax_liability(not_expected),
    advice(in_2month).
refund(rejected):-
    fs_report(late);
    claimed(not_report_ahead);
    document(incomplete),
    advice(rejected).
refund1(accepted):-
```

commodity(export),
document(complete),
fs_report(timly),
claimed(report_ahead),advice(accepted).
ent(complete):-custom_declaration(valid),
bill_of_lodging(valid),
bank_permit_invoice(valid),
contractual_agreement(valid),
vat_invoice(valid),
bank_credit_advice(valid).

ayer:-

l,write('this is a tax.....'),nl.
e(offset):-nl,write('advice offset.....'),nl.
e(accepted):-nl,write('advice accepted for acceptance.....'),nl.
e(carried_forward):-nl,write('advice carried_forward.....'),nl.
e(in_2month):-nl,write('advice in_2month.....'),nl.
e(rejected):-nl,write('advice rejected.....'),nl.
modity(X):-ask(commodity,X).
valued(fs_report).
valued(claimed).
valued(zero_rate).
valued(tax_liability).
valued(commodity).