



ADDIS ABABA UNIVERSITY  
SCHOOL OF GRADUATE STUDIES

WEB-BASED LEGAL DECISION SUPPORT EXPERT SYSTEM: THE CASE  
OF ETHIOPIA

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## List of Acronyms

API	Application Programing Interface
ANN	Artificial Neural Network
CBR	Case Knowledge Base
ES	Expert System
HTML	Hyper Text Markup Language
IE	Inference Engine
IKBALS	Intelligent Knowledge Based Legal System
KB	Knowledge Base
KBES	Knowledge Based Expert System
KBS	Knowledge-Based System
LDSES	Legal Decision Support Expert System
LESTER	Legal Expert System for Termination of Employment Review
NN	Neural Network
OPINE	Office Practice INquiry Expert
RBR	Rule Based Reasoning
SAX	The Simple API for XML
UI	User Interface
VAT	Value Added Tax
XML	Extensible Markup Language
W3C	World Wide Web Consortium

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## ABSTRACT

Addressing legal information scarcity of the society is the major issue in guardianship of the rule of law. Legal documents play a basic role in discharging the law to the public besides constituting learning material for student, researchers and legal practitioners. Unless the legal documents present on the web is structured properly and efficient information retrieval method is used, accumulation of information merely cannot be a solution for legal information scarcity.

If the legal information on the web is structured using XML, it will be very easy to retrieve a specific information from a large set of documents. If the user doesn't have prior legal knowledge, the user may be in problem of how to formulate a query, and how to select the best information from the retrieved set of results and how to use that information. In addition, how to combine the pieces of information to make a decision is still an annoyance for a nonprofessional person. Thus, there should be a human legal expert to assist the user on how to use the legal information to make a better legal decision, on certain legal matters.

The computerized solution to address the above problem, and to assist legal decision making processes, without the involvement of a human legal expert, is to develop Legal Decision Support Expert System (LDSES). Therefore, this work is to develop LDSES in family law for the case of Ethiopia. We used Rule Based Reasoning methodology of Expert System (ES) to develop the LDSES. We made a discussion with the human legal expert and we reviewed the Ethiopian revised family code to collect the domain knowledge and then to develop the LDSES knowledge base.

The general Architecture of ES has been used with some modification. We added a component called *LDSES\_Preprocessor* on the general architecture of ES. We established a logic flow chart to develop and test the knowledge base. The *LDSES\_Preprocessor* component helps to minimize the time the system has consumed in order to scan the large set of rules from the knowledge base. The overall performance of the proposed LDSES from summary of validation report is 87.6%. And the legal information provided by the proposed model of LDSES for making a legal decision is about 96% effective.

**Keywords:** Legal decision support expert system model, Legal expert system, Expert system model, Decision support system model, Decision support system.

## CHAPTER ONE

### INTRODUCTION

Information technology is expanding to serve more domains, such as Medicine, Production Companies (like Garment factories, automotive factories, Food Processing industries and etc.), Military, Hospitals, and so on, which are some of the examples whose day to day procedures are highly supported by information technology. Progress in information technology is continuous. Activities of human beings which were believed as they cannot be supplanted by machine a few years ago now become possible. It is now the time for machines that are going to replace human beings as machine started to have feelings, think logically, respond to natural changes, learn from the previous experience like humans and involved in the areas that are left for human beings only, like surgery e.g. Da Vinci Surgical Robot [21]. But machines have one very important characteristic that makes them super unique than human beings, that is, they never forget and bored which human beings lack such a quality.

An Expert System (ES) is a program made up of a set of rules that analyzes information, usually supplied by the user of the system, as well as provides analysis of the problem(s), and, depending upon their design, provides a recommended course of user action in order to implement corrections. An expert system can be thought as an alternative to the human expert. It is the technology of replacing human expert with the electronic one. Simulation of the expertise human possesses can be achieved with the use of artificial intelligence techniques. Because artificial intelligence is a recent evolutionary concept in the history of computer science, it is on developing. Researchers pay much attention in developing this science. For example, MYCIN [38] system was designed as a consultation system for the diagnosis and treatment of infectious blood diseases. The domain knowledge in MYCIN is represented strictly as a database of rules, which is interpreted by a general inference procedure.

Using the concept of Artificial Intelligence (AI), so many applications have been developed. We can take the “Da Vinci Surgeon Robot” [21] as an example. It is an artificial surgeon Doctor that performs a surgical operation like the human surgeon doctor, but with more reliability and precision. Even though this science is expanding for the designing of expert system, the depth it goes in replacing human expert in legal matters is not deep yet. Not many researches have been

done on the feasibility, appropriateness, and potential problems of applying ES to legal matters [85]. It will be necessary to conduct more researches on the legal professional's judgment process, and an examination of the task characteristics of the judgment process in legal issues and a better understanding of the legal professional's expertise will be required in the designing of legal expert system.

A legal expert system is a domain specific expert system that uses artificial intelligence to emulate the decision making abilities of human expert in the field of law. A legal expert system employs a rule base (knowledge base) and an inference engine to accumulate reference and produce expert knowledge on specific subject within the legal domain. A legal expert system is a system that contains the same knowledge of particular legal domain as human expert has. Thus, according to the classification of legal knowledge, such as (Criminal law and Civil law i.e. labor law, property law, marital law, contract law, etc.), there can be various categories of expert systems, as well. The pieces of information have to be connected to each other so that the system can reason like human expert does. It also makes it possible for the system to reason on a particular case by referring to legal sources it used. An expert system in law is applied not in decision making but in decision support. The information provided by the system is always subjected to the evaluation of the user who can accept it or not.

## **1.1 Motivation**

Information is a key to any institution and any individual to make life better. Because of information deficiency, a company may arrive at false pronouncement which latter brings a bankruptcy and shuts down of the business. Besides, individuals who have right information for certain issues, before they arrive at any decision are more successful than those individuals who have little or no information. Every successful company has sufficient information about their business and customers.

As information is a key to make life better in any field, it is true for legal departments, too. The societies who have legal information lead a significant nonviolent life better than those who don't have. Therefore, to keep the prevalence of law, it is not a best solution to make the number of first instance or higher courts more. Rather, it makes sense if governments try to invest in creating legal awareness of the societies. The reason why developed countries relatively lead an

unruffled life better than the developing countries is the difference of legal awareness of the societies. The reason why, most countries included civic and ethical education as a subject like math, science in their national education curriculum is to create legal responsive citizen and to create a better living nation.

The other alternative to create legal responsive citizen may be to make legal documents available when it is needed. It enables the society to be aware of which act is legal and which one is illegal. For such purposes, the Internet plays a major role.

In most legal traditional activities, legal processes are characterized by the presence of paper documents that have to be properly managed, processed, archived and prepared for long term preservation. Legal documents play an important role in all legal activities. In particular, they serve as efficient media to transmit the legal knowledge to the society. Moreover, they form an important body of a learning material for students, researchers and legal practitioners.

Legal document databases and repositories are increasingly accessible via web portals that are maintained by public or private institutions. Search engines and legal document retrieval systems are being developed and are increasingly considered as primary means for satisfying legal information needs. This kind of information is usually searched and accessed by means of full text search: almost every term in the text of the document can function as a search key. In this specific searching paradigm, users formulate and submit queries that are composed of one or several search terms and documents that contain the query terms which are retrieved and possibly ranked according to the relevance to the query. In addition to this, in the effort to make searching more effective in terms of user satisfaction, searching techniques can be carried out by selecting documents based on the descriptors attached to them which reflect, for example, the domain of the law, subject, title, the institution that issued the document and etc. Thus, in the internal data structure of legal information retrieval systems, legal documents are indexed with the terms that occur in their natural language texts and with some extra descriptive data called metadata.

There are several ways being experimented and implemented to improve the search technology for retrieving legal documents. Legal documents typically combine structured and unstructured information. The former, for instance, constitutes common document architecture and

organization, reference structure and metadata information, while the latter is totally characterized by inclusion of natural language texts that express and reveal the law being discharged. The structured parts of legal documents are being tagged with markup language such as XML (Extensible Markup Language) and following this approach there is a current trend in information retrieval techniques to integrate the structured information of legal documents (as marked by XML) when computing the relevance ranking of these documents to information query. The use of document structure allows in generating a more precise answer to legal information query. That means, instead of returning the complete legal document content as an answer, a structured element or several elements can be presented as a best match for information needs. Such approach is claimed to meet the current need of users of the legal document retrieval systems, who demand more precise and short results to their information queries. This retrieval strategy is believed to bring particular benefits for getting a precise and accurate result from information repositories containing long documents, or documents covering a wide variety of topics (such as legal documents), where the user's effort to locate significant content within a document can be reduced by directing them to the most relevant parts of the document. It has been observed from literature that this approach of information retrieval is best for legal domain documents [1, 2, 3].

Even though the cumulative amount of legal document databases have an impact to flourish legal information to anyone who pursues it, it should be supplemented with the best information retrieval mechanism to address the issue properly. The intention of all information retrieval paradigms is to help users to filter out the information they require in the most precise and accurate way from large sets of documents. The accuracy and precision are determined by the matching of the retrieved result with the users query; not by how much the information they retrieved is essential for making a better decision. Unless the user knows how to exactly represent the information he/she needs as a query, the result of any searching operation may not be valuable for decision making as intended. Having much electronic legal information databases and best search strategy make the legal aspect to move one step forward for addressing the legal information scarcity of the people. Still there is a draw back if the user doesn't have knowledge of how to represent what he/she needs as a descriptive query for searching.

This draw back motivated us to think of addressing the problem of legal information accessibility. By having a legal decision support expert system (which is a type of expert system), we can address the legal information shortage to the society at anytime and anywhere without requiring a human legal expert. And from literature that we reviewed, we are convinced developing legal expert system is a good solution to help anybody to get a real advise to arrive at a better decision, and thus this in turn brings the prevalence of law, the uniformity of decisions made by judges, and legal information accessibility can be achieved in a better way than having more advanced legal information retrieval strategy [4, 5, 6].

## **1.2 Statement of the problem**

A reliable information access is always a fuel for making the best decision. Because of shortage of legal information, the people's right is always undermined by the other person. The courts will make a decision which is far from the reality because either the plaintive or the defendant has lack of legal knowledge and therefore either the plaintive has not properly stated the truth, or the defendant will not defend in the way that can make the plaintive claim unacceptable.

Up to now, there is no system developed for Ethiopian case that can help the users for making a legal decision. Even if there are systems that are developed outside Ethiopia, because of local differences of law, those developed systems will not be usable for other countries, except in the country where the systems are developed.

In the existing legal issues of Ethiopia, as there is no system that creates a legal awareness for the citizen or that hones the legal knowledge of the human legal experts,

- There is lack of commonality in interpreting the law. As a result, for similar cases different decisions may be made. Then, because of this, there is always a chain of appeal from first instance court to high court, from high court to Supreme Court. And sometimes the decision made by the lower court may be modified or may totally be rejected by the upper court.
- There is a delay in decision making of most simple cases. This may happen because either the plaintive is not able to represent the truth as the legal procedure commands so it

takes time to make correction according to the procedure or the defendant can't defend in the right way. This will consume the time of both the court and the user.

- The lawyer that we sometime consult may not have enough knowledge on the issue that we are asking him/her for advice. Therefore, the lawyer may not give us immediate advice or the advice he/she may give us will not be accepted by the court.
- The persons who bring the case to the court may not have economic potential to pay for a lawyer for consultation. So, they may lack information of how their case can be viewed according to the law. Therefore, they may consume the time and resource of the court and themselves if the case they are presenting is invalid.
- If we need advisory from human legal expertise, the consultation we get sometimes may be different depending upon the staff that we are asking for consultation. The expertise knowledge is dependent on his/her experiences.
- It is sometimes financially costly to consult a lawyer.

So, having a legal expert system will have a potential to solve the above stated problems by giving automated and uniform consultation of the users. For example, if a plaintiff needs a judgment on some cases before he/she presents the case to the court, it is possible to get some consultation on how the case should be presented and the system forecasts what the final decision looks like by asking the user to provide the answer of some smart questions generated by the system according to the case.

### **1.3 Objectives**

#### **General objective**

The general objective of this research is:-

- To develop a web based legal decision support expert system that provides legal consultation and decision support service on selected category for the case of Ethiopia.

## **Specific objectives**

To arrive at the general objective of this work, the following specific objectives should be met.

- Explore the related work in the designing of legal expert system.
- Identify the methodology and tools to design legal expert system.
- Select a specific law category in the Ethiopian law case, which we can demonstrate the model of legal decision support expert system.
- Design the legal decision support expert system on the selected law category.
- Implement the legal decision support expert system
- Test and Validate implementation the legal decision support expert system model.

### **1.4 Scope and limitation of the study**

- The primary concern of this thesis is to develop a legal decision support expert system on selected category of law for the case of Ethiopia.
- Even though there are different categories of law like criminal law and civil law (property law, labor law, contract law and etc.), this work is limited to develop an expert system that provides decision support and advisory service on Civil law for the case of Ethiopia.
- In the federal legal system of Ethiopia, the codes are in two versions (Amharic and English). Because of time constraints, we develop the Legal Decision Support Expert System (LDSES) only for the English version of the code.
- We couldn't integrate the NLP technique, to analyze the user queries.

## **1.5 Methodology**

In order to meet the general objective of the study, different methodologies are applied. The methodologies that are functional are presented below.

### **1.5.1 Literature review**

In order to have a better understanding of expert system in general and the legal expert system in particular, and the domain area -law, a number of literature and articles will be reviewed.

### **1.5.2 Tools**

A number of expert system shells for developing the Legal Decision Support Expert System (LDSES) were studied. JESS, LISP, Visual Prolog and E2gRule Engine are among those studied expert system shells. LISP and Visual Prolog are for stand-alone version. Therefore both are not important for the purpose of developing web based expert systems. JESS and E2gRuleEngine which are both java platform expert system shells and both can be integrated on the web. But JESS is a licensed expert system and E2gRuleEngine is an open source. Therefore, E2gRuleEngine as an expert system shell was selected for the proposed model of LDSES. In addition, ASP.NET and C# Programming language were used as a major development tool for prototyping the proposed web based legal decision support expert system.

### **1.5.3 Data collection**

Interview and discussion with a legal expert and legal document analysis were the two principal techniques that were used in order to get sufficient information about the domain area-law. Through interview and discussion, it was intended to get sufficient notions on how the legal experts interact with their customers, what major questions they are raising before any advice or suggestion, how they are interpreting the law and how they are relating the customers' case with the legal codes.

Through document analysis, it was tried to get the proclamation, statute and rule which any legal experts are referring when they are unable to memorize it. After that, those proclamation, regulation and statute were formalized into sets of rule to develop a knowledge base that the proposed expert systems are using for advising the user.

#### 1.5.4 Validation

To evaluate the system, two groups were established. The first group contained six legal experts (two judges, two attorneys and two law school lecturers of Debre Birhan University). The second group contained four non-legal experts who don't have prior legal knowledge, but they can read and understand English. Then, the result of the group's evaluation was summarized.

### 1.6 Application of the result

The final result of this work is to produce an expert system that can provide a decision support in legal matters. The following users of the system can get advantage from the proposed legal expert system:

- **Judges** can consult the expert system about some cases according to the Ethiopian law before they are giving final decision.
- **Students of law school** can use this legal expert system to study how cases can be seen in law by providing some cases and get the final advice.
- **Lawyers** could sharpen their skills and develop better solutions for their cases
- **Any person** can use this expert system to know more about the case he/she might/may confront. This will have a benefit for both the case holder and the court for:
  - Speedier delivery of legal advice.
  - Reducing the time spent in repetitive, labor intensive legal tasks.
  - The development of knowledge management techniques that was not dependent on staff.
  - Reducing the overhead and labor costs and higher profitability for law firms.
  - Reducing fees to get legal consultation.
  - Increasing productivity of the court.
  - Reducing dependence on human expertise.
  - Potential savings in staff overheads

## **1.7 Thesis organization**

The rest of the thesis is organized as follows. Chapter Two is about literature review which discusses the general background of the law. Understanding the general background of the law enables us to grasp some basic ideas about the domain of this research area. Moreover, it contains how the legal information can be presented on the web. For this purpose, XML representation and XML IR systems are discussed. In addition, in Chapter Two, an expert system is defined, the purpose of expert system is explained, and the legal expert systems development challenges are covered. Chapter Three presents different types of related works that are attempted to develop a legal decision support system using different methodologies. The Rule Based Reasoning and Case Based Reasoning, and the legal expert system examples developed using these methodologies are discussed under this chapter. Chapter Four presents the design of web based legal decision support expert system. In Chapter Five, the implementation of the web based legal decision support expert system is discussed. Under Chapter Six, the evaluation of the proposed system is discussed, and finally, Chapter Seven concludes the thesis by outlining the contributions of this work and forwarding some directions for future research.

## CHAPTER TWO

### LITERATURE REVIEW

In this chapter, the theoretical background of law, XML document structuring techniques and the expert system in general are presented. The first part presents the definition, classification and source of the law. The legal system of Ethiopia and the hierarchical structure of the country's legislative bodies over a certain period of time are discussed. The second part describes the XML document structuring techniques for efficient textual information retrieval mechanisms. The third part of this chapter, on the other hand, presents definition and histories of expert system and its evolution, different examples of expert system, the different techniques and principles behind the designing of expert system in general and the legal expert system in particular, what makes legal expert system more difficult than the other types of expert and how to handle those difficulties are discussed.

#### **2.1 The philosophy behind law**

It is possible to describe law as the body of official rules and regulations, generally found in constitutions, legislation, judicial opinions, and the like, that is used to govern a society and to control the behavior of its members. So, law is a formal mechanism of social control. Legal systems are particular ways of establishing and maintaining social order [9].

As it is described in [10], law is the set of rules that guides our conduct in society and is enforceable through public agencies. Our relations with one another are governed by many rules of conduct—from important concepts of ethics and fair play to minor etiquette matters such as which fork to use and how to introduce strangers to one another. We obey these rules because we think they are right or simply because we desire the approval of others. Some rules of conduct, however, are considered so important that they are enforced through the government. Traditionally, the most serious breaches of the society's rules are labeled crimes, and people who commit crimes may be arrested, prosecuted, and punished by officials paid by the government. Crimes are kinds of misconduct considered so harmful that the society employs public officers to try to prevent misconduct and to punish those who engage in it.

Law is, generally, a system of rules which are enforced through social institutions to govern behavior. Laws can be made by legislatures through legislation (resulting in statutes), the executive through decrees and regulations, or judges through binding precedents (normally in common law jurisdictions). Private individuals can create legally binding contracts, including (in some jurisdictions) arbitration agreements that exclude the normal court process. The formation of laws themselves may be influenced by a constitution (written or unwritten) and the rights encoded therein. The law shapes politics, economics, and society in various ways and serves as a mediator of relations between people [11].

Different scholars have defined law in different ways, as it is termed in [7, 9].

*John Austin (English jurist (1790 - 1859))* in his "Province of Jurisprudence Determined" article he defined law as "A rule laid down for the guidance of an intelligent being by an intelligent being having power over him." "A body of rules fixed and enforced by a sovereign political authority."

*St Thomas Aquinas (Italian philosopher of theology (1226 - 1274))* defined law as "Law is nothing else than an ordinance of reason for the common good, made by him who has care of the community, and promulgated"

*Max Weber (German Sociologist (1864 –1920))* "Law...exists if it is externally guaranteed by the probability of coercion (physical or psychological) to bring about conformity or avenge violation, and is applied by a staff of people holding themselves especially ready for that purpose."

*Glanville Williams (1911 – 1997)* "Law is the cement of society and also an essential medium of change. Knowledge of law increases the understanding of public affairs. Its study promotes accuracy of expression, facility in argument and skill in interpreting the written word, as well as some understanding of social values".

Law is a social science that grows and develops with the society it is enacted to govern. This fact is mentioned as a reason why a single whole definition of law is not found. Since a law regulates and reflects a real life of a society, a new development of culture and social activity in the society creates new challenges, which are to be governed by a new law [7].

As noted in [8] there is a possibility for the number and variety of definitions given to law to increase. The reason for this is that law reflects the real life and the will of the society and it changes whenever the society encounters a new problem to be solved or a new social interactions and activities to be governed.

## **2.2 Classification of law**

Most nations today follow one of two major legal tradition; *Common law* or *Civil law* [89]. The common law tradition emerged in England during the middle Ages and was applied within British colonies across continents. The civil law tradition developed in continental Europe at the same time and was applied in the colonies of European imperial powers such as Spain and Portugal. Civil law was also adopted in the nineteenth and twentieth centuries by countries formerly possessing distinctive legal traditions, such as Russia and Japan, which sought to reform their legal systems in order to gain economic and political power comparable to that of Western European nation-states.

### **2.2.1 The common law system**

As it is discussed in [89], *Common law* is generally uncodified. This means that there is no comprehensive compilation of legal rules and statutes. While common law does rely on some scattered statutes, which are legislative decisions, it is largely based on *precedent*, meaning the judicial decisions that have already been made in similar cases. These precedents are maintained over time through the records of the courts as well as historically documented in collections of case law known as yearbooks and reports. The precedents to be applied in the decision of each new case are determined by the presiding judge. As a result, judges have an enormous role in shaping American and British law. Common law functions as an adversarial system, a contest between two opposing parties before a judge who moderates. A jury of ordinary people without legal training decides on the facts of the case. The judge then determines the appropriate sentence based on the jury's verdict.

### 2.2.2 The civil law system

*Civil Law also called (continental law), in contrast, is codified.* Countries with civil law systems have comprehensive, continuously updated legal codes that specify all matters capable of being brought before a court, the applicable procedure, and the appropriate punishment for each offense. Such codes distinguish between different categories of law: substantive law establishes which acts are subject to criminal or civil prosecution, procedural law establishes how to determine whether a particular action constitutes a criminal act, and penal law establishes the appropriate penalty. In a civil law system, the judge's role is to establish the facts of the case and to apply the provisions of the applicable code. Though the judge often brings the formal charges, investigates the matter, and decides on the case, he or she works within a framework established by a comprehensive, codified set of laws. The judge's decision is consequently less crucial in shaping civil law than the decisions of legislators and legal scholars who draft and interpret the codes [89].

In continental (civil) legal system in general, the law has been classified into two: public and private law.

#### A. Private law

*Private law* is the part of the law that deals with such aspects of relationships between individuals that are of no direct concern to the state. It includes the law of property and trust, family law, the law of contract, mercantile law and the law of tort. Private law deals with those relations between individuals with which the state is not directly concerned: as in the relations between husband and wife, parent and child, and the various kinds of property, contracts, torts, trusts, legacies, the right recognized by the rules of admiralty, etc. [90].

Areas of private law as it is discussed in [91]:

- I. **Civil:** In England and Wales, *civil law* means non-criminal law. It is a branch of the law. The law relating to civil wrongs and quasi-contracts is part of the civil law. The law of property is embraced by civil law. Civil law can, like criminal law, be divided into substantive law and procedural law. The rights and duties of individuals amongst themselves is the primary concern of civil law. It is often suggested that civil proceedings

are taken for the purpose of obtaining compensation for injury, and may thus be distinguished from criminal proceedings, whose purpose is to inflict punishment. However, exemplary or punitive damages may be awarded in civil proceedings. It was also formerly possible for common informers to sue for a penalty in civil proceedings

- Contract law: *a contract* (or informally known as an agreement in some jurisdictions) is an agreement having a lawful object entered into voluntarily by two or more parties, each of whom intends to create one or more legal obligations between them. The elements of a contract are "offer" and "acceptance" by "competent persons" having legal capacity who exchanges "consideration" to create "mutuality of obligation. Proof of some or all of these elements may be done in writing, though contracts may be made entirely orally or by conduct.
- Tort law, in common law jurisdictions, is a civil wrong that unfairly causes someone else to suffer loss or harm resulting in legal liability for the person who commits the tortious act, called a *tortfeasor*. Although crimes may be torts, the cause of legal action is not necessarily a crime, as the harm may be due to negligence which does not amount to criminal negligence. The victim of the harm can recover their loss as damages in a lawsuit. In order to prevail, the plaintiff in the lawsuit must show that the actions or lack of action was the legally recognizable cause of the harm.
- Property law: property is that which belongs to or with something, whether as an attribute or as a component of said thing. In the context of this article, property is one or more components (rather than attributes), whether physical or incorporeal, of a person's estate; or so belonging to, as in being owned by, a person or jointly a group of people or a legal entity like a corporation or even a society. Depending on the nature of the property, an owner of property has the right to consume, alter, share, redefine, rent, mortgage, pawn, sell, exchange, transfer, give away or destroy it, or to exclude others from doing these things, as well as perhaps to abandon it.

- Family law is an area of the law that deals with family-related issues and domestic relations including, but not limited to marriage, civil unions, divorce, spousal abuse, child custody and visitation, property, alimony, and child support awards, as well as child abuse issues, and adoption.
  - Succession law (inheritance): Inheritance is the practice of passing on property, titles, debts, rights and obligations upon the death of an individual. It has long played an important role in human societies. The rules of inheritance differ between societies and have changed over time. In law, an *heir* is a person who is entitled to receive a share of the deceased's (the person who died) property, subject to the rules of inheritance in the jurisdiction where the deceased (decedent) died or owned property at the time of death.
- II.** Labor law mediates the relationship between workers (employees), employers, trade unions and the government. Collective labor law relates to the tripartite relationship between employee, employer and union. Individual labor law concerns employees' rights at work and through the contract for work. Employment standards are social norms (in some cases also technical standards) for the minimum socially acceptable conditions under which employees or contractors are allowed to work. Government agencies (such as the former US Employment Standards Administration) enforce labor law (legislative, regulatory, or judicial).
- III.** Commercial law, also known as business law, is the body of law that applies to the rights, relations, and conduct of persons and businesses engaged in commerce, merchandising, trade, and sales. It is often considered to be a branch of civil law and deals with issues of both private law and public law.
- IV.** Corporate law (also "company" or "corporations" law) is the study of how shareholders, directors, employees, creditors, and other stakeholders such as consumers, the community and the environment interact with one another. Corporate law is a part of a broader company's law (or law of business associations)

- V. Competition law is law that promotes or seeks to maintain market competition by regulating anti-competitive conduct by companies. Competition law is implemented through Public and Private Enforcement

## **B. Public law**

*Public law* is that part of law which governs relationships between individuals and the government, and those relationships between individuals which are of direct concern to the society. Public law comprises constitutional law, administrative law, tax law and criminal law, as well as all procedural law. In public law, mandatory rules (not optional) prevail [92].

As described in [92] areas of public law are:-

- I. **Constitutional law:** In modern states, constitutional law lays out the foundations of the state. Above all, it postulates the supremacy of law in the functioning of the state – the rule of law. Secondly, it sets out the form of government – how its different branches work, how they are elected or appointed, and the division of powers and responsibilities between them. Traditionally, the basic elements of government are the executive, the legislature and the judiciary. And thirdly, in describing what are the basic human rights, which must be protected for every person, and what further civil and political rights citizens have, it sets the fundamental borders to what *any* government must and must not do. In most jurisdictions, constitutional law is enshrined in a written document, the Constitution, sometimes together with amendments or other constitutional laws. In some countries, however, such a supreme entrenched written document does not exist for historical and political reasons – the Constitution of the United Kingdom is an unwritten one.
- II. **Administrative law** refers to the body of law which regulates bureaucratic managerial procedures and defines the powers of administrative agencies. These laws are enforced by the executive branch of a government rather than the judicial or legislative branches (if they are different in that particular jurisdiction). This body of law regulates international trade, manufacturing, pollution, taxation, and the like. This is sometimes seen as a subcategory of civil law and sometimes seen as public law as it deals with regulation and public institutions.

**III.** Criminal law involves the state imposing sanctions for defined crimes committed by individuals or businesses, so that society can achieve its brand of justice and a peaceable social order. This differs from civil law in that civil actions are disputes between two parties that are not of significant public concern.

### **2.3 The legal system of Ethiopia**

As it is mentioned in [13], the Ethiopia's legal system started to develop in a modernized way in the twentieth century particularly when the country's laws started to be legislated in the form of codes. This was observed in the beginning of the second half of the 20<sup>th</sup> century. Consequently, the country is named as a civil law country mainly because of the codification of its laws. Among several legal systems currently prevailing, two of them are universally recognized and followed. These are Roman-Germanic legal system, which is commonly referred to as continental European law and Anglo- American legal system or common law [14]. The first is based on rules that are codified, systematized and developed by legislative bodies (law making bodies) or parliaments. Consequently, in countries following this legal system, the decisions and interpretations of law by judges are based on the respective codification act (Civil Code or Penal Code) enacted by the appropriate state authorities [8]. On the other hand, Anglo-American legal system was systematized or historically developed not by the acts of parliament, but as a result of decisions or judgments of higher courts.

### **2.4 Order of laws in Ethiopia**

As it is discussed in [15], in a given legal system there are numbers of law making bodies. The law making organs of a state are not on the same footing with each other's as far as rank of authority is concerned. The difference in the rank of authority of the different law making bodies reflects the difference in authority of laws made by them. Laws made of inferior law making bodies are also subordinate to those of the higher ones. This is called hierarchy of law making bodies and that of laws. The hierarchy of legislation can be separated into two broad categories: primary and delegated (subordinate) legislations. Primary legislations are laws that are made by a legislative body (by the house or houses of the parliament). On the other hand, subordinate legislations are those administrative orders and regulations which are made by executive

authorities. These authorities are given the power to enact such laws from the legislator by way of delegation.

Because of the advent of internet, there is no shortage of legal information access. Even though the amount of electronic information about different legal issues is expanding largely on the web, how to access the specific information from accumulated legal information is the key question. To address such question one way can be structuring the information. For this purpose we can use Extensible Markup Language (XML) techniques will be the best solution.

## **2.5 Xml retrieval for legislation**

The increasing amount of electronic information over the web is one way to address the information scarcity in any discipline for making a better decision. But merely the expansion of electronic information may not be a better solution; rather the increasing amount of information is handled properly for latter efficient usage. One way of structuring the information available on the web is by using XML. XML stands for Extensible Markup Language and it is developed by W3C (World Wide Web Consortium)

Legislation typically involves structured information including the division of a statute in, for instance titles, chapters, sections and articles, and the typical metadata (e.g., indication of the date of enactment, the area of applicability and references to other statutes) that are assigned to the statute or its parts. Additionally, legislation contains large parts of unstructured information found in the natural language texts. The structured information is increasingly tagged with markup languages such as *XML*. The use of such a markup language makes it possible that documents can be easily interchanged between institutions and systems, and that the markups are interpretable across the use of different software [34].

As discussed in [57], the use of the document structure allows generating a more precise answer to an information query. Instead of returning the complete document as the answer, a structural element or several elements are given. Such an approach meets the current need of users of legal information systems, who demand more precise answers to information queries.

Managing the enormous amount of information available on the web or on document repositories requires efficient and effective indexing and retrieval methods Textual information usually exists

in three different forms, depending on its level or granularity of structuring: structured, unstructured and semi-structured. Structured information is mainly characterized by a pre-defined format, similar to a database table where the format of each record of a table is fixed and unambiguously defined by a database schema (e.g. the type, length and other attributes of each record). In contrast to this, unstructured information has no fixed pre-defined format, and is typically expressed in natural language. For example the information available on the web is unstructured information type. Although, this information is usually tagged by HTML (Hyper Text Markup Language) the resulting structure is only for presentation purposes and carries essentially no semantic meaning. As far as accessing these types of information is concerned, accessing structured information requires powerful but non flexible query languages, such as SQL, whereas accessing unstructured information is through flexible but mostly simplistic means, such as a simple keyword matching or bag of words techniques [18].

The third type of textual information, semi-structured information, lies between structured and unstructured information. It has tight structure but this structure is not as rigid as the database schema. Textual documents often contain a mixture of structured and unstructured content. XML is one way to format this mixed content. After its development, in 1998, XML has been used in:

1. Allowing computers to communicate data using a common language.
2. Providing humans with a common means of structuring, describing and exchanging information.

## **2.6 Xml retrieval models**

Legislative documents have a hierarchical structure in which sections with detailed content are nested in larger sections. The aim of the XML retrieval models is to incorporate the knowledge on the document structure and on specific content elements in computing the relevance of an information unit. Because the structure of an XML document is tagged, the document can be broken up in different units (of varying length when these units are nested) that can be returned as an answer to the information need. The user of a legislative retrieval system can retrieve a complete chapter, an article or even a list element of a paragraph depending on what is most relevant as an answer to the query [34].

## 2.7 Xml query languages

In XML retrieval models, the logical document structure is additionally used to determine which document components are most meaningful to return as query answers. With appropriate query languages, this structure can be specified by the user [27]. For example, users can issue a query that look for an article that discusses the payment of tax. Here, the “article” specifies the structural constraints on the retrieval units where as the “payment of tax” specifies the content (textual) constraints.

If the legal information on the web is structured using XML, it will be very easy to retrieve a specific information from a large set of documents. To retrieve information, the user query is analyzed and a set of candidate answers will be displayed as a result in order of their rank. Selecting the best will be left for the user. The retrieved answer at the first rank may not be necessary the valuable information. If the user doesn’t have prior legal knowledge, the user may be in problem how to select the best information from the retrieved set of information and how to use that information. In addition, how to combine the pieces of information to make a decision is still a head ache for a lay person

As in [58] the goal of most legal work – seen as a process of text handling – is actually to combine different types of texts in an effective way. Statutes, regulations, cases, precedents, legal literature, contracts are examples of documents that may have to be investigated together in order to solve a legal problem or even to be able to understand the practical meaning of a legal rule. This well-known phenomenon can be described as *legal rule fragmentation*: the necessary information is often scattered in different documents or even in different data banks, and the links among the required pieces of information are difficult to establish. This problem, though particularly hard in a strongly text-centered field like the legal domain, is not limited to the legal area.

For such reason, it will be valuable if there is a system that assists the user legal information needs for decision making. And an expert system which is specifically known as legal expert system will enable to go one step forward to assist the user in legal decision making though a series of question and answering mechanism. The system asks a series of question and the user provides the answer then the system the will suggest what the user should do.

## 2.8 Expert System

The term expert system comes from the world of artificial intelligence. Originally, it comprised the idea that computer programs can be devised to solve complex problems of decision making, as well as, or even better than human experts [29].

An Expert System is a computer program that represents and reasons with knowledge of some specialist subject with a view to solving problems or giving advice. To solve expert-level problems, expert systems will need efficient access to substantial domain knowledge base, and reasoning mechanism to apply the knowledge to problems they are given. Usually, they will also need to be able to explain to the users who rely on them, how they have reached their decisions.

As in [29], an expert system is a so-called knowledge base, a formal model of knowledge that is used to make inferences to arrive at relevant decisions. This knowledge base can have different forms and in general a distinction is made between rule-based and case-based systems. In a rule-based expert system, reasoning is based largely on production rules, that is, hundreds or even thousands of coded rules in the form of IF-THEN statements. For example, IF a client's total capital is below \$ 10.000 THEN the client is exempted from paying wealth tax. By combining many such rules, very complex inferences can be made. In a case-based system, the knowledge base consists of a larger number of coded case descriptions and the system bases its inferences on automated procedures (usually of a mathematical or statistical kind) to compare the case at hand with the different cases in the knowledge base. In the early years of legal expert systems, it was assumed that the development of such systems was particularly useful for more complex legal reasoning tasks, in situations where a human expert would be faced with personal limitations in knowledge and skills. Nowadays, however, legal expert systems are more often regarded as important tools to control administrative processes and to enhance administrative efficiency, that is, the use of expert systems in public and private bureaucracies to process large numbers of cases in a standardized and controllable manner.

One of the first systems with which the phrase expert system has been associated is heuristic DENDRAL. It was developed in 1965 at Stanford University [40]. The heuristic DENDRAL system ordered assistant in the field of organic chemistry in determining the structural formula of a chemical compound that has been isolated from a given sample.

The second example of expert system is the familiar early application MYCIN [38] designed to assist medical diagnosis. MYCIN was the first large expert system to perform at the level of a human expert and to provide users with an explanation of its reasoning. The MYCIN system was capable of assisting physicians in the diagnosing and treatment of some infectious diseases, particularly meningitis and bacterial septicemia [41]. It contains a number of heuristic rules (about 450 rules) that are used by physicians in the identification of certain infections.

### **2.8.1 Component of Expert System**

Expert systems have three major components: Knowledge base (KB), inference engine (IE) and user interface (UI) are the main components. A typical knowledge based system may contain additional components like explanation facility, knowledge acquisition and blackboard.

#### **A. Knowledge base**

The knowledge base contains the domain-specific knowledge required to solve the problem. The knowledge base is created by the knowledge engineer, who conducts a series of interviews with the expert and organizes the knowledge in a form that can be directly used by the system. The knowledge engineer has to have the knowledge of KBES technology and should know how to develop an expert system using a development environment or an expert system development shell. It is not necessary that the knowledge engineer be proficient in the domain in which the expert system is being developed. But a general knowledge and familiarity with the key terms used in the domain is always desirable, since this will not only help in better understanding the domain knowledge but will also reduce the communication gap between the knowledge engineer and the expert. Before deciding on the structure of the knowledge base, the knowledge engineer should have a clear idea of different knowledge representation schemes and the suitability of each under different circumstances [42].

As discussed in [43], the KB, which is a heart of knowledge base systems, is a set of rules that represents the knowledge about the domain. It contains the problem solving knowledge of a particular application. In rule based expert system, KBs can be represented by production rules. These rules consist of a condition or premise followed by an action or conclusion (IF condition...THEN action). Production rules permit the relationships that makeup the knowledge

base to be broken down into manageable units. During consultation, the rule base is searched for conditions that can be satisfied by facts supplied by the user. This operation is performed by the inference engine.

Developing an expert system involves tasks such as acquiring knowledge from an acknowledged domain expert, documenting it and organizing it, generating knowledge *net* to check the relationships between different knowledge sources, checking for consistency in the knowledge and finally transforming the *knowledge net* into a computer program using appropriate tools. Such a program, called an expert system, is a formal system for storing facts and their relationships and the strategies for using them. In general, an expert system has knowledge about physical objects, relationships among them, events, relationships among events and relationships between objects and events. In addition, required types of search mechanisms must be represented to drive the system. Depending on the type of problems, other types of knowledge, such as time relationships, uncertainty levels of facts and assertions, performance levels, difference in behavior of objects in different situations, assumptions, justifications, knowledge about knowledge (Meta knowledge), additional explanations on facts and relationships etc., have to be represented [43].

## **B. The Inference Engine**

The Inference Engine (IE) is sometimes called as an Expert system shell. As defined in [29], the expert system shell is an existing knowledge independent framework into which domain knowledge can be inserted to produce a working expert system.

According to [43] an inference engine is also called as inference mechanism. The inference mechanism is a control strategy or search technique, which searches through the knowledge base to arrive at decisions. The knowledge base is the state space and the inference mechanism is a search process. As expert systems predominantly process symbols, the inference process manipulates symbols by selection of rules, matching the symbols of facts and then firing the rules to establish new facts. This process is continued like a chain until a specified goal is arrived at. In an expert system, inference can be done in a number of ways.

A number of different types of inferences can be achieved using the knowledge represented in frames. Those inferences will not generally form the control strategy for overall problem solving as in the case of rule base inference. But they demonstrate many intelligent features that human beings use in the process of problem solving. One such feature is simulation of common sense. An example is presented below, which illustrates simulation of common sense using frames [42].

Consider a situation, where someone tells you that *A is father of B* and *B is male*. Later a reference to *son of A* brings to your mind that *B is son of A*. No explicit statement is made at any time that *B is son of A*. But because of the common sense (based on knowledge you have on the relationship between parent and child) you are able to make a statement *B is son of A*. Similar situations, i.e., inference based on common sense, can be simulated in computer programs using techniques associated with frames and frame management [42].

The IE is a general program that activates the knowledge in the knowledge base. It tries to fire that rule by proving the conditions of the rule true using a sequence of rules in the knowledge base. The function of the IE is to explore information and relationships from the knowledge base to provide answers, predictions and suggestions in a way a human expert would understand. As a result, it consists of algorithms for manipulating the knowledge represented in the knowledge base to solve a problem presented to the system. The two popular methods of inference are backward chaining and forward chaining. Backward chaining is a goal-driven process, whereas forward chaining is data driven. [43].

Backward chaining inference method can be described as working backward from the goal. In this method, an IE searches the inference rules until it finds one where the IF clause is known to be true. In other words, it starts with some facts and applies rules to find all possible conclusions. Goal driven is a commonly used term for describing backward chaining which refers to the method used to process the rule. In this method, the IE identifies one or more hypotheses and begins searching for rules that contain the hypothesis as a consequent.

On the other hand, forward chaining is a data driven inference process in which the system starts with the initial set of elements (facts) in the working memory. Then, it keeps on firing rules until there are no rules, which can be applied, or the goal has been reached. In this strategy, rules are applied whenever their left-hand-side conditions are satisfied. To use this strategy, one

must begin by entering information about the current problem as facts in the database. Forward chaining is very popular, as is evidenced by the fact that it is known by so many different names such as bottom-up, data-driven control, pattern-directed, or antecedent reasoning [42].

### **C. User interface**

The User Interface (UI) is the intermediate between the users and the inference engine. The user can interact with the system through the UI.

According to [55] the expert system user interface is comprised of two major components; Interviewer and Explanation.

#### **I. The Interviewer Component**

This controls the dialog with the user and/or allows any measured data to be read into the system. For example, it might ask the user a series of questions, or it might read a file containing a series of test results.

#### **II. The Explanation Component**

This gives the system's solution, and also makes the system's operation transparent by providing the user with information about its reasoning process. For example, it might output the conclusion, and also the sequence of rules that was used to come to that conclusion. It might instead explain why it could not reach a conclusion.

### **2.8.2 Phases in development of expert system**

The process of building an expert system is called knowledge engineering. A knowledge engineer is a person who builds an expert system, performs the task of extracting the knowledge from the domain expert. The knowledge of the expert(s) is stored in his/her mind in a very abstract way. Knowledge acquisition, knowledge representation and evaluation are the main phases in knowledge engineering. In the following section, these phases are discussed in brief.

## **A. Knowledge acquisition**

Knowledge acquisition is the process of acquiring knowledge from the domain expert, books, documents, sensors, or computer files and structuring and organizing that knowledge into suitable form for knowledge representation. So, in this phase, an expert can enter their knowledge or expertise into the expert system and to refine it later as and when required [44].

As in [44, 45], knowledge acquisition is the most important as well as the most difficult task in the development of expert system. The main reason for its difficulty is the communication gap between the knowledge engineer and the domain expert. For example, experts may not know how to express their knowledge; experts may be unwilling to share their knowledge; testing and refining knowledge is complicated; system builders tend to collect knowledge from one source, but the relevant knowledge may be scattered across several sources and experts may change their behavior when they are observed or interviewed.

Several techniques are available for knowledge acquisition. Interview, questionnaires, document analysis and observation to acquire factual and explicit knowledge are the common approaches.

Even though, knowledge engineers play a major role in knowledge acquisition, automated systems that allow the expert to interact directly with the system are becoming common.

According to [44], the knowledge acquisition process is usually comprised of three principal stages:

- Knowledge elicitation- It is the interaction between the expert and the knowledge engineer to obtain the expert knowledge in some systematic way. As the result, it is concerned with obtaining information directly from domain experts in a systematic way.
- Intermediate representation- The knowledge that is obtained is usually stored in some form of human friendly medium.
- Executable form- The intermediate representation of the knowledge is then compiled into an executable form (e.g. production rules) that the inference engine can process.

## **B. Knowledge representation**

After knowledge has been gathered from domain experts and different sources, a model for representing the knowledge must be developed. Thus, knowledge representation is the preparation of a knowledge map and encoding of the knowledge in the knowledge base. Good knowledge representation methods have completeness, compactness, clearness and good performance characteristics [44]. Frames, semantic networks and rules are some common knowledge representation methods.

Even though, frame representation scheme is appropriate to highly well-defined structured knowledge, it is difficult to use it in unstructured knowledge due to the fact that instantiating new frames by matching to archetypes and implementing some logical relationships between concepts are difficult [46].

## **C. Knowledge evaluation/validation**

Evaluation is the degree to which inferences and decisions are justified by evidence. For expert systems, this requires analyzing the decision-making capabilities of a system. So, knowledge based system evaluation process involves assessment of many aspects of a knowledge based system. According to Michael et al. [47], validation or evaluation process consists of three methods: construct validation, content validation, and criterion-related validation.

Construct validation attempts to verify that a measurement device actually measures what it maintains to measure. For expert systems, this means that the system must perform like an expert, and expert decisions must differ from novice decisions. So, construct validity for an expert system could be inferred through high expert reliability and significant differences between expert and novice recommendations [47].

Content validation addresses the extent to which a particular measure represents the content universe of the property being measured. For expert systems, this means the system's logic mimics the process experts use to make their decisions. But content validation is not concerned with what the expert system decides instead of attempting to ascertain if the process and logic that the system uses to reach its decisions are similar to those used by experts. However, due to

the resources and time required to take this approach, this tactic has generally not been used to evaluate expert systems [47].

Criterion-related validation measures the statistical relationship that exists between a given index and a criterion score. In this method, a system would be evaluated by comparing system decisions to the correct answers. A valid system would produce the same answers as the experts. As the result, criterion-related validation measures the relationship between the decisions developed by the system and decisions developed by human experts [47].

As the result we have gathered the required knowledge from the experts (Legal Expert) and secondary sources of information and have represented using the rule based method of knowledge representation.

Since as there are varieties of human expert in varieties of domain, there can be different variety of Expert System as well. For example, as there are Economist, Physician, legal experts we can build a variety of Expert that mimic the human expert knowledge and provide similar analysis that a human expert does. Thus, according to the domain that the expert system is developed there can be Economic Analyst Expert System, Medical Diagnosis Expert system, Legal Expert System, and the like. For this study we will focus on Legal Expert System.

## **2.9 Legal Expert System**

A legal expert system is a domain specific expert system that uses artificial intelligence to emulate the decision making abilities of human expert in the field of law. A legal expert system employs a rule base (knowledge base) and an inference engine to accumulate reference and produce expert knowledge on specific subjects within the legal domain. A legal expert system is a system that contains the same knowledge of particular legal domains as a human expert has.

It has been suggested that legal expert systems could help to manage the rapid expansion of legal information and decisions that began to intensify in the late 1960s [30]. Many of the first legal expert systems were created in the 1970s and 1980s [31, 32].

As mentioned in [39], the list of the possible benefits of a legal expert system include: -

- Faster delivery of legal advice.
- Liberation of fee earning time otherwise spent in the labor-intensive and repetitive tasks of taking instructions, carrying out legal research and giving advice.
- Increased productivity.
- Reduced dependence on transitory human expertise.
- Potential savings in staff overheads.
- Increased scope for delegation of tasks to a lower grade of fee earner
- Reduction in human error leading to improved claims record and lower insurance.
- Cost savings arising from the above.
- Increased profitability for the provider of legal services.
- From the client's perspective lower fees

Legal expert systems can also support administrative processes, facilitating decision making processes, automating rule-based analyses and exchanging information directly with citizen-users.

As stated in [29], although in some technical domains Expert System ambitious goal is still valid, it is generally relaxed for applications in legal and administrative domains. One simple, everyday example is a computer program that helps a tax payer fill in his tax returns and informs him about the implications his answers will have in terms of the amount of tax to be paid. A second, quite different example is a system which, based on a textual summary of a case at hand, can help a legal professional to find applicable case law.

## 2.10 Application of legal expert system

According to [29], there are four types of applications of Legal Expert System:

- I. Knowledge-based information services for citizens/clients: while in the Internet era many organizations have started to put all kinds of rules and statutes on their Web sites, research shows that most people find it very hard to apply such written rules to their personal situation. In such circumstances expert system technology may help to personalize the information. Banks, for example, may add expert system modules to their Web sites to help the customer understand which of the different mortgage plans is most suitable in his/her particular situation.
- II. Knowledge acquisition from citizens/clients information: in combination with the above application, expert systems may be used to help gather information from citizens and organizations, so that their cases can be processed more easily. An example is the Taxis system in Greece, which helps companies in submitting their VAT (Value Added Tax) declarations in a correct manner.
- III. Semi-automated decision making in street-level bureaucracies: in many government agencies, the application of legal statutes is the responsibility of so-called street level bureaucrats, that is, lower level staff with at most limited legal training. Expert systems can be used to support these bureaucrats in making formally correct decisions. An example is the use of expert systems by the Australian Department of Veterans Affairs in determining individual entitlements to disability pensions.
- IV. Automated application of legal rules in high-volume administrations: some administrative agencies are responsible for the repetitive application of the same regulation to very large numbers of case.



The design of most intelligent systems is usually inspired by the desire to emulate human capabilities in some way. One example of this is the way that humans are able to recall previous similar experiences when attempting to solve problems [50]. CBR is an approach to intelligent systems development that aims to emulate this capability. A CBR system stores problems, retrieves closest matches when a new problem needs to be solved, adapts the previous approach to suit the new problem exactly and finally stores the new case. The stored knowledge is known as the case base and one way of storing these is as objects with links between classes and instances that enable effective retrieval to take place. Such an approach might be more appropriate in the legal domain.

### **I. What is a case?**

A case can be said to be the record of a previous experience or problem. The information recorded about this past experience will, by necessity, depend on the domain of the reasoner and the purpose to which the case will be put. In the instance of a problem solving CBR system, the details will usually include the specification of the problem and the relevant attributes of the environment that are the circumstances of the problem. The other vital part of the case is the solution that was applied in the previous situation. Depending on how the CBR system reasons with cases, this solution may include only the facts of the solution, or, additionally, the steps or processes involved in obtaining the solution. It is also important to include the achieved measure of success in the case description if the cases in the case base have achieved different degrees of success or failure [55].

## **II. When to use case based reasoning**

As noted in [55], while case-based reasoning is useful for many types of problems and in many different domains, there are times when it is not the most appropriate methodology to employ. There are a number of characteristics of problems and their domains that can be used to determine whether case-based reasoning is applicable [71, 72, 73].

- **Does the domain have an underlying model?**

If a process is random, or if the factors leading to the success or failure of a solution cannot be captured in the case description, any reasoning from past cases may be futile.

- **Are there exceptions and novel cases?**

Domains without novel or exceptional cases may be better modeled with rules, which could be inductively determined from the cases.

- **Do cases recur?**

If a case is not likely to be used in a subsequent problem, because of a lack of similarity then there is little, if any, value in storing the case. In these domains, when cases are not similar enough to be adapted then perhaps it would be better to build a model of the process of developing the solution, rather than a model of the solution domain.

- **Is there significant benefit in adapting past solutions?**

One must consider whether there is a significant difference in the resources expended (time, processing, etc) between creating a solution to a problem from scratch and creating a solution through modifying a similar solution.

- **Are relevant previous cases obtainable?**

It is possible to obtain the data that records the necessary characteristics of past cases? Do the recorded cases contain the features of the problem and its context that influenced the outcome of the solution? Is the solution recorded in the detail necessary for it to be adapted in future? If the answer to the majority of questions above is positive, then it is likely that a case-based reasoning may be applicable and relevant.

### **III. Why use CBR**

As many authors have discussed previously, when used in the appropriate situations, case-based reasoning offers many advantages [70, 72, 73]. In this section we summarize many of them. Some points have appeared in more detail in some of the above references, and often from varying points of view. The order in which they appear here is not indicative of their level of importance.

- **Reduction of the Knowledge Acquisition Task**

By eliminating the extraction of a model or a set of rules as is necessary in model/rule based systems, the knowledge acquisition tasks consists mainly of the collection of the relevant existing experiences/cases and their representation and storage.

- **Graceful degradation of performance**

Some model based systems cannot even attempt to solve a problem on the boundaries of its knowledge or scope, or when there is missing or incomplete data. In contrast case-based systems can often have a reasonably successful attempt at solving these types of problem. Able to reason in domains that have not been fully understood, defined or modeled.

While insufficient knowledge may exist about a domain to build a causal model of it or derive a set of heuristics for it, a case-based reasoner can function with only a set of cases from the domain. The underlying theory does not have to be quantified.

- **Reason in a domain with a small body of knowledge**

While a domain in which there is little known underlying knowledge and few cases from which to start limits the type of reasoning that can be done in it, a case based reasoner can start with the few known cases and incrementally increase its knowledge as cases are added to it. The addition of these cases will also cause the system to grow in the directions encountered by the system in its problem solving endeavors.

- **Reason with incomplete or imprecise data and concepts**

As cases are retrieved not just when identical to the current query case but when they are within some measure of similarity, incompleteness and imprecision can be dealt with. While these factors may cause a slight degradation in performance due to the current and retrieved having increased disparity, reasoning can still continue

- **Avoid repeating all the steps that need to be taken to arrive at a solution**

In problem domains that require significant processes to carry out the creation of a solution from scratch, the modifying of a previous solution can significantly reduce this processing. By reusing a previous solution, the steps taken to reach the retrieved solution can be reused themselves.

- **Provide a means of explanation**

Case-based reasoning can supply a previous case and its (successful) solution to convince a user, or justify to a user, a solution it is providing to their current problem. In most domains, there will be times when a user wishes to be reassured about the quality of the solution they are being given. By explaining how a previous case was successful in a situation, using the similarities between the cases and the reasoning involved in adaptation a CBR system can explain its solution to a user. Even in a hybrid system that may use multiple methods to find a solution, this explanation mechanism can augment the causal (or other) explanation given to the user.

- **Reflects human reasoning**

As there are many situations where we, as humans, use a form of case-based reasoning, it is not difficult to convince implementers, users and managers of the validity of the paradigm. Likewise, humans can understand a CBR system's reasoning and explanations and are able to be convinced of the validity of the solutions they are receiving. If the human user is wary of the validity of the received solution, they are less likely to use the solution given to them by the reasoner. The more critical the domain, the lower the chances of use, and the higher the level of the user's understanding and credulity will need to be.

#### **IV. Case representation**

Cases in a case base can represent many different types of knowledge and store it in many different representational formats. The objective of a system will greatly influence what is stored. A case based reasoning system may be aimed at the creation of a new design or plan, the diagnosis of a new problem, or the argument of a point of view with precedents. In each type of system, a case may represent something different. The cases could be people, things or objects, situations, diagnoses, designs, plans or rulings among others. In many practical CBR applications, cases are usually represented as two unstructured sets of attribute value pairs, i.e. the problem and solution features [74]. However, the decision of what to represent can be one of the difficult decisions to make.

For example: In some sort of medical CBR system, that diagnosis a patient, a case could represent an individual's entire case history or be limited to a single visit to a doctor. In this situation the case may be a set of symptoms along with the diagnosis. It may also include a prognosis or treatment. If a case is a person then a more complete model is being used as this could incorporate the change of symptoms from one visit to the next. It is however harder to find and use cases in this format to search for a particular set of symptoms in a current problem and obtain a diagnosis/treatment. Alternatively if a case is simply a single visit to the doctor involving the symptoms at the time of that visit and the diagnosis of those symptoms, the changes in symptoms that might be a useful key in solving a problem may be missed.

#### **V. Case based inferencing**

At its most basic, all case-based reasoning involves a kind of table look up. The table is an indexed store of cases which will be referred to as the CBR system's case database. Historically, the case database has also been called the CBR system's memory or its Case Knowledge Base (CKB), terms which focus on the need to organize and index cases in the database for purposes of retrieval. Much as we might look up telephone numbers of 'Attorneys' or 'Computers-Service and Repair' establishments in the index of the Yellow Pages, a CBR system 'looks up,' in the index of its CKB, past cases that bear on the current problem. Instead of being an alphabetical index of services, a CBR system's index includes information, abstracted from cases, which represents the circumstances in which the case has some utility in problem analysis or solution.

In other words, the index terms represent a case's relevance. Employing the index, the program retrieves and selects the most similar cases to the problem and applies them in a solution [70].

## **VI. Case retrieval**

Case retrieval is the process of finding within the case base those cases that are the closest to the current case. To carry out case retrieval there must be criteria that determine how a case is judged to be appropriate for retrieval and a mechanism to control how the case base is searched. The selection criterion is necessary to decide which case is the best one to retrieve, that is, to determine how close the current and stored cases are.

This criterion depends in part on what the case retriever is searching for. Most often the case retriever is searching for an entire case, the features of which will be compared to the current query case. There are however times when a portion of a case is required. This may be because no full case that exists and a solution is being built by selecting portions of multiple cases, or because a retrieved case is being modified by adopting a portion of another case in the case base.

The actual processes involved in retrieving a case from the case base depend very much on the memory model and indexing procedures used. Retrieval methods employed by researchers and implementers are extremely diverse, ranging from a simple nearest neighbor search to the use of intelligent agents. We discuss here the most common, traditional methods.

### **A. Nearest Neighbor Retrieval**

In nearest neighbor retrieval, the case retrieved is chosen when the weighted sum of its features that match that query case is greater than the other cases in the case base. In simple terms, a case that matches the query case on  $n$  number of features, will be retrieved rather than a case which matches on  $k$  number of features where  $k < n$ . Some features that are considered more important in a problem solving situation may have their importance denoted by weighting these features more heavily in the matching.

### **B. Inductive approaches**

When inductive approaches are used to determine the case base structure, that is to determine the relative importance of features for discriminating between similar cases, the resulting

hierarchical structure of the case base provides a reduced search space for the case-retriever. This may in turn reduce the search time for queries.

### **C. Knowledge Guided Approaches**

Knowledge guided approaches to retrieval use domain knowledge to determine the features of a case which are important for that case in particular to be retrieved in future. In some situations different features of each case will have been important for the success level of that case.

As with the inductive approaches to retrieval, knowledge guided indexing may result in a hierarchical structure, effective for searching.

## **VII. Case adaption**

Case adaptation is the process of translating the retrieved solution into the solution appropriate for the current problem [13].

As it is described in [13], there are a number of approaches that can be taken to carry out case adaptation.

- The solution returned could be used as a solution to the current problem, without modification, or with modifications where the stored solution is not entirely appropriate for the current situation.
- The steps or processes that were followed to obtain the previous solution could be re-run, without modifications, or with modifications where the steps taken in the past solution are not fully satisfactory in the current situation.
- Where more than one case has been retrieved a solution could be derived from multiple cases, or alternatively several alternative solutions could be presented.

## **VIII. Advantage of CBR**

One of the most time consuming aspects when developing a rule-based system is the knowledge acquisition task. Acquiring domain specific information and converting it into some formal representation can be a huge task and, in some situations, especially less understood domains the formalization of the knowledge cannot be done at all. Case-based systems usually require significantly less knowledge acquisition as it involves collecting a set of past experiences without the added necessity of extracting a formal domain model from these cases. In many domains, there are insufficient cases to extract a domain model [55].

The other benefit of CBR mechanism is that, a system can be created with a small, or limited, amount of experience and incrementally developed, adding more cases to the case base as they become available [55].

## **IX. Disadvantage of CBR**

To develop a case base reasoning system, we have to collect sufficient cases for the domain that the system is intended to be developed. If there are insufficient real previous cases, it will not be possible to develop the system. Therefore, collecting cases from a country which follows civil law legal system will be very difficult because it is very difficult to find well-organized cases.

When we develop a case base reasoning system, it should require a higher caution in selecting the cases which are going to be stored in the case base. If the solution for the previous problem in the case is inappropriate, then the system will follow the same trend for similar cases of the previous unsuccessful problem. Therefore, the benefit of the system will be in question. For example if the physician treatment is not appropriate for certain patient and if that patient history and the treatment applied is used as a precedent case, then the system will display this case treatment as a solution for the new case that is assumed as it has similar history. Therefore, the treatment will be similar to the previous case but it was not an appropriate treatment.

### 2.11.2 Rule Based Reasoning (RBR).

In rule based systems, one has a rule base consisting of a set of production rules of the form IF A THEN B where A is a condition and B an action. If the condition A holds, then action B is carried out. 'A' can be a composite condition consisting say of a conjunction of premises (rules) A1, A2, ...An. In addition, the rule based system has an inference engine, which compares the data it holds in working memory with the condition parts of rules to determine which rules fire [55].

In a rule-based legal expert system, information is represented in the form of deductive rules within the knowledge base. A rule-based expert system represents knowledge of a particular domain, such as medicine, finance, or law in the form of “if-then” rules. Here’s an example of a rule:

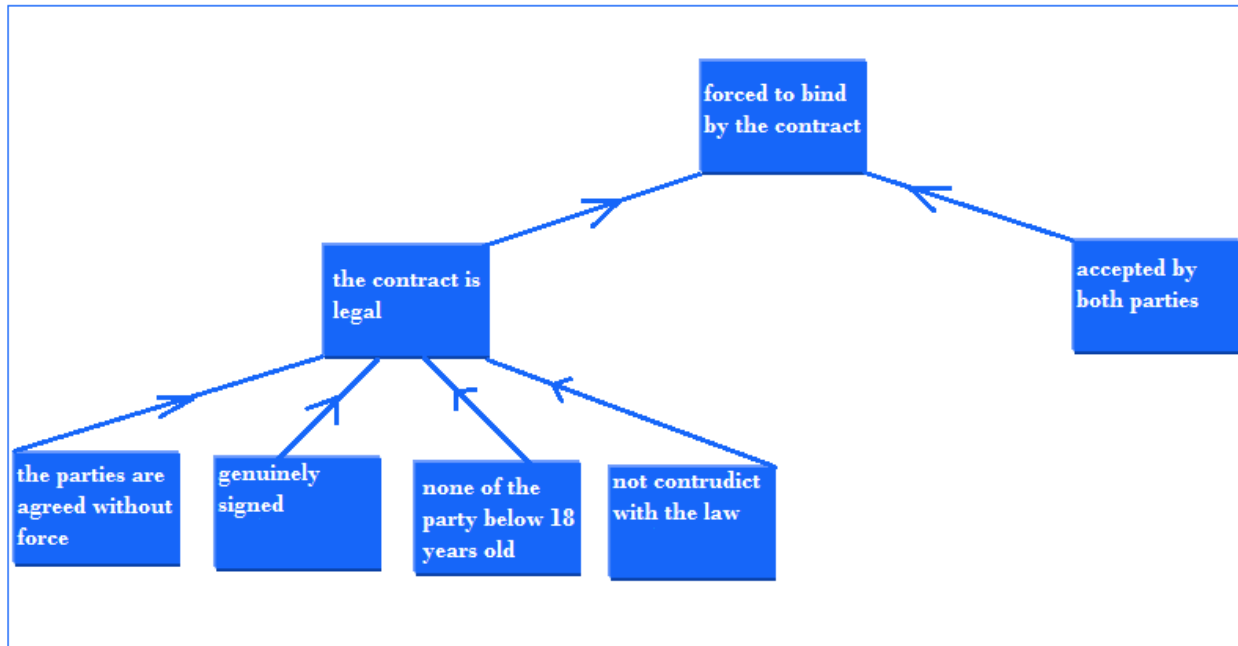
➤ **In the contract signed by two parties**

1. The parties are forced to abide by the contract agreement **if**,
2. The contract is legal **and**,
3. The contract was accepted by both parties.

A rule consists of a bunch of variables (here, three Boolean statements) together with some logical operators (if, then, and, or, not, mathematical operators, etc.). Rules are chained together to form a rule base, each rule can be refined into other rules. For instance rule 2 can be broken down as follows

2. The contract is legal **if**,
  - 2.1 The parties are agreed without any obligation **and**,
  - 2.2 The contract does not contradict with the constitution **and**,
  - 2.3 The contract is signed without cheating **and**,
  - 2.4 None of the contract member is below 18 years old.

The breakdown of rules into smaller rules is depicted in figure 2.2



**Figure 2.2 Diagrammatic representations of refining rules.**

### **Advantage of RBR**

From this extremely simple example, we can start to get a sense of the strengths and limitations of rule-based representations of legal knowledge. Let's start with the strengths. First, the law, to a significant degree, seems to consist of rules, and representing them in a constrained, logical language is fairly straightforward and natural. As a result, rule-based systems are transparent: the system code looks a lot like the text that's being represented. This "isomorphism" means that you can trace the system logic back to the original source material, easily spot errors, and quickly adapt to changes in the law. Furthermore, rule-based systems can justify their determinations by explaining how they arrived at a particular conclusion and by providing audit trails. It's also fairly easy for people to interact with rule-based systems, as they integrate well with interviews. In short, it's relatively easy to put legal knowledge into rule-based systems, easy to maintain it, and easy to get it out [85].

## **Disadvantage of RBR**

There's the problem of how to model vague or "open-textured" concepts. For instance, if a liability determination turns upon whether a person's conduct was "reasonable", the uncertainty and fuzziness of that term can't be modeled in a way analogous to human thinking. The other limitation facing rule-based systems is the "knowledge acquisition bottleneck." This is the effort required to codify, test, and validate expert domain knowledge. Part of the challenge derives from the reasons we have already mentioned, and part results from the need to capture the knowledge of human subject matter experts who don't always think in complete and precise "if-then" constructs [85].

## **2.12 Challenges of legal expert system**

### **A. Computerized problem solving**

The limitations of most computerized problem solving techniques inhibit the success of many expert systems in the legal domain. Expert systems typically rely on deductive reasoning models that have difficulty according degrees of weight to certain principles of law or importance to previously decided cases that may or may not influence a decision in an immediate case or context [35].

### **B. Time and cost effectiveness**

Creating a functioning expert system requires significant investments in software architecture, subject matter expertise and knowledge Engineering. Faced with these challenges, many system architects restrict the domain in terms of subject matter and jurisdiction. The consequence of this approach is the creation of narrowly focused and geographically restricted legal expert systems that are difficult to justify on a cost-benefit basis [36].

According to [36], the investment of time required to develop a knowledge- based system even in a narrow area of law is considerable. Firstly, there is the onerous task of deriving the domain knowledge and structuring this in a manner which is comprehensible to the knowledge engineer. Once derived the knowledge and expertise has to be translated into computer code. Testing improving and updating the system also needs to be factored into the time required. Owing to law's complexity and open-texture a legal expert system requires more time than many other domains. From the point of view of a legal practitioner time represents lost fee earning time measurable in financial terms. There is a strong financial disincentive therefore to deter practicing lawyers from acting as domain experts.

From the perspective of the end user, it is not likely to be cost effective to invest in the purchase of an expert system to resolve a particular legal problem that may only arise infrequently. However, a web service application which is only accessed and paid for on a pay for use basis makes more economic sense.

### **C. Domain related problem**

The inherent complexity of law as a discipline raises immediate challenges for legal expert system knowledge engineers. Legal matters often involve interrelated facts and issues, which further compound the complexity [36].

Factual uncertainty may also arise when there are disputed versions of factual representations that must be input into an expert system to begin the reasoning process [36].

- **The open textured nature of law**

As discussed in [86], open texture is the philosophy of language, philosophy of law as a term is introduced by Friedrich Weismann in his paper "Verifiability" (1945) for an unavoidable feature of empirical terms or statements. An empirical term, no matter how precise its core meaning, faces unlimited uncertainties of meaning when its dominant reference is extended or when it is employed in different contexts. The number of possible conditions in which it may be used is infinite. In the face of such open texture, Weismann concluded that no final verifiability is available for empirical statements. Open texture is the possibility of vagueness, because vagueness arises when a word is actually used in a fluctuating way while open texture exists

because there are always possible gaps in determining the meaning of a term. The term is used widely in legal philosophy for the particular cases in which a legal rule, although having a care of settled meaning, is unclear regarding what it prescribes or prohibits. No clear cut conceptual boundary is provided in these cases and consequently general legal rules are limited in their capacity to determine decisions and must be supplemented by judicial discretion. This feature of legal rules is a major reason for the criticism of legal formalism.

The importance of language for the law and the jurisprudence is without question. Lawyers work with words, sentences, and texts. The language is a central subject of the lawyer's work. The particularity of the legal language is the use of a special vocabulary. The presence of a particular term has specific connotations. The result is that legal language is more precise than natural language. At best legal texts are clear, simple, and pithy. Legal thinking is based on the vocabulary of legal terms which are used to express a definite concept. Lawyers have formed with the theoretical methods of abstraction and logic thinking notions of human beings, objects, and processes.

According to [88], the indefiniteness in law is as a specific consequence of the prevalence of open textured terms. They define an open textured terms as one whose extension or use cannot be determined in advance of its application. Open textured reasoning involves analysis of reasoning in defeasible rules, vague terms or classification ambiguities. This analysis of open texture is central to the designing of Legal Expert System. The existence of judicial discretion is a form of open textured.

The distinct types of situations considered by [87], which are difficult to resolve because of the open textured nature of law, are:

- a) **Classification difficulties:** for example, let's say that Addis Ababa University Arat kilo branch drafts a new rule that prohibits students not to enter the campus with their vehicle because the parking is only for the campus staff. Because of the newly drafted rule, there can be expected to be a little disagreement that the rule applies to which types of student: is that for UG (Under graduate), PG (Post Graduate) or Doctorial program students? Let say if the rule applies to all types of students, does it exclude or include students who are the campus staff because there are students who are working as a

campus staff but currently taking some courses? There are number of situations for which the application of the rule is debatable. Here, the term student brings the classification difficulties which lead the newly drafted rule to be considered as an open textured. Because there are different types of students, there are night students, extension students and even, there can be a student from higher government officials whose personal security has to be given a higher priority.

**b) Defensible rules.** Another types of textured arises from the defeasibility of legal concepts and rules. Any concept or rule, no matter how well defined, is always open to rebuke. Rarely do premises or consequents exist in laws that are universally accepted. Whilst an Ethiopian statute definitively prohibits drink-driving, few courts would convict a person who was forced to drive drunk at a gunpoint. The rule, in this case is defeated in the context of exceptional circumstances.

**c) Vague terms.** Legal tasks are often open textured because some terms or the connection between terms are vague. A judge finds the various interpretations of terms such as reasonable or sufficient stems from vagueness of these terms and not from classification dilemmas or defeasibility requirements. The totality of terms is one reason that deduction is an inappropriate differencing procedure for many problems in law.

The existence of judicial discretion contributes to the open textured nature of law. Yet, situations that involve discretion cannot be described as instances of classification difficulties, defeasible rules or the presence of vague terms. Thus in [37], it is argued that the existence of discretion is a distinct form of open texture.

As discussed in [37], consider a Family Court judges who agree on all the facts of a family law property dispute. Members of the panel can conceivably arrive at different percentage of the assets that ought to be awarded to the wife. The different outcomes may partly be due to the presence of vague terms that are interpreted differently by various judges. One judge classifies a lottery win as a contribution to the marriage whereas another does not. Different outcomes may even be the result of defeasible rules. One judge applies the principle of an asset-by-asset approach, whereas another considers that principle irrelevant and adopts the global approach.

As argued in [37], while the above scenarios describe situations that are open textured, there is another situation, common in family law cases that are not captured by these instances of open texture. Let us assume that all judges interpret the terms in the same way. Therefore, there are no classification anomalies and all judges have used the same principles. Even in such a situation, the outcomes may still be different, because judges apply different weights to each relevant factor. For example, one judge may provide a highest weight for the future opportunity of spouses, whereas the other judge may give the highest weight for the contribution of each spouse for the common property. No judge is wrong at law because the statute clearly affords the decision-maker precisely this sort of discretion. Thus, an additional situation is apparent; one where the decision-maker is free to assign weights to relevant factors, or combine relevant factors in a manner of his/her own choosing. This discretion will certainly contribute to the open textured nature of law and to indeterminacy.

### **Dynamism**

Law in any jurisdiction is not static. Therefore, any legal expert system has to be flexible and constantly updated to take account of changes emanating from legislation, statutory instruments, and ordinance. However, in a world where legislation is constantly changing, a legal expert system also needs to be able to cope with the challenge of major changes in the law.

As it is discussed in [36], the problems posed by expert systems in the domain of legal practice have been formidable. The complexity, uncertainty, and dynamic nature of legal advice have acted as significant barriers to the development of effective and useful commercial applications. Financial disincentives have also impeded the development of commercial legal applications of expert systems on the supply side. Cost effectiveness of traditional expert system software loaded on to a stand-alone computer or local area network has been questionable therefore restricting the demand for such systems.

## 2.13 Summary

In this Chapter, the domain area of the present work is discussed in detail. This helps us to grasp sufficient knowledge about the basic behavior of the domain of this research, law. As it is discussed, law doesn't have a global definition and different scholars define law differently. The global legal system grouped into two (i.e. Common law and Civil law legal system). In Common law legal system, there is no comprehensive compilation of legal rules and statutes. It does rely on precedents. But, Civil law legal system is codified. Because law documents are structured as titles, chapters, sections and articles, it is suitable to represent using XML. Therefore, a specific article can be returned as a result of user query. XML representation is not sufficient to satisfy the legal information need of a user. If the user doesn't know how to formulate a query and how to use the result, still the user legal information needs will be there for making a better legal decision. For such purpose, expert system will be the best computerized solution. Expert system is a computer program, which can be devised to solve complex problems of decision making. And legal expert system is a special type of expert system, in which the domain area is on legal matters. There are CBR and RBR methodology for developing an expert system. Depending on the nature of the legal system, civil law legal system is suitable for RBR expert system because codes can be easily converted into rules.

## **CHAPTER THREE**

### **RELATED WORK**

In this chapter, different attempts to develop a legal expert system, which will help litigant in legal decision making processes, are discussed. When considering decision making as a knowledge-manufacturing process, the purpose of a decision support system is to help the user manage knowledge. A decision support system fulfills this purpose by enhancing the user's competence in representing and processing knowledge. It supplements human knowledge management skills with computer-based means for managing knowledge. A decision support system accepts, stores, uses, receives and presents knowledge pertinent to the decisions being made. Its capabilities are defined by the types of knowledge with which it can work, the ways in which it can represent these various types of knowledge, and its capabilities for processing these representations.

There are two major strategies for developing a legal expert system as discussed in Chapter Two. Here, the related works that are reviewed are categorized as rule based legal decision support systems, case based legal decision support systems and combined (i.e. both rule based and case based ) decision support systems.

#### **3.1 Rule based reasoning legal decision support expert system**

As the name already indicates, rule-based systems are composed of a finite number of rules. These rules normally can be formulated as conditional clauses of the following form: If condition A holds, then it can be concluded that the statement B is true as well. Thereby, the "if"-part of the rule is called proposition or left hand side where as the "then"-formulation is referred to as conclusion or right hand side. Beside these rules, the knowledge base in rule-based systems consists of facts. Facts, in general, are elements that can be described by a finite amount of discrete values. The coherences between the elements are represented by rules [33]

There are many knowledge representation techniques [37, 60]. Logic is particularly useful in the domain of automated theorem providing, which can trace its roots to the work of Newell and Simon in the early 1960s, the earliest legal knowledge based systems were developed in the 1970's; they were primarily rule-or logic based.

The JUDITH system [61] used rules to represent part of the German Civil Code. Two different kinds of rules were used; general rules which define the elements of the claim, and specific rules extracted from cases. Things and relations are used to represent the everyday world of human affairs and are classified hierarchically into categories. A fact comprises two things and a relation between them; facts are assembled into situations. These situations are compared with the situation of the instant case, and the system determines the extent to which the instant case falls within or near the law of intentional torts.

TAXMAN was a logic-based deductive reasoner concerned with the taxation of corporate organizations. In [64, 65] that domain is chosen because, the developers believed the corporate tax domain is primarily a tidy world of formal financial rights and obligations.

TAXMAN I [64] used an entirely rule based model. TAXMAN II [65] proceeded beyond the scope of rule-based systems by attempting to deal with open textured concepts such as continuity of interest, business purpose and step transactions. It represented legal arguments as a sequence of mappings from a prototypical case to a contested case, in an attempt to perform analogical reasoning. Instead of adding cases to the knowledge base, open textured concepts were represented using a prototype-a concrete description expressed in the lower level representation language-together with a sequence of deformations or transformations of one concrete description into another.

In developing TAXMAN II, the developer noted:

- Legal concepts are open textured;
- Legal rules are dynamic as they are applied to new situations they are constantly modified to fit the new facts;
- In the process of theory construction, there are plausible arguments of varying degrees of persuasiveness for each alternative version of the rule in each new fact situation, rather than in a single correct answer.

TAXADVISOR [66] used EMYCIN to assist lawyers in estate tax planning. It collected data about clients and suggested strategic plan about various aspects such as life insurance, retirement schemes, wills and making gifts and purchases. Rather than provide statutory interpretation, TAXADVISOR uses lawyers' experience and strategies to produce plans.

The British Nationality Act as a Logic Program [67] uses logic programming to perform statutory interpretation upon the British Nationality Act of 1981. The data needed for individual cases is stored in the APES shell. The answers produced by APES are the logical consequences of the rules together with information. The knowledge in the rules is represented in and/or graphs. Whilst the system is an interesting application of logic, the paper is jurisprudentially flawed, because it believes that law is straightforward and ambiguous.

For example, the authors claim that a statement as to whether an infant was born in the United Kingdom is a readily verifiable fact. But is this statement true? The boundaries of the United Kingdom are both constantly changing and in dispute. When the system was developed in 1986, if a child was born in Hong Kong, was she born in the United Kingdom under the Act? At that time, Hong Kong citizens had British citizenship, but not the right of abode in the United Kingdom. Are the Falkland Islands (or Malvinas to others), part of the United Kingdom? These issues cannot be determined by reference to the Act or Precedents. They depend on International Treaties, and even more significantly, delicate negotiations.

ExperTAX [68] was developed by Coopers and Lybrand to provide advice to clients of United States' certified public accountants on how to conduct the tax accrual and tax planning functions. The system improves staff accountants' productivity; the quality of information provided to them and accelerates their training process.

As in [37], SOFTLAW Corporation Limited is an Australian company that provides software solution for the administration of complex legislation, policy and procedure. SOFTLAW product-STATUTE Expert-is a knowledge base management system specifically designed for administrative rules. SOFTLAW has a comprehensive software project management methodology, which provides the following tools to software teams;

- A. A document process model, which outlines all procedures and the products to be developed during the life of a project.

- B. Templates for producing documentation on all issues to be considered at each step in the process; and
- C. A team model, which ensures representation of all perspectives in the team.

Many Government agencies administer complicated legislation, policy or processes. Agencies structure their work organization, budget and level of client service around managing this complexity. The traditional management approach uses high numbers of specialized in-house staff, trained in individual aspects of an agency's work.

SOFTLAW can create a rule base model of any complex legislation, policy or process. This makes the source material accessible to generalist users. STATUTE expert guides a user through the rule base, and advises on the right course of action.

Law firms interpret and apply legislation to give advice to businesses and individuals. STATUTE expert models complex legislation and rules and removes the experience of complexity for the user. With STATUTE Expert, lawyers can provide online advice on procedural law, supported by comprehensive legal reasoning.

They can work effectively and quickly with unfamiliar legislation. Routine work can be done by non-specialists and generalists. Costs to a firm and to clients can be reduced.

Government regulation affects every business. Regulatory regimes are often complex, costly and burdensome for businesses. Which want to meet their obligations as simply and cheaply as possible? Regulatory agencies have conflicting interests. Their policy is to target their regulations precisely and maximize the level of compliance. They also want to meet the needs of the businesses they regulate and the industry groups that pressure them to reduce the burden of compliance. Using rule base technology, SOFTLAW has created tools that remove most of the complexity from regulations, helping industry to comply quickly, easily and reliably.

SOFTLAW is successful commercial enterprise which provides legal decision support systems for governments in Australia, the United Kingdom and the United States. It is listed on Sydney (Australia) stock exchange.

The JAES project [36] in essence aimed to embody the rules on passing of property and risk that are contained in sections 16 to 20 Sale of Goods Act (SGA) in a prototype expert system.

Disputes between buyers and sellers on the question of which party bears the risk of accidental damage to goods are inevitable. Insurance companies need to clearly identify the risk-borne party when settling claims. Traditionally, in such a situation, sections 16- 20 of the Sale of Goods Act (SGA) are applied by lawyers who advise the parties or their respective insurers. The traditional approach is both time consuming and expensive. JAES was developed by the authors in order to speed up the process and make it more cost effective especially for low value and routine disputes. The inference engine applies the logic contained in the knowledge base to the information input by the user and outputs advice on whether the seller or the buyer bears the risk of loss or damage to goods in a particular contract for the sale of goods. The rules comprised in sections 16 to 20 SGA were deliberately selected as the subject matter for the knowledge base, as the authors perceived them to be an attractive area for a legal expert system for the following reasons:

- The logical basis underlying sections 16 to 20 SGA is relatively clear.
- It is an area of the law of practical commercial importance.
- This area of law has been stable with relatively infrequent statutory amendments.

A modular approach to the design of the system was adopted. Owing to the number of rules required, the system's performance needed to be enhanced in a later version by utilizing a Q-learning algorithm.

Split Up [37] is a rule based / neural network/ decision support system that represent knowledge using frames based on the argument structure proposed by the British philosopher, Toulmin. Split Up makes predictions about marital property following a divorce in Australia; a domain that is considered discretionary in that a judge has considerable flexibility. The end users of Split Up are judges and registrars of the Family Court of Australia, mediators and lawyers. Each end user has specific and divergent needs and thus uses the system in different ways however all users rely on effective explanations. The argument based representation of knowledge enables the system to have the flexibility required of different users, to generate effective explanations and also facilitates knowledge acquisition. The framework has been used to integrate rules with neural networks but can easily be used to integrate other inference methods. The system predicts the percentage of marital property a Family Court of Australia judge will award litigants to a

divorce. Consultations with domain experts from a state funded legal service identified a total of 94 relevant variables. Data reflecting values for these variables has been collected from over one hundred judgments made by decision makers in the Family Court. The data was used to train neural networks.

A Web-based Decision Support System for Divorce Lawyers [59] is a knowledge based system that could advise on Scots law relating the allocation of matrimonial property when two people divorce. The system was intended to be comprehensible both to lawyers and lay persons; it would allow a user to go through a step by step consultation. The user interface was built using java Server Pages (JSPs); and JESS (the Java Expert System Shell) was used to develop rule based reasoning.

### **3.2 Case based reasoning legal decision support expert system**

The processes that make up case-based reasoning can be seen as a reflection of a particular type of human reasoning. In many situations, the problems humans encounter are solved with a human equivalent of CBR. When a person encounters a previously inexperienced situation or problem, they often refer to a past experience of a similar problem. This similar, previous experience may be one they have had or one another person has experienced. In the case that the experience was made by another human, the case will have been added to the (human) reasoner's memory via either an oral or written account of that experience [55]. For example, many students will come to their teacher or lecturer with various requests. These requests might be for an extension to a deadline or perhaps additional materials. It is a common experience of the teacher on refusal of one of these requests to have the student argue the point. One of the common techniques a student will use is to present evidence that in another course, or with another lecturer or teacher, their request was granted in a similar situation, with similar underlying rules.

Reasoners compare problems to prior cases to draw conclusions about a problem and guide decision making. All Case-Based Reasoning (CBR) employs some methods for generalizing from cases to support indexing and relevance assessment and evidences two basic inference methods: constraining search by tracing a solution from a past case or evaluating a case by comparing it to past cases. Across domains and tasks, however, humans reason with cases in subtly different ways evidencing different mixes of and mechanisms for these components [70].

HYPO is an adversarial case-based reasoning system that deals with trade secrets law [75]. Probably the best known and most documented of all case-based reasoning systems, Hypo was developed by Kevin Ashley and Edwina Rissland at the University of Massachusetts. Hypo analyses problem situations in the trade law area and retrieves relevant cases from its case base, forms them into legal arguments. Hypo, a computer program that performs case-based reasoning in the legal domain, helps attorneys analyze and make arguments about new fact situations in terms of the most relevant precedent cases. To perform this task, Hypo must make factual comparisons of cases relative to the problem situation and determine the legal significance of comparisons in terms of arguments about the problem situation. The authors describe techniques that Hypo uses to compare cases, choose the best cases for evaluating, and construct arguments about a new fact situation. They demonstrate how Hypo critically compares a problem situation to the most relevantly similar precedent cases to outline an argument regarding how to decide the current fact situation (CFS) based on its significant similarities to and differences from most on point cases (MOPCS). Hypo's main tool for this task is the claim lattice mechanism. The authors present a detailed example of a claim lattice actually generated by Hypo to analyze a real legal case.

Another system is OPINE (Office Practice INquiry Expert) [78] a generic case-based reasoner for use in legal domains. OPINE is different to the previously described CBR systems as it has only a single function and that is to provide evaluation of likely case outcome. It is a single function to provide evaluation of likely case outcome and it is set in a particular legal context that of advice giving. The system employs paradigm based reasoning to perform the task. The authors develop a case base that can be structured to reflect the added significance of a high level precedent in hierarchical schemes for decision making.

An earlier system by Lambert & Grunewald [79] is LESTER (Legal Expert System for Termination of Employment Review), a case-based reasoning program in the area of unjust discharge from employment under collective bargaining agreements.

William Bain, in his PhD dissertation [77] discusses the system JUDGE. JUDGE is a case based reasoning system that attempts to model the sentencing of criminals done by real-life judges by comparing current cases to what judges have done in the past. He used interviews with judges

asking them to describe what they would do in certain hypothetical cases to determine the factors involved. The JUDGE system has been developed to demonstrate the utility of using the goals of a program to reason about input situations by indication differences (and their effects) between the input and other stored situations, and then storing the input along with some notation of the reasoning which was applied to it. The domain of the system is criminal law concerning the formation of sentences for criminal cases; the goals of the program refer to features which are significant to human judges. These include the extent of harm suffered by victim, interpretations which both explain a person's actions. Such as "self-defense" and which suggest a degree to which an action was justifiable, and the relative importance of mediating circumstances. The manner in which input items are stored reflects their relationships to those situations already stored, with respect to the goals of the system

### **3.3 Hybrid legal decision support systems**

Some of the legal decision support system had been developed by using both the case base and the rule based reasoning methodology. Because of this, the system would combine the strong side of each methodology and compensates the drawback of rule based reasoning methodology by case based reasoning and the vice versa. Among the system that are developed by combining both the rule based and case based reasoning methodologies some of them are discussed.

ASHD-II [53] was developed as a hybrid legal system in the area of divorce law. It consisted of a rule base and a case base. The reason for the development of this hybrid was to take advantage of both of these methods since the nature of law means that it can be necessary to use precedents (easily represented by CBR) and other legal sources such as statutes, codes (more easily represented in a rule based format). The system illustrated that there was success in terms of creating the hybrid system but that even this did not fully capture the behavior of a legal practitioner and they concluded that the system was more useful as an aid to the less experienced practitioner.

HELIC-II[81] (Hypothetical Explanation constructor by Legal Inference with Cases by 2 inference engines) is a hybrid legal system for the penal code, using legal rules (the law) and cases (precedents). HELIC-II draws legal conclusions for a given case by referring to a statutory law (legal rules) and judicial precedents (old cases). This system consists of two inference

engines. The rule-based engine draws legal consequences logically by using legal rules. The case-based engine generates legal concepts by referencing similar old cases. These engines complementally draw all possible conclusions, and output them in the form of inference trees. Users can use these trees as material to construct arguments in a legal suit. HELIC-II is implemented on the parallel inference machine, and it can draw conclusions quickly by parallel inference. As an example, a legal inference system for the Penal Code is introduced, and the effectiveness of the legal reasoning and parallel inference model is shown.

The IKBALS (Intelligent Knowledge Based Legal System) [82] project aims to build intelligent legal tool. The project integrates rule based and case reasoning with intelligent information retrieval. The authors aim to build legal support tools which can be modified to suit various domains rather than single purpose legal expert systems. They focus on principles behind developing legal knowledge based systems. The original domain chosen was the *Accident Compensation Act* 1989 (Victoria, Australia), which relates to the provision of benefits for employees injured at work. For various reasons, which are indicated in the paper, the authors changed their domain to that of *Credit Act* 1984 (Victoria, Australia). This Act regulates the provision of loans by financial institutions. The rule based part of the system provides advice on the Credit Act has been commercially developed in conjunction with a legal firm.

Another system which used ANNs for knowledge extraction is HILDA [83], which use the knowledge extracted from a ANN to guide the rule inferences and cases retrieval. HILDA incorporates some aspects of rule based reasoning (“RBR”) and case based reasoning (“CBR”) to assist the user in predicting case outcomes and generating arguments and case decisions. The system can use the NN to guide RBR and CBR in a number of ways. Knowledge extracted from a NN could also be used to iteratively refine the system's domain theory. This refined domain theory is one way in which HILDA can carry out RBR and CBR

Hollatz [84] also developed a neuro-fuzzy approach in legal reasoning which tried to find structure in precedent decisions as well as to identify legal precedents. Train a neuro-fuzzy system using both rule-based knowledge and inductive learning to find structure in legal precedent decisions as well as to identify legal precedents. Similar to humans, an information processing system should be able to exploit knowledge that is presented in form of rules as well

as information that is acquired through experience. The author demonstrates how fuzzy rule-based knowledge can be used to pre-structure a neural network. In this way, the network has problem specific knowledge prior to training. After training, the altered fuzzy rules can be extracted and interpreted by an expert. The viability of the approach is demonstrated in a legal application, where fuzzy rules defined by a legal expert as well as previous court decisions are used for network structuring and training

### **3.4 Summary**

From the related work we have seen so far, we have learned that it is possible to develop a Legal Decision Support Expert System (LDSES) for the case of Ethiopia. And we have seen RBR is better than CBR for our purpose. Because in RBR the knowledge base is composed of set of rules, while the knowledge base in CBR is composed of a set of precedents (prior cases). Since the Ethiopian legal system is not categorized as Common law legal system, there are no well-organized precedents. Therefore, it will be difficult to use CBR as a methodology for developing a LDSES for the case of Ethiopia. Even if we can develop LDSES using CBR, it will not be as such important. In Ethiopian courts, to pass certain decision on some issues, mainly articles are presented as evidence, not the prior similar case decision, unless the prior cases are from the federal cassation division. All attempts to develop LDSES are made outside Ethiopia. Those different attempts outside Ethiopia cannot be adapted directly because legal matters are sensitive. There is a difference in legal codes between the countries where those attempts are made and Ethiopia.

## CHAPTER FOUR

### DESIGN OF THE LEGAL DECISION SUPPORT EXPERT SYSTEM

In this chapter we will discuss how we designed the proposed Legal Decision Support Expert System. The first step in designing the proposed LDSES is to select the category of law, which the proposed LDSES is developed. As it is described in chapter two, there are two major categories of law i.e., civil and criminal. Civil law by itself is also classified into different categories like family law, property law, succession law, contract law, etc. After the category of law in which we relied on to develop the legal decision support system are selected, how to encode the codes into computer rules which the computer can use those rules to analyze the users input is described and then to provide some suggestions are discussed.

#### 4.1 Selecting the category of law

As it is described in Chapter Two, criminal law is that part of law which characterizes certain kinds of wrong-doings as offense against the state, not necessarily violating any private right, and punishable by the state. Crime is defined as an act of disobedience of the law forbidden under pain of punishment, which ranges from death or imprisonment to a financial penalty or absolute discharge. Such wrong doing is mostly proved by evidence it can be like eye witness. Because of this nature, it seems that it will require intensive study and collaborative work with legal staffs and computer professionals to develop a feasible system. The resource (human, material and money) and the time limitation will make developing a decision support system for criminal law not possible now.

Civil law is concerned with the rights and duties of individuals toward each other. And each duty and right is clearly stated as a statute; as a result, developing a decision support will be relatively possible at the current resource, time and knowledge limitation.

In addition to the above reasons, from the report collected from *Debrebirhan Wereda Court* and *North Shoa High Court*, the majority of cases for each consecutive year since 2003 E.C are civil cases. So that it is believed that conducting research for developing a legal decision support system for civil category of law is valuable to address the majority of the society's problem.

The summarized reports collected from Debre Birhan Wereda Court and North Shoa High Court are shown in Table 4.1 and Table 4.2 respectively.

<b>Debre Birhan woreda court</b>										
	<b>Civil</b>					<b>Criminal</b>				
<b>Year /E.C</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>Total</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>Total</b>
<b>Cases</b>	<b>95</b>	<b>1375</b>	<b>1851</b>	<b>2356</b>	<b>5677</b>	<b>26</b>	<b>905</b>	<b>1313</b>	<b>1685</b>	<b>3931</b>

**Table 4.1 Debre Birhan woreda court presented cases since 2003 E.C**

<b>North Shoa high court</b>										
	<b>Civil</b>					<b>Criminal</b>				
<b>Year /E.C</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>Total</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>Total</b>
<b>Cases</b>	<b>414</b>	<b>2770</b>	<b>3009</b>	<b>3041</b>	<b>9234</b>	<b>428</b>	<b>2234</b>	<b>1945</b>	<b>1756</b>	<b>6363</b>

**Table 4.2 North Shoa high court presented cases since 2003 E.C**

Once civil law is selected as a category of law, we can develop the model of the proposed legal decision support expert system. Even in civil law, there are different branches of law as stated above, like family law, property law, case law, etc. Among the listed classification of civil law, family law is the latest revision. And it is believed that the latest revised code minimizes the chance of judge discretionary power. The discretionary power of judges will be less if there is no gap or open textured concept. Therefore, family law category is selected to demonstrate the proposed legal decision support expert system.

## **4.2 Knowledge acquisition**

In this work, gathering the needed knowledge, analyzing the knowledge and modeling the gathered knowledge are the basic activities that were done. To collect the required knowledge, both secondary and primary sources of knowledge were used. To imitate the human legal expert in deductive reasoning, there were discussions with two federal high court judge and two attorneys (both in Federal and regional courts) and two law teachers. From such discussions, it was able to understand how the statute in family codes of Ethiopia was used to reason out for certain claims.

### 4.3 Methodology

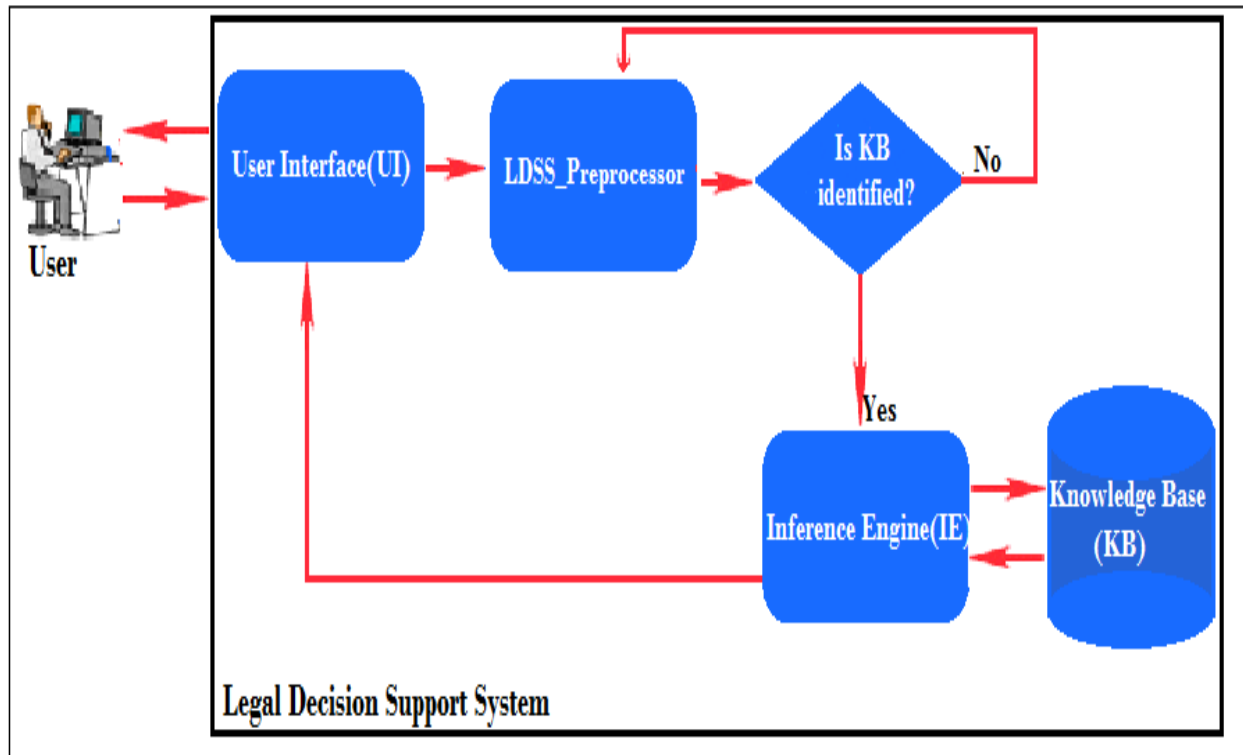
As discussed in Chapter Three, there are two major methodologies in designing legal expert system. In this work, rule based reasoning methodology is used for the following two major reasons:

1. The systems that are developed are on family law in case of Ethiopia law. Because the Ethiopian judiciary system is called written law, the judges follow the statute and regulation for deciding on certain cases, not based on the precedents. Therefore, for certain cases the statute should always be present as evidence for proving certain cases. Furthermore, because rule based reasoning techniques use set of rules as an evidence for proving certain cases, it will be appropriate for written law judicial systems.
2. Collecting similar cases are impossible from the courts because the cases in the courts are accessible for the case owner only. When the researcher tried to collect precedent cases, both the *Debre Birhan Wereda Court* and *North Shoa High Court* were not willing to give the copy, saying that it contradicted the secrecy of private information of the case owner.

Hence, because of these reasons, it is decided to build the model of the proposed legal decision support expert system using the rule based reasoning methodologies.

### 4.4 Architecture of the proposed system

From the literature reviewed, we could not find any architecture designed for the legal expert system purpose. The architecture bellow shown in figure 4.5, are adopted from the general architecture of expert system, with some modification. The general architecture of the expert system has only, the User Interface (UI), Inference Engine (IE), and Knowledge Base (KB). Here, on the architecture of the proposed LDSES system, we add “*LDSES\_Preprocessor*” component for the purpose of increasing the performance of the system. The details about “*LDSES\_Preprocessor*” is presented in section 4.5.3



**Figure 4.5 The architecture of the proposed legal decision support expert system**

**4.4.1 User Interface (UI):** is the front end (the outer layer) of the expert system. It is used to accept input from the user and feed it into the “*LDSES\_Preprocessor*” component of the expert system at the first time and after the first communication the remaining communication will be with the inference engine of the system. And after the user information is processed, the final result is also exposed on the user interface

**4.4.2 Legal Decision Support System Pre-processor (LDSES-Preprocessor):-** is the crucial component that we introduced on to the general architecture of the expert system, for this research. It helps to minimize the time the system has consumed in order to scan the large set of rules from the knowledge base. Without the presence of this component, to determine which rule (s) to fire after certain user input, the system has to scan, through all the possible rules from the knowledge base until it is decided which rule should be fired, or until it is determined as there is no rule definition for the user input.

**Example:** It is often possible to use the natural structure of a problem to group related rules into knowledge bases that are linked as necessary during the course of a consultation. For example, the family law mainly tries to solve disputes arising in **Marriage, Filiation, Minors** and **Adoption**. Rather than putting all those different types of Family law code (knowledge) in one knowledge base, putting each different category of family law in separate knowledge base and load the most valuable knowledge base during the communication of the system and the user, to solve the user's problem, will be more efficient (reduce the time and resource used during inferencing) way of implementing an expert system.

The expert system would initially load the "**LDSES\_Preprocessor**" component that would use prompts and rules to determine whether the **Marriage.kb, Filiation.kb, Minors.kb** or **Adoption.kb** was used to solve the user's problem. Then, the appropriate knowledge base would be loaded, and the consultation will be continued. This decomposition of knowledge will be possible and will be used properly, only when there is additional component (like LDSES\_Preprocessor) which can work cooperatively with the inference engine. The LDSES\_Preprocessor component that we added on the common architecture of an expert system, will determine which knowledge base has to be loaded for the inference engine reference to process the user input.

### **Advantages of decomposing the rule base when implementing expert systems include:**

- The knowledge engineering (collecting data and convert into rule base) process may be facilitated by this architecture: the specific family law specialized experts can be used to input detailed knowledge of the domain area.
- Debugging the knowledge base may be simplified by testing smaller knowledge bases one at a time, then integrating them into the overall application.
- Maintenance of the knowledge base may be more efficient if responsibility can be delegated to subsystem experts:
  - Additions/extensions that will improve recommendation quality may be more readily identified if the rules are grouped into logically dependent sets. In diagnostic systems, Experts with more detailed expertise in each of these areas could then be called on to enhance the systems knowledge.
- Maintenance in decision table format (with software like e2gRuleWriter, for example) may be simplified if the overall rule base is structured into smaller rule sets so there are fewer columns in the decision table and these columns represent more integrated knowledge.

**4.4.3 Inference Engine (IE):** the inference engine is the third layer of the expert system. The Inference Engine (IE) is sometimes called as an expert system shell. As defined in [29], the expert system shell is an existing knowledge independent framework into which domain knowledge can be inserted to produce a working expert system. It accepts the user input from the user interface and the “*LDSES\_Preprocessor*” then searches the possible combination of rules from the knowledge base for providing the required, decision support service to the users.

**4.4.4 Knowledge Base (KB):** - it is the backend of the expert system. The knowledge base contains the domain-specific knowledge required to solve the problem. The knowledge base is created by conducting a series of interviews with the legal expert and by reviewing the Ethiopian revised family code, and organizes the knowledge in a form If-Then rules that can be directly used by the system. The knowledge base, for our purpose, contain a set of mutually exclusive fragmented knowledge bases (marriage.kb, filiation.kb, minors.kb, and adoption.kb ).

## CHAPTER FIVE

### IMPLEMENTATION OF LEGAL DECISION SUPPORT EXPERT SYSTEM

In this Chapter, we present a detailed description of the implementation of the components and sub-components of the Legal Decision Support Expert System (LDSES) discussed in Chapter Four of this document. First, the knowledge engineering strategies and the algorithm which encompasses both the Data collection and Data encoding are discussed. Data encoding is the process of converting the domain knowledge into set of rules called the knowledge base. Second, the designing of additional components that the LDSES include in addition to consultation, like provide the users a capability of uploading sample cases that the user can refer to and download the sample cases for personal reference is covered. And finally, we discussed the interface of the proposed Legal decision support system.

#### 5.1 The knowledge engineering (data collection and encoding)

Knowledge engineering is the process of gathering and codifying an expert system's knowledge in a form that is accessible to a non-expert through an expert system. Expertise necessary to solve the problem must exist. Expert systems cannot solve problems that no human expert can solve. In most cases, this means that access to an acknowledged expert who provides advice in the problem domain is required. For small scale expert systems, some of the expertise might be documented in published sources, but interaction with a person who has experience in actually solving the problem while we are developing the knowledge base is still recommended. Based on this recommendation, we have used both the acknowledged expert and the published sources as a source of information for the knowledge engineering purpose. In addition to the *Ethiopian Revised Code* (which can be considered as a published source), we have used two attorneys (Both in federal and regional courts) and one Federal high court judge and two law school lecturers from Debre Birhan University as an expertise source of the domain knowledge.

The first strategy we have used for the knowledge engineering purpose was just fabricating a sample case that might be present in the Court. Second, we identify the possible methods that the judges in the court might have used in arriving at a final verdict, and then finally we draw the logic flow chart and write the equivalent rules which act as a rule.

For example: If someone asks the human legal expert for advice about “*IS OUR MARRIAGE VALID ACCORDING TO ETHIOPIAN REVISED FAMILY CODE?*” then the human legal expert examines whether the person will satisfy all the *ESSENTIAL CONDITION OF MARRIAGE* by asking a series of questions. If the *ESSENTIAL CONDITION OF MARRIAGE* is satisfied, then the human legal expert will respond *THE MARRIAGE WILL BE VALID*. Otherwise, the marriage will be invalid by asserting the reason why it will be invalid.

For representing the analyzing capability of the human legal domain expert as an expert system, the first and the best technique we have found is developing a *LOGIC FLOW CHART*. It is the best strategy that we recommend both for developing and testing the knowledge base. The developed logic flow chart for “Is our marriage will be Valid according to Ethiopian Revised Family code?” shown in Figure 5.1

After we have developed the logic flow chart shown in Figure 5.1, the next step is to develop the knowledge base that the inference engine will use in advising the user as human legal experts do.

We have used a java platform called *e2gRuleEngine* expert system shell that analyzes the user input and provides some consultation according to the user inputs. The set of rules is Prefix with a key word *RULE* followed by a short identifying description of the rule enclosed in square brackets. *REM* statements: These are single line comments ignored when the knowledge base is processed. The *REM* command must appear at the beginning of the line, and everything else on that line is ignored.

A serious of questions that will be present to the user will be preceded by a key word *PROMPT*. *PROMPT* definitions: *Prompts* should be included in the knowledge base after all rules are defined. Possible elements of each prompt include:-

- ✓ The first line begins with *PROMPT* followed by an attribute name enclosed in square brackets followed by the prompt type
- ✓ The prompt type can be *YESNO*, *Multi Choice*, *Forced Choice*, *All Choice*, *Choice*, *Numeric* and *Text*
- ✓ The second line provides the stem of the prompt enclosed in matching single or double quotes.

### Is our Marriage Valid According to Ethiopian Revised Family Code: Logic Flow Chart

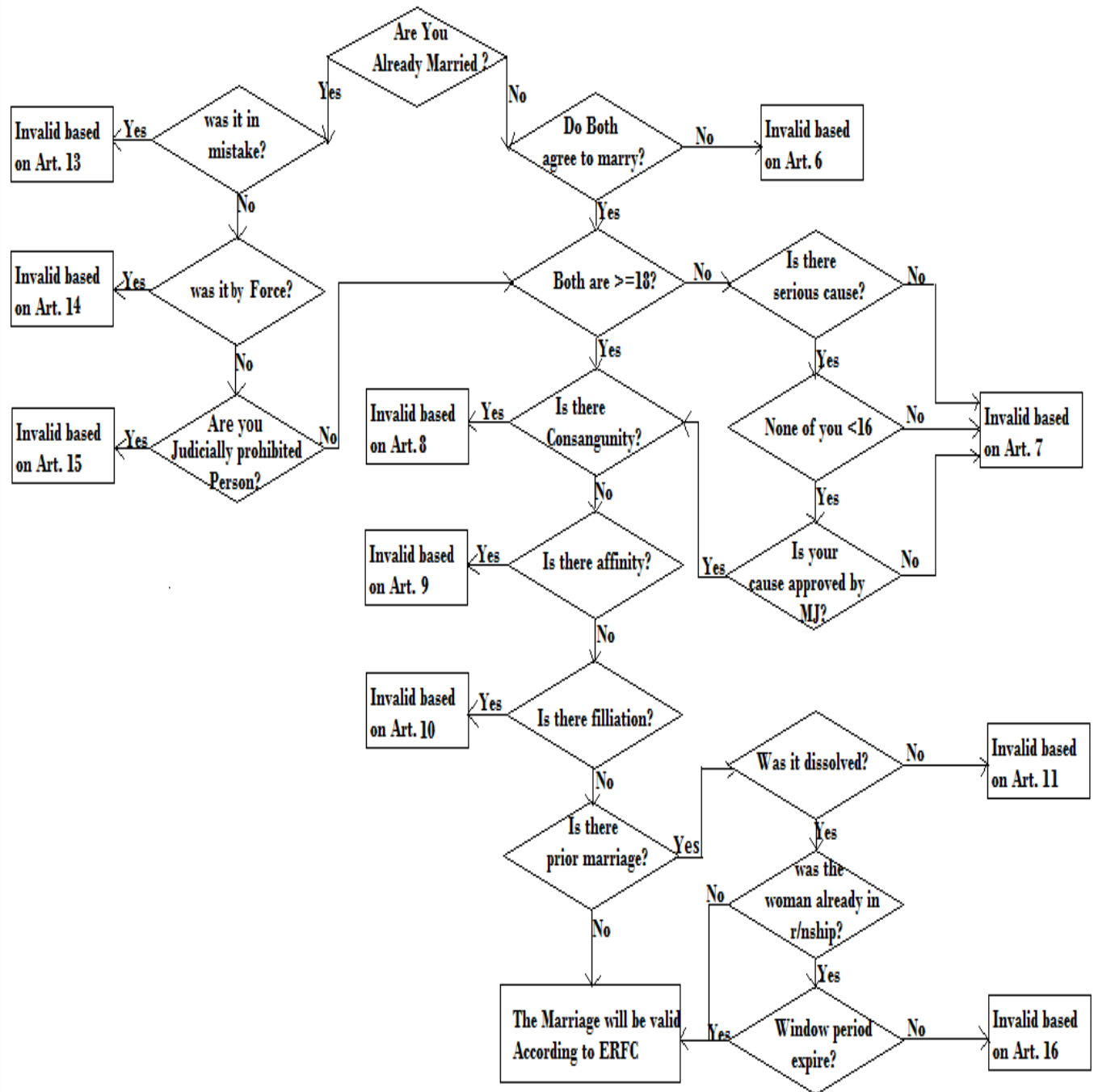


Figure 5.1. The Logic Flow Chart.

GOAL: is the final decision if the consecutive rules are satisfied. GOAL definitions: Each GOAL is defined on a single line that begins with GOAL followed by the name of the goal attribute enclosed in square brackets. GOALS may be specified before or after PROMPTS, but must follow RULE definitions. There has to be at least one GOAL statement in a knowledge base: GOALS are the attributes for which the inference engine seeks values. The inferencing process ends when all GOALS have been resolved or cannot be resolved.

We select English as a language for the communication between the user and the system. The system presents the smart question using normal English. The reason we are using English is because we used the English version of the revised family code of Ethiopia. Since the revised family codes are presented in two versions (Amharic and English), it will not be difficult to develop the Amharic version of the LDSES. Because of time constraint, we develop only the English version of LDSES.

Figure 5.2 shows The Equivalent Knowledge Base (Rule base) that the Expert system uses for the Logic flow chart that is shown in Figure 5.1.

```

REM =====
REM The Rules
REM =====

RULE [check previous marriage]
If [Already married] = true
Then [preMarriage] = "Exist"
Else [preMarriage] = "not exist"

RULE [checking mistaken]
If [Is mistaken?] = true
Then [mistaken] = true
Else [mistaken] = false

RULE [decide mistaken marriage]
If [preMarriage] = "Exist" and
[mistaken] = true
Then [The System Prediction ] = "Your Marriage will be invalid According to Ethiopian Revised family code, article 13."

RULE [identify forced marriage]
If [why married?] : "By Family pushh" "To protect my family from future accident" "By other obligatory(not my intetional) reason"
Then [forcedMarriage] = true
Else [forcedMarriage] = false

RULE [evaluate forced marriage, not mistaken]
If [preMarriage] = "Exist" and
[mistaken]=false and
[forcedMarriage] = true
Then [The System Prediction ] = "Your Marriage will be invalid According to Ethiopian Revised family code, article 14."

RULE [evaluate forced marriage, not mistaken, judiciary prohibited]
If [preMarriage] = "Exist" and
[mistaken] = false and
[forcedMarriage] = false and
[judicially prohibited?] = true
Then [The System Prediction ] = "Your Marriage will be invalid According to Ethiopian Revised family code, article 15."

RULE [evaluate forced marriage, not mistaken, not judiciary prohibited]
If [preMarriage] = "Exist" and
[mistaken] = false and
[forcedMarriage] = false and
[judicially prohibited?]=false
Then [order] = "consider other facts"

```

RULE [evaluate order]  
If [order] = "consider other facts" and  
[marriage age>=18]=false  
Then [orderOne] = "consider other facts"

RULE [assign orderone]  
If [preMarriage] = "not exist" and  
[consent?] = true and  
[marriage age>=18] = false  
Then [orderOne]="consider other facts"

RULE [evaluate marriag not exist]  
If [preMarriage] = "not exist" and  
[consent?] = false  
Then [The System Prediction ] = "Your Marriage will be invalid According to Ethiopian Revised family code, article 6."

RULE [evaluate marriag not exist]  
If [orderone] = "consider other facts" and  
[serious cause?] = false  
Then [The System Prediction ] = "Your Marriage will be invalid According to Ethiopian Revised family code, article 7, sub article 2."

RULE [evaluate marriag not exist]  
If [orderone] = "consider other facts" and  
[serious cause?] = true  
Then [ordertwo] = "analyze other facts"

RULE [anlayze other existing facts]  
If [ordertwo] = "analyze other facts" and  
[your age>=16?] = false  
Then [The System Prediction ] = "Your Marriage will be invalid According to Ethiopian Revised family code, article 7, sub article 2."

RULE [anlayze other existing facts]  
If [ordertwo] = "analyze other facts" and  
[your age>=16?] = true and  
[cause approved by mj?] = false  
Then [The System Prediction ] = "Your Marriage will be invalid According to Ethiopian Revised family code, article 7, sub article 2."

RULE [anlayze other existing facts]  
If [order2] = "analyze other facts" and  
[your age>=16?] = true and  
[cause approved by mj?] = true  
Then [orderthree] = "analyze other facts"

RULE [analyze other facts]  
If [order] = "consider other facts" and  
[marriage age>=18] = true  
Then [orderfour] = "consider other facts"

```
RULE [analyze marriage exts]
If [preMarriage] = "not exist" and
[consent?] = true and
[marriage age>=18] = true
Then [orderfour] = "consider other facts"
```

```
RULE [analyze orderthree]
If [orderthree] = "analyze other facts"
Then [orderfour] = "consider other facts"
```

```
RULE [determining consanguinity]
If [pre relationship] : "Mother or Father" "son or Daughter" "Sister or Brother" "Aunt or Uncle"
Then [consanguinity] = true
Else [consanguinity] = false
```

```
RULE [analyze order four]
If [orderfour] = "consider other facts" and
[consanguinity] = true
Then [The System Prediction ] = "Your Marriage will be invalid According to Ethiopian Revised family code, article 8."
```

```
RULE [determining Affinity]
If [Affinity existence] : "My brother wife(sister or brother)" "My sister husband(sister or brother)"
Then [Affinity] = true
Else [Affinity] = false
```

```
RULE [Affinity, consanguinity not exist]
If [orderfour] = "consider other facts" and
[consanguinity] = false and
[Affinity] = true
Then [The System Prediction ] = "Your Marriage will be invalid According to Ethiopian Revised family code, article 9."
```

```
RULE [Affinity, consanguinity not exist]
If [orderfour] = "consider other facts" and
[consanguinity] = false and
[Affinity] = false
Then [orderfive] = "proceed"
```

```
RULE [analyze orderfive]
If [orderfive] = "proceed" and
[fillation] = true
Then [The System Prediction ] = "Your Marriage will be invalid According to Ethiopian Revised family code, article 10."
```

```
RULE [analyze orderfive]
If [orderfive] = "proceed" and
[fillation] = false and
[pre engaged] = true and
[Is dissolved] = false
Then [The System Prediction ] = "Your Marriage will be invalid According to Ethiopian Revised family code, article 17."
```

```

RULE [analyze orderfive]
If [orderfive] = "proceed" and
[fillation] = false and
[pre engaged] = true and
[Is dissolved] = true
Then [ordersix] = "final consultation"

RULE [final consutation process]
If [ordersix] = "final consultation" and
[was woman engaged?] = true and
[window period expire?] = false
Then [The System Prediction ]="Your Marriage will be invalid According to Ethiopian Revised family code, article 16."

Rem the marriage will be accepted according to Ethiopian Revised family code!
RULE [final decision]
If [orderfive] = "proceed" and
[fillation] = false and
[pre engaged] = false
Then [The System Prediction ] = "Your Marriage will be Accepted(valid) According to Ethiopian Revised family cod."

RULE [final consutation process]
If [ordersix] = "final consultation" and
[was woman engaged?] = true and
[window period expire?] = true
Then [The System Prediction ] = "Your Marriage will be Accepted(valid) According to Ethiopian Revised family code."

RULE [final consutation process]
If [ordersix]="final consultation" and
[was woman engaged?]=false
Then [The System Prediction ]="Your Marriage will be Accepted(valid) According to Ethiopian Revised family code."

REM =====
REM The prompts
REM =====

PROMPT [Already merried] YesNo
"Are you already married and now, you are living together?"

PROMPT [Is mistaken?] YESNO
"Do you Married without knowing each other in detail and now are you unable to tollerate it?"

PROMPT [why married?] MultChoice
"what was the cause for your marriage to happen?"
"By Family push which i dont agreed"
"To protect my family from future accident"
"By other obligatory(not my intentional) reason"
"It is because we loved each other"

```

PROMPT [judicially prohibited?] YESNO  
 "Is there judiciary prohibited (either you or your spouse)?"

PROMPT [consent?] YESNO  
 "Do both you and your future spouse agreed to be married?"

PROMPT [marriage age>=18] YESNO  
 "Is your and your spouse Age is not less than eighteen years old?"

PROMPT [serious cause?] YESNO  
 "Is there a serious cause that forced you to be married?"

PROMPT [cause approved by mj?] YESNO  
 "Is your cause forced you to married approved by Ministry of Justice?"

PROMPT [your age>=16?] YESNO  
 "Is your and your future spouse age not less than sixteen years old?"

PROMPT [pre relationship] MultChoice  
 "what type of relationship between you and your future spouse exist already?"  
 "Mother or Father"  
 "Son or Daughter"  
 "Sister or Brother"  
 "Aunt or Uncle"  
 "None of the above"

PROMPT [Affinity existance] MultChoice  
 "what type of other relationship by marriage already exist between you and your spouse?"  
 "My brother wife(sister or brother)"  
 "My sister husband(sister or brother)"  
 "None of the above"

PROMPT [fillation] YESNO  
 "Do your community people or other have doubt that your spouse can be your sister or brother?"

PROMPT [pre engaged] YESNO  
 "Is there prior marriage you or your future spouse was engaged?"

PROMPT [Is dissolved] YESNO  
 "Eventhough, there is previous engagement, it is dissolved"

PROMPT [was woman engaged?] YESNO  
 "was the woman previously engaged?"

PROMPT [window period expire?] YESNO  
 "does the woman stayed alone for not less than 180 days, since the dissolution of previous Marriage?"

GOAL [The System Prediction ]

TRANSLATE TR\_RESULTS = "According to Your Input and Ethiopian Revised Family Code The System Prediction for"

**Figure 5.2 The corresponding Rule Base for the Logic Flow Chart shown in figure 5.1**

## 5.2 The upload and download cases functionality of the LDSES

In addition to Legal decision support functionality, the system is intended to include the upload and download sample cases. The interface for uploading and downloading sample family case is depicted in Figure 5.17 and in Figure 5.17, respectively. We believe that incorporating such functionality may make the system more helpful for the user of the system. The user can upload which can be their experiences or others' experience of family related cases and the other users can download the uploaded samples case which is assumed that it has similarity with the case he/she desires a consultation, for further reference.

During uploading the documents, the following policies are implemented:

- ✓ The user can upload only PDF and Microsoft word documents (i.e. file with doc, docx extension), and other files like executable file will not be allowed to be uploaded for security reasons
- ✓ The user can only upload a file with a maximum size of 2MB. This is because we believe that a Microsoft or PDF document of size 2MB can contain sufficient information about the case and restricting the user may protect the system from a denial of service attack threats. Because of the malicious, user may try to upload a large file with hundreds of Terabytes size which results the denial of the upload service because either the storage memory is full or the uploading document is in progress. We designed this upload and download functionality of the system using C# programming language, and ASP.NET server controls.

## 5.3 Integration of different components of the system

Besides the consultation and upload and download sample cases, the system has contained other additional functionalities. Even though the components are not mandatory, it makes the system more realistic. The system will contain some other functionality like *post and view some up-to-date news about family related cases; comment submitting; register user of the system; and Administrative side functionalities (like manage user of the system, view comment, manage legal news and etc.)*. These different components of the system made the Legal Decision Support System a full real web application and an Expert system.

## 5.4. User interface of legal decision support system.

When the user first accesses our legal decision support expert system (www.ldss.somee.com), the home page will be the first to be displayed on the user screen. The home page of the proposed legal decision support expert system is shown in Figure 5.3

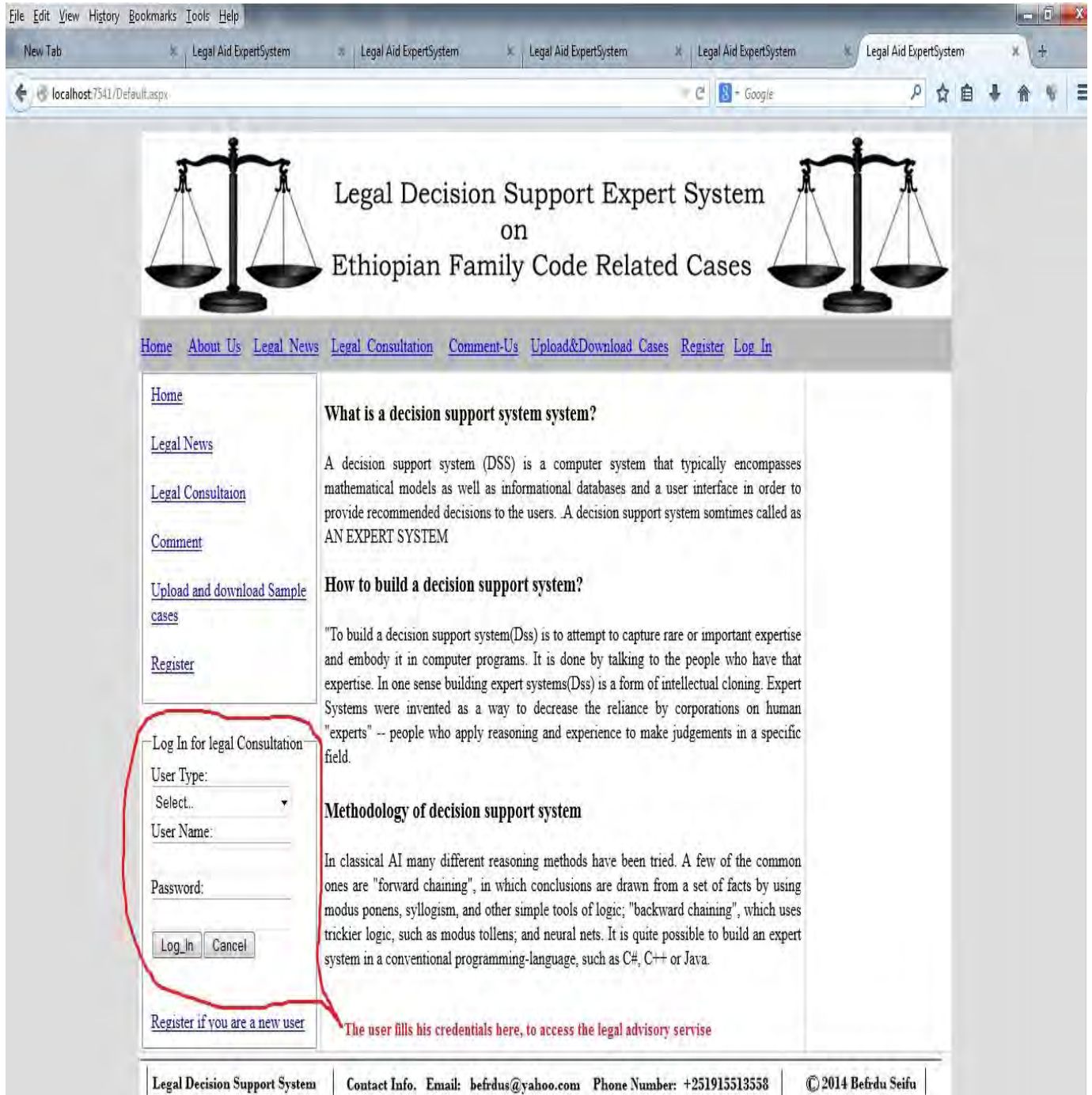


Figure 5.3 Home page of the proposed legal decision support expert system.

After the user accesses the above displayed home page, the user's account is mandatory to get *Legal consultation*, to *download and upload sample family related cases*, or to *send comment for the developer of the system*. If the user does not have credentials to use the system, he/she has to register to the system to get the above listed services. The registration page looks like as it is displayed in Figure 5.4



**Figure 5.4 Registration page for the proposed legal decision support expert system.**

During registration, the user has to fill all the required information and at last he has to create user name and password for log into the system to get the protected service like (*Legal consultation, upload and download sample family cases, and send to comment*). The log\_In interface can be accessed either by clicking on (*Lega\_Consultation, Comment\_Us, Upload&Download Cases link*) or simply by clicking on the *Log\_In Link*. The *Log\_In* Screen is shown in Figure 5.5



**Figure 5.5 The login screen of the proposed legal decision support expert system**

Then, if user is successful at logging on to the system, he/she can send comment, upload and download sample family case, and he/she can get legal consultation.

For example, if the user wants to get a legal consultation for whether as “He can adopt child B or not”, he has to answer the entire question provided by the system. The system filters which questions to ask depending on the user answer. For instance, *to adopt a child if a person is married the spouse agreement is mandatory*; only if the user’s answer for “*what is your marriage status now?*” is Married, then the system presents another question “*Does your spouse agrees to adopt a child?*”, otherwise ignore this because it is not applicable at this instance.

According to the architecture of the proposed system, the first component of the expert system that the user interact is “LDSSES\_Preprocessor” . This component selects and loads the knowledge base depending on the user’s input. The input submitted to “LDSSES\_Preprocessor” will be selected from the user interface shown in figure 5.6. For example, if the user wants to get “*whether he can adopt a child or not*” the “adoption.kb” file will be loaded for the inference Engine.



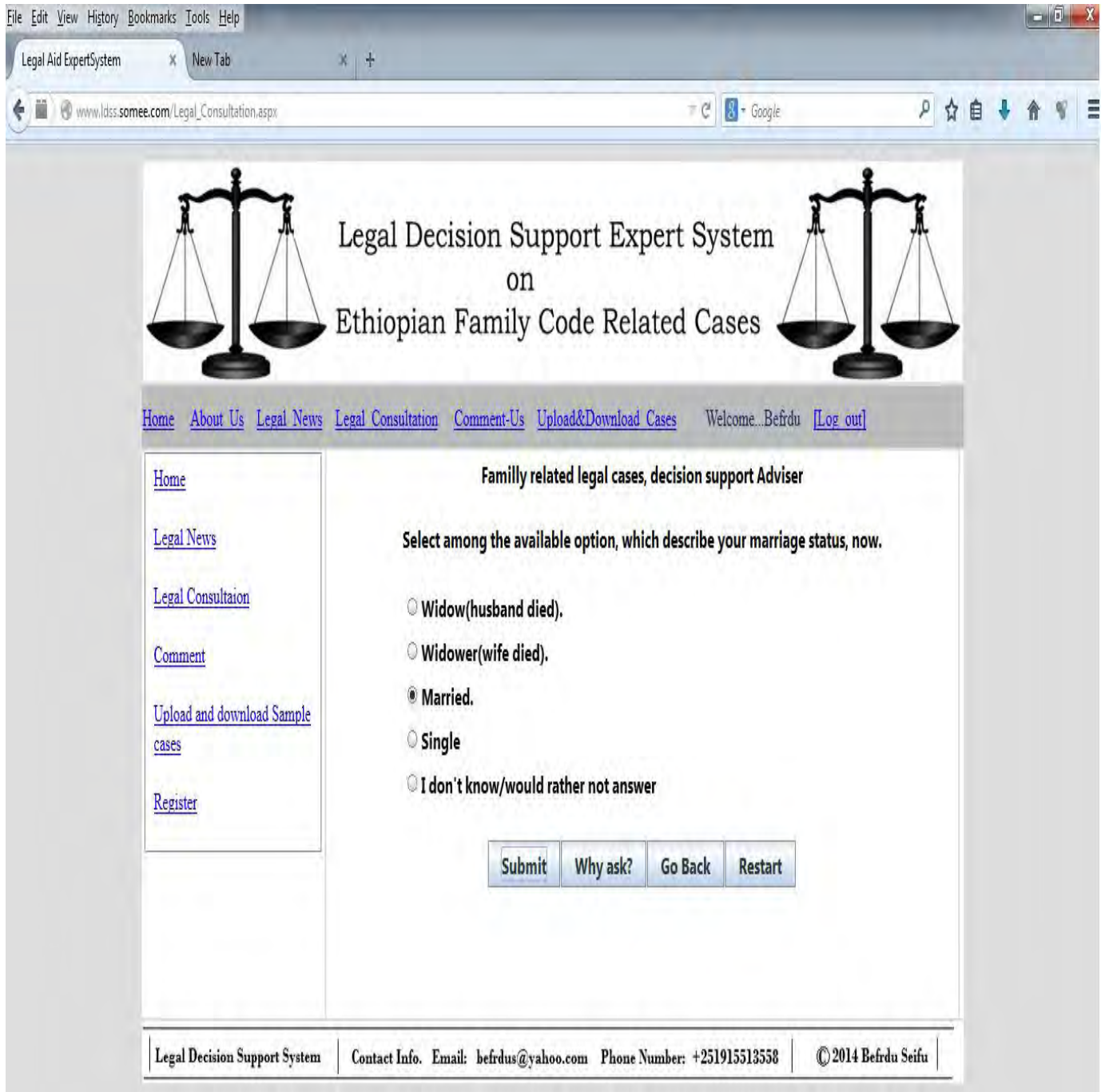
Figure 5.6 The input submitted to “LDSSES\_Preprocessor” selection user interface.

The snapshot of the dialog that can be made between the user and the system will be shown in the following consecutive figures.



**Figure 5.7 Instances of dialogue between the user and the expert system**

The user answer is YES for “*Is your age greater than or equal to 25 years?*” Then, the next question is to ask as he is married; the question supplied by the system is presented in Figure 5.8



**Figure 5.8 Instances of dialogue between the user and the expert system**

Because the user is married, the system has to know as the spouse of the user is agreed to adopt the child because according to Ethiopian Revised family code, article 186(1) states that “where the adopter is married, an agreement of adoption cannot be made unless the spouse conjointly adopts the child” figure 5.9 shows this prompt.



**Figure 5.9** Instances of dialogue between the user and the expert system

The next question will be about the age of the adopted child; shown in figure 5.10



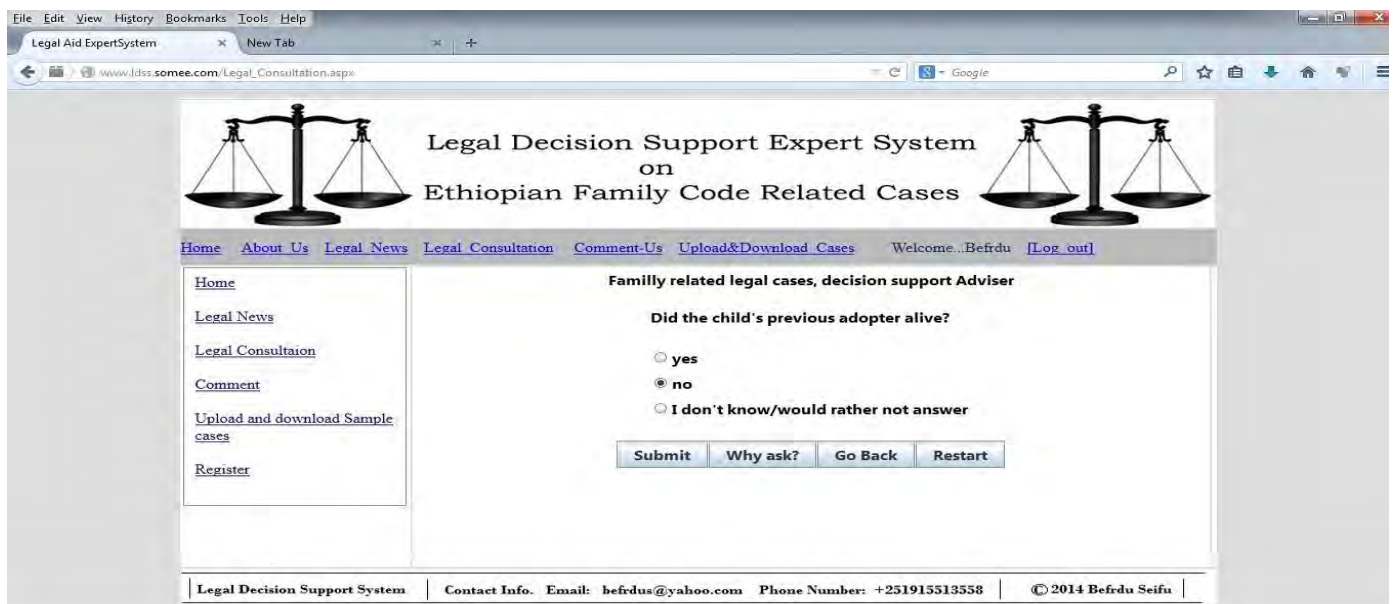
**Figure 5.10** Instances of dialogue between the user and the expert system

Then after, asking as the child was adopted before; shown in figure 5.11



**Figure 5.11 Instances of dialogue between the user and the expert system**

The child cannot be adopted by more than one adopter unless these two are spouses (Article 189). But if the previous adopters died, a new adoption is possible (Article 189(2)). In this example, because the child was adopted before, then the next question should be “As the previous adopter alive”; shown in figure 5.12



**Figure 5.12 Instances of dialogue between the user and the expert system**

The next question supplied by the system was about the parents to the adopted child; shown in figure 5.13



Figure 5.13 Instances of dialogue between the user and the expert system

Then next, the expert system asks the nationality of the adopter; shown in figure 5.14



Figure 5.14 Instances of dialogue between the user and the expert system

After all the necessary questions have been answered by the user, finally, according to the user input the system will provide the legal consultation. This consultation is shown in figure 5.15



**Figure 5.15 The final consultation according the law and the user input.**

The final consultation is “You can adopt the child. But because your Nationality is not an Ethiopian, the adoption will be allowed after the court approves your financial capability and other necessary conditions for the child’s growth. And because the child is not born, it is adoption of merely conceived child according to the Ethiopian Revised Family Code Article 187. And you have to be aware that under Article 187, sub Article 2, it declares that adoption agreement may be revoked unilaterally at the will of the mother within six months following the birth of the child.

Then you can click on the link “Click on this link” to get other supplementary information about Adoption according to Ethiopian Revised Family Code shown in figure 5.16

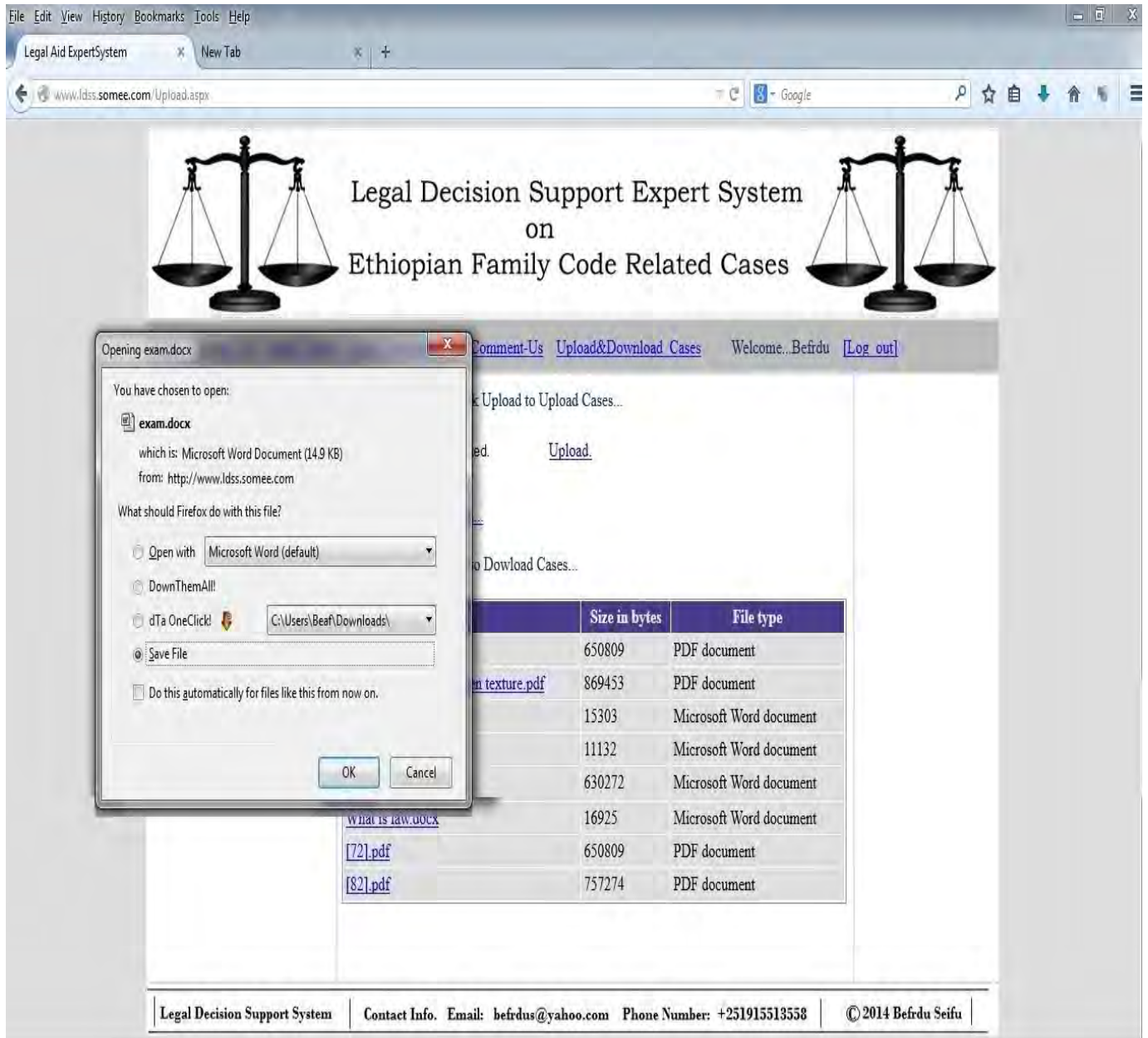


**Figure 5.16** The supplementary information about adoption according to Ethiopian family law. The other component of the system is the “upload and download sample family cases”. This component helps the user to download sample cases for further references and to upload sample cases to share with other user of the system. The user interface of the upload and download functionality is displayed in figure 5.17



**Figure 5.17 The upload component of the expert system user interface.**

To download sample cases, simply click on the file name of the case that you are going to download. The download user interface of the system is shown in figure 5.18



**Figure 5.18** The download component of the Expert System user interface.

The proposed system has intended to have two types of users: “Admin” and “User”; until now we have seen only the “User” pages. The “Admin” user of the system will perform administrative tasks. The admin home page is depicted in figure 5.19



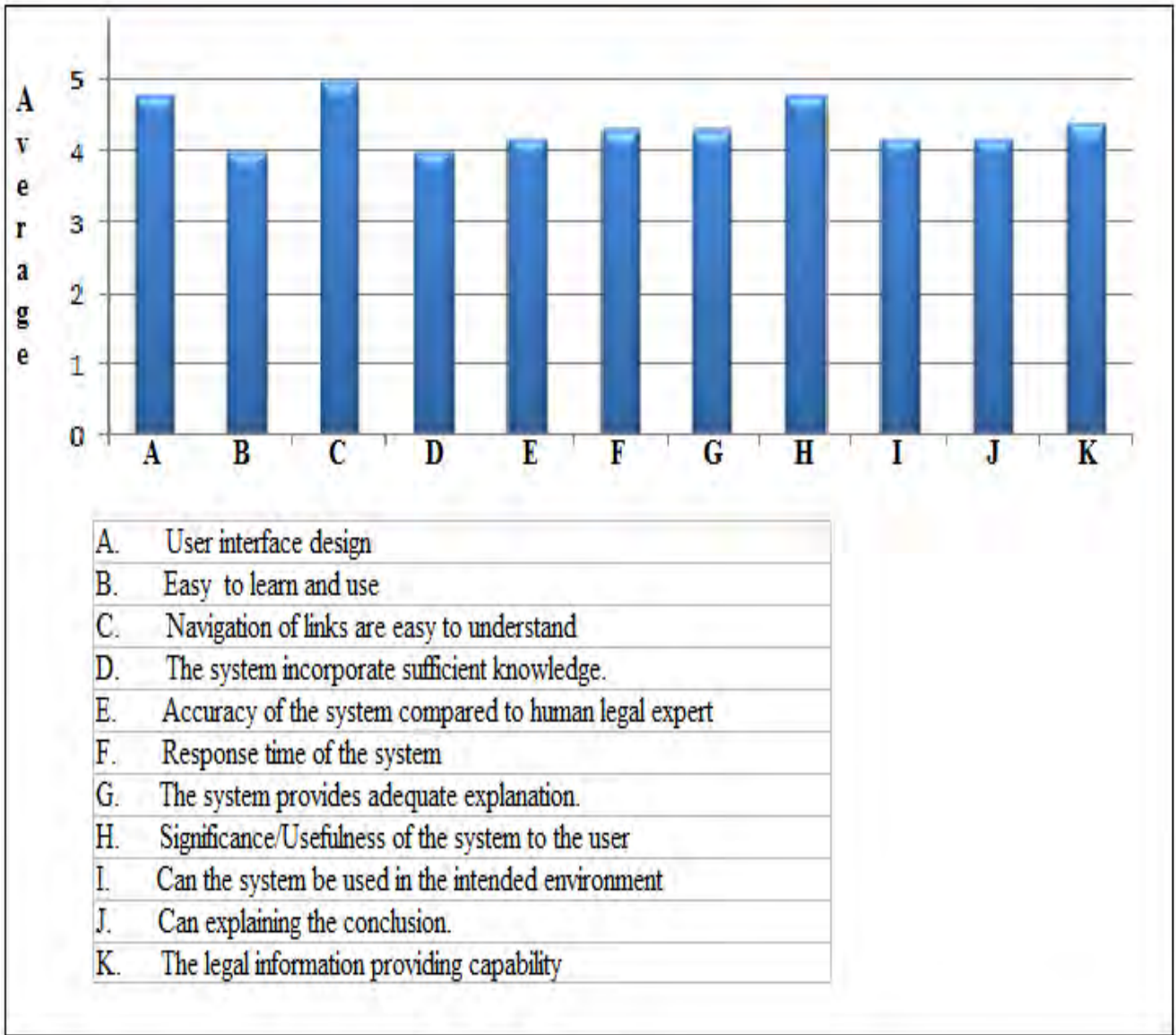
**Figure 5.19**The Admin home page of the Expert system.

## CHAPTER SIX

### VALIDATION OF THE PROPOSED LDSES

Computer system validation is the process of establishing documented evidence that a computerized system will consistently perform as intended in its operational environment. Software validation is not employed only on new development project. Today, more and more systems are built using commercial off-the-shelf software products, software components from other vendors or earlier versions of the same system. By validating the developed system, we can be sure that the resulting system performs correctly without unintended side effects, and that it meets its safety, security, reliability and auditing. Once the new system has been implemented and is in full use, the system should be validated. The purpose of validation is to assess the system to see if it does what it was supposed to do, that it is working well, and that everyone is happy with it.

To evaluate the system, we established two groups. The first group contains six legal experts (two judges, two attorneys and two law school lecturers from Debre Birhan University). The second group contains four none legal experts who don't have prior legal knowledge, but they can read and understand English. All members of the first group, established to validate the proposed LDSES system, already knew what is expected from the system. They participated and consulted us during the knowledge engineering phase. But the remaining member of the group (i.e. the four none legal experts) did not know what the system is intended to do. Thus, before they started to evaluate the system, we made a detail discussion about what the system is doing. There are a total of eleven closed ended questions for each group, refer to appendix I. The possible answer for those closed ended question are, Excellent, Very Good, Good, Fair, and Poor. Therefore, for the comfort of analyzing the relative performance of the system based on users evaluation, we assigned numbers for each word like Excellent = 5, Very good = 4, Good = 3, Fair = 2 and Poor = 1. The system evaluators gave the value for each closed ended question. Figure 6.1 shows the result of the analysis of users' feedback.



**Figure 6.1 Summary of user’s feedback about the proposed LDSES.**

Depending on the information we gathered from the two validators group, the average percentage of the user satisfaction is about 87.6%. From this average value, we can conclude that the system satisfies the users. And by making some elementary modification, it is possible to increase the satisfaction percentage value. The system support for making legal decision is on average 96% (the average score of the 8<sup>th</sup> evaluation criteria), refer to appendix II. So, when we evaluate the average percentage value, we believe that we achieve the objective of the research.

## CHAPTER SEVEN

### CONCLUSION AND RECOMMENDATIONS

In this Chapter, a summary of the work, the contributions of the work and recommendations for future improvement are presented.

#### 7.1 Conclusions

Since the advent of computer, so many cumbersome and time consuming activities of human being are simplified by the intervention of computer in different areas. At this time, there is no area of activities of human being, which is not supported by computer. From the simplest document repository service to very complex human activities like surgery, computer has a role. Despite the existing situations, in the legal matters, especially providing legal consultation is left for human expert, only. Even though there are so many attempts outside Ethiopia, there is no research conducted up to now on legal decision support expert system and for providing legal consultation for any legal information seekers for the case of Ethiopia. In this work, we tried to assess the experience of researchers for developing a legal decision support system. We identified the challenges for developing LDSES. We improve the commonly used expert system architecture, for the proposed legal decision support system. And finally, we developed and validated the LDSES mode we developed for Family law in the case of Ethiopia.

So by adopting the general architecture of expert systems, we developed an architecture that fits better for the proposed Legal Expert System. The general architecture of the expert system is containing three major components only (i.e. User Interface (UI), Inference Engine (IE) and Knowledge Base (KB)). If we simply adopt this architecture, there will be only one big Knowledge Base. And to determine which rules should be selected for the particular instance of communication is determined, after the Inference Engine is scanning all rules from the knowledge base. In this way, much time will be lost by scanning all the rules from the Knowledge Base to find the appropriate rules. Therefore, we added additional component called "*LDSES\_Preprocessor*", to the general architecture of the system.

The purpose of "*LDSES\_Preprocessor*" is to select among the available knowledge base and load the appropriate KB. The IE communication will be only with the identified Knowledge

Base. For this purpose, we created four mutually exclusive knowledge base called (marriage.kb, adoption.kb, minor.kb and filiation.kb). If the users need legal consultation related to marriage, marriage.kb Knowledge base will be identified by the “*LDSES\_Preprocessor*”. Then the Inference Engine communication will be with the identified knowledge Base (marriage.kb), the remaining Knowledge Base is considered as irrelevant for the current situation. If the combined, total number of rules, from the four fragmented KB is 100, and if all share equal number of rules, say each twenty five rules. Then the selection of rules will be from among twenty five rules. And the remaining seventy five rules will not be seen by the IE to select the next rule. In this way, the consultation can be made with minimal time and resource.

Based on user validation report summary, we found constructive evaluation result. According to the validator group response, the legal information providing capability of the proposed LDSES model, for making legal decision on the selected issue, on average, is about 96%.

## **7.2 Contribution of this work**

The objective of this work was to develop a legal decision support expert system in family law for the case of Ethiopia. And we showed that using a system as it is possible to provide legal consultation for any users. To develop the proposed LDSES, we did the following:-

- We studied about the domain knowledge, in detail.
- We reviewed the related work for developing expert system in the areas of legal matters.
- By adopting the general architecture of Expert system, we modified it by adding another component called *LDSES\_Preprocessor* , which can reduce the response time of LDSES. Because of this additional component, the knowledge engineering process called data encoding becomes easier.
- We develop a logic flow chart, which makes designing and testing Knowledge Base cooler.
- Finally, we develop and validate the LDSES model.

### **7.3 Recommendations for future work**

Although the result of this work is promising, further work needs to be done in order to upgrade LDSES to a full working system. The LDSES is developed mainly, depending on the revised family code of Ethiopia. But, the real case may need a combined knowledge from different categories of law. Therefore, to develop a real legal consultation expert system, exhaustive work has to be done during Knowledge Engineering phase.

The following are some of the recommendations that can be conducted in the future:

- In the LDSES, to get the legal consultation service, the user has to select from the available legal question. The user has not a chance to ask a question outside the available option. Such a way may not be convenient for the user. It may be required that, in some case the user openly input his question, through an input text box. Then the system has to analyze the user input and determine in which area the user is seeking the consultation service. To analyze and determine what type of consultation service the system has to provide, based on the user input, it will be good to use NLP (Natural Language Process) techniques.
- The language of communication between the user and LDSES model is in English in addition to using NLP techniques for analyzing the user input. It may be recommended if the system has Amharic or any other local language versions. Before the consultation service begins, the user may be given an option to select the language for communicating with the system. So that the communication language will be the selected one.
- The LDSES KB is developed based on the written family code. But in real situation, the written code is not the only source of rules. According to Ethiopian constitution, Proclamation Number 425/2005, it is declared that “decision of the federal supreme court cassation division is counted as forcible law”. Therefore, collecting those decisions and incorporating in the KB will make the system more realistic.
- If possible, it will be better to combine both Case based Reasoning and Rule Based Reasoning as an inferencing mechanism.

## REFERENCES

- [1] Moens, M-F; Combining structured and unstructured information in a retrieval model for accessing legislation. In proceedings of the tenth international conference on artificial intelligence and law. New York: ACM, 2005.
- [2] Sorina Cornoiu; Vector Space Model for Legal XML Retrieval. 9th international Conference on development and application systems, Suceava, Romania, May 22-24, 2008.
- [3] Marie-Francine Moens, „XML Retrieval Models for Legislations“ in T. Gordon (ed.), Legal knowledge and information systems.jurix 2004: The seventeenth Annual conference. Amsterdam: IOS press, PP. 1-10, 2004.
- [4] Jhon Zeleznikow; An Australian perspective on research and development required for the construction of applied legal decision support systems. University of Edinburgh, UK: 2003.
- [5] Jaap Hage; A model of juridical acts: part 1; the word of law. University of Maastricht and Hasselt, Maastricht, Netherland; 5 April 2011.
- [6] Floris Bex and Bart Verheij; legal stories and the process of proof. Cambridge University press; Denmark, 6 December 2012.
- [7] Mahajan V.D, Jurisprudence, legal theory, fifth edition, eastern Book company, Luknow,Delhi p27, 1998.
- [8] Girma Gizaw, The world history of law and legal institutions: Ancient, modern and contemporary. Addis Ababa, Second edition 2007.
- [9] Law and Morality;[http://sixthformlaw.info/01\\_modules/other\\_material/law\\_and\\_morality/0\\_what\\_is\\_law.htm](http://sixthformlaw.info/01_modules/other_material/law_and_morality/0_what_is_law.htm). Retrieved on June 2014.
- [10] What is law? Produced by the N.C Institute of Government; unpublished article. Accessed on June 2014.
- [11] Law; <http://en.wikipedia.org/wiki/Law>. Retrieved on July 2014.
- [12] Oxford Dictionary of Law, Oxford University press, p.347, 1997.
- [13] Robert Allen, The development of the legal system: Ethiopia Experience, Journal of law Review V.53, no 3, pp. 562-84,1967.

- [14] Michael Bogdan, comparative law, Kluwer Law and Taxation Publisher, first edition, p.87, 1994.
- [15] George Krzewnawiyz, Hierarchy of laws in Ethiopia: journal of Ethiopia law V.1 no.1 p.111, 1966.
- [16] Ayle Bogale, Hierarchy of laws within the present federal legal structure of Ethiopia: Faculty of law Addis Ababa University, Addis Ababa, May 1999.
- [17] Alexander Boer et al., „A Content Management System based on an Event-based Model of Version Management Information in Legislation“ in T. Gordon (ed.), Legal Knowledge and Information Systems. Jurix 2004: The Seventeenth Annual Conference. Amsterdam: IOS Press, pp. 19-28, 2004.
- [18] Ontologies - Introduction and overview, unpublished M.Sc Thesis Vrije University Brussels. [www.starlab.vub.ac.be/teaching/Ontologies-intr-OverV.pdv](http://www.starlab.vub.ac.be/teaching/Ontologies-intr-OverV.pdv), retrieved August 2014.
- [19] Leventhal, Lewis Fuchs, Designing; XML Internet Applications, Prentice Hall, NJ USA, 1998.
- [20] Pardi, William J., XML in Action Web Technology, Microsoft Press, 1999 WA USA.
- [21] Over View of Da Vinci Surgical Robot; <https://www.youtube.com/watch?v=EiVY-htgRUY> Accessed on July, 2014.
- [22] Saliha Smadhi; System of Information Retrieval in XML Documents. Université de Pau, France. 2003.
- [23] Hiemstra,D; Statistical Language Models for Intelligent XML retrieval. In H.Blanken,T.Grabs,H.-J.Schek,R.Schenkel & G.Weikum(Eds),Intelligent Search On XML Data (pp 107-118). Berlin: Springer, 2003.
- [24] XML and Database; [www.rpbouret.com/xml/XMLAndDatabases.htm](http://www.rpbouret.com/xml/XMLAndDatabases.htm). Consulting, writing, and research in XML and databases. Ronald Bourret. Accessed on July, 2014.

- [25] Moens, M-F; Combining structured and unstructured information in a retrieval model for accessing legislation. In proceedings of the tenth international conference on artificial intelligence and law. New York: ACM 2005.
- [26] Kevin Reiss, Indexing XML Documents: A Hybrid Approach. LIS 329 Fall 02. May 10, 2003.
- [27] Mounia Lalmas, Andrew Trotman; XML Retrieval Advances in Information Retrieval, 28<sup>th</sup> European Conference on IR Research, ECIR, 2006.
- [28] S. Amer-Yahia and M. Lalmas. XML Search: Languages, INEX and Scoring, SIGMOD Record, 35(4):16-23, 2006.
- [29] Jörgen S. Svensson. Legal Expert System in Administrative organization University of Twente, The Netherlands, 2005.
- [30] Schweighofer, Erich; Werner Winiwarter Legal Expert System KONTERM, 1993.
- [31] Susskind, Richard; "Expert Systems in Law: A Jurisprudential Approach to Artificial Intelligence and Legal Reasoning", 1986.
- [32] Berman, Donald H and Carole D. Hafner ;"The Potential of Artificial Intelligence to Help Solve the Crisis in Our Legal System", 1989.
- [33] Tina.B, Paulo.N,Francisco.A, Torsten.E; From Real-world regulation to concrete norms for software agents-a case based reasoning, 2009.
- [34] Marie-Francine Moens, „XML Retrieval Models for Legislation“ in T. Gordon (ed.), Legal Knowledge and Information Systems. Jurix. The Seventeenth Annual Conference. Amsterdam: IOS Press, 2004.
- [35] Aikenhead, M. "Legal Knowledge-Based Systems: some observations on the future". [www.link.springer.com/content/pdf/bbm%3A978-1-84628-732-9%2F1.pdf](http://www.link.springer.com/content/pdf/bbm%3A978-1-84628-732-9%2F1.pdf), retrieved on August 2014.
- [36] Stevens, Charles; Vishal Barot & Jenny Carter; "The Next Generation of Legal Expert Systems - New Dawn or False Dawn?", 2010.

- [37] JOHN ZELEZNIKOW. SPLIT-UP: A Web Based Decision support System that advises up on the distribution of marital property, 2006.
- [38] SHORTLIFFE E. H. "Computer based medical consultations; MYCIN, Elsevier", New York, 1976.
- [39] Jenkins, J; What can information technology do for law? Harvard Journal of Law & Technology Volume 21, Number 2 2008.
- [40] Lucas, P. Expert Systems, Published in the Encyclopedia of Life Support Systems of UNESCO, 2000;
- [41] Buchanan, B.G. and Shortliffe, E.H. (eds.); Rule-Based Expert Systems: The MYCIN Experiments of the Stanford Heuristic Programming Project, Reading, MA: Addison-Wesley.
- [42] C.S. Krishnamoorthy; S. Rajeev; Artificial Intelligence and Expert Systems for Engineers by CRC Press LLC ISBN: 0849391253, 1996.
- [43] Rajkumar, T., and Bardina, E.J; Web-based Weather Expert System (WES) for Space Shuttle Launch, C'03 Conference Proceedings. IEEE International Conference on Systems, Man and Cybernetics. Conference Theme - System Security and Assurance, 5040-5045, 2003.
- [44] Sasikumar, M., Ramani, S., Muthu Raman, S., Anjaneyulu ,K. and Chandrasekar ,R.; A Practical Introduction to Rule Based Expert Systems, Narosa Publishing House, New Delhi, 2007.
- [45] Crowley, J; An information technology enabled Poultry Expert System: Perception of veterinarians and veterinary students, International Journal Education and Development using ICT, 2: 100-107, 2006.
- [46] Duan, Yanqing; Edwards, John S. and Xu, M.X.; Web-based expert systems: benefits and challenges. *Information and management*, 42 (6), pp. 799-811, 2005.
- [47] Michael C. Sturman and T. Milkovich; Validation of Expert Systems: Personal Choice Expert - A Flexible Employee Benefit System, CAHRS Working Paper Series, 1992.

- [48] Charles Stevens, Vishal Barot, and Jenny Carter; The Next Generation of Legal Expert Systems-New Dawn or False Dawn; The thirtieth SGAG international conference on innovative techniques of Artificial intelligence, Cambridge, UK, 2010.
- [49] Buchanan, B. G., and Feigenbaum, E. A. Forward. In Davis, R., and Lenat, D. B.; Knowledge-Based Systems in Artificial Intelligence. McGraw-Hill, 1982.
- [50] Hopgood, A; Intelligent Systems for engineers and Scientists, CRC Press, 2001.
- [51] Rissland E. Ashley, K, Branting, K.; Case Based Reasoning & Law, The Knowledge Engineering Review, vol. 20:3, 293-2981, 2006.
- [52] Rissland E., Valcarce, E., Ashley, K.; Explaining and arguing with examples- Proceedings of Fourth National on Artificial Intelligence. AAAI Press, 288-294, 1984.
- [53] Pal, K., & Campbell, J.; An Application of Rule-Based and Case-Based Reasoning within a Single Legal Knowledge-Based System, The Data Base for Advances in Information Systems, vol. 28, 4, 1997.
- [54] Aleven, V.; Using background knowledge in case-based legal reasoning: A computational model and an intelligent learning environment, Artificial Intelligence, 2003.
- [55] Julie Main, Tharam Dillon and Simon Shiu; A tutorial on case based reasoning. Unpublished article. [www.link.springer.com/chapter/10.1007/978-1-4471-0687-6-1#page1](http://www.link.springer.com/chapter/10.1007/978-1-4471-0687-6-1#page1), retrieved on August 2014.
- [56] John A. Bullinaria; The Expert System, unpublished article, 2005.
- [57] Daniels, J.J. & Rissland; Finding legally relevant passages in case opinions. In Proceedings of the Sixth International Conference on Artificial Intelligence and Law (pp. 39-46). New York: ACM, 1997.
- [58] Thomasset, Claude, Louis-Claude Paquin; Expert Systems in Law and the Representation of Legal Knowledge: Can we isolate it from the Why and the Who?, 1989.
- [59] Lilian Edwards and Jhon Kingston; A web based Decision Support System for Divorce Lawyers in Scottish law. School of informatics, university of Edinburgh, 2003.

- [60] Newell, A. and Simon, H. Human problem solving; Prentice Hall, Englewood Cliffs, NJ, 1972.
- [61] Popp, W.G and Schlink, B.; JUDITH, A computer program to advice lawyers in reasoning a case, 1975. [www.shodnganga.infibnet.a.in/bistream/10603/7654/22/12-reference.pdf](http://www.shodnganga.infibnet.a.in/bistream/10603/7654/22/12-reference.pdf), retrieved on August 2014.
- [62] Henok Sahilu Mengistu; Change aware legal document retrieval model; master thesis in the department of computer science; Addis Ababa University, 2009.
- [63] Meldman, J. A.; A structural model for computer-aided legal analysis. Rutgers J Computers and Law, 1977.
- [64] McCarty, L. T.; Reflections on TAXMAN: an experiment in artificial intelligence and legal reasoning. Harvard Law Review, 1977.
- [65] McCarty, L. T.; The TAXMAN project: Towards a cognitive theory of legal argument; Computer Science and Law, Cambridge University Press, 1980.
- [66] Michaelsen, R. H. and Michie, D; Expert systems in business; University of Illinois, 1983.
- [67] Sergot, M. J, Sadri, F, Kowalski, R. A, Kriwaczek, F, Hammond, P and Cory H.T.; The British Nationality Act as a logic program, 1986.
- [68] Shpilberg D, L. Graham and H. Schatz; ExperTAX; an expert system for corporate tax planning; University of southern California, Los Angeles, CA, 1986.
- [69] Susskind, R. and Tindali, C.; VATIA: Ernst and Whinny's VAT expert system; Proceeding of fourth international conference, London, 1988.
- [70] Kevin D, Ashley; Case-Based Reasoning and its Implications for Legal Expert Systems; Kluwer Academic Publisher, printed in Netherland, 1992.
- [71] Janet Kolodner; Case-Based Reasoning; Morgan Kaufmann, San Mateo, CA, 1993.
- [72] JANET L. KOLONDNER. An introduction to case-based reasoning. Artificial Intelligence Review, 6(1):3-34, 1992.
- [73] Janet Kolodner and Wiliam Mark; Case-based reasoning. IEEE Expert, 7(5):5-6, October 1992.

- [74] Gebhardt, T., Vob, A. Grather, W. , Schmidt-Beltz, B., Reasoning with Complex Cases, Kluwer Academic Publishers, Norwell, MA, 1997.
- [75] Andrzej Kowalski; Case-based reasoning and the deep structure approach to knowledge representation. In Proceedings of the Third International Conference on Artificial Intelligence and Law: Oxford, England: 25-28 June, 1991.
- [76] Kevin D. Ashley. Modeling legal Argument: Reasoning with Cases & Hypotheticals. MIT Press, Cambridge, MA, 1990.
- [77] William Michael Bain; Case-Based Reasoning: A Computer Model of Subjective Assessment; PhD thesis, Department of Computer Science, Yale University, 1986.
- [78] Kenneth A. Lambert and Mark H. Grunewald; Legal theory and case-based reasoner; The importance of context and the process of focusing. In Proceedings of the Third International Conference on Artificial Intelligence and Law: Oxford, England: 25-28 June, 1991.
- [79] Kenneth A. Lambert and Mark H. Grunewald; LESTER: Using paradigm cases in a quasi-precedential legal domain. In Proceedings of the Second International Conference on Artificial Intelligence and Law: Vancouver, BC, Canada:, pages 87-92, New York, NY, 1989. International Conference on Artificial Intelligence and Law, ACM Press, 1989.
- [80] Hirota, K., Yoshino, H., Xu, M.Q., Zhu, Y., Horie, D., "A fuzzy case based reasoning system for the legal inference," in Proceedings of fuzzy systems, World Congress on Computational Intelligence, pp.1350-1354, 1988.
- [81] Katsumi Nitta, Yoshihisa Ohtake, Shigeru Maeda, Masayuki Ono, Hiroshi Ohsaki, and Kiyokazu Sakane; HELIC-II: a legal reasoning system on the parallel inference machine; In FGCS '92: Proceedings of the International Conference on Fifth Generation Computer Systems: Tokyo, Japan: 1-5 June 1992, volume 2, pages 1115-1124, Burke, VA, 1992. ICOT, IOS Press.
- [82] John Zeleznikow, George Vossos and Daniel Hunter; The IKBALS Project; Multi Modal reasoning in legal knowledge bases system, 1994.

- [83] Egri, P.A., Underwood, P.F.; HILDA: Knowledge extraction from neural networks in legal rule based and case-based reasoning, Neural Networks, Proceedings, IEEE international conference on, Vol. 4. Pp. 1800-1805, 1995.
- [84] Hollatz, J.; "Neuro-fuzzy in legal reasoning," in Proceedings in Fuzzy Systems, International Joint conference of the 4th IEEE International Conference on Fuzzy Systems and the 2nd International Fuzzy Engineering Symposium, pp.655-662, 2010.
- [85] Rule based legal expert system; <http://blog.law.cornell.edu/voxpath/2010/07/01/rule-based-legal-information-systems/> Accessed on August 20 2014.
- [86] Open texture; [http://www.blackwellreference.com/public/tocnode?id=g9781405106795\\_chunk\\_g978140510679516\\_ss1-43](http://www.blackwellreference.com/public/tocnode?id=g9781405106795_chunk_g978140510679516_ss1-43). Accessed on March 2014.
- [87] Henry Prakken , Logical Tools for Modelling Legal Argument. A Study of Defeasible Reasoning in Law. 1997.
- [88] Bench-Capon, Trevor and Sergot, Marek J. Towards a rule-based representation of open texture in law. 1988.
- [89] Common Law and Civil Law Tradition; <https://www.law.berkeley.edu/library/robbins/pdf/CommonLawCivilLawTraditions.pdf>. Accessed on July 2014.
- [90] Private Law; <http://www.duhaime.org/LegalDictionary/P/PrivateLaw.aspx>. Retrieved on July 2014.
- [91] Private Law; [http://en.wikipedia.org/wiki/Private\\_law](http://en.wikipedia.org/wiki/Private_law). Retrieved on July 2014.
- [92] Public Law; [http://en.wikipedia.org/wiki/Public\\_law](http://en.wikipedia.org/wiki/Public_law). Retrieved on July 2014.

## APPENDICES

### Appendix I: - Questionnaire filled by evaluator groups to validate LDSES model

Name \_\_\_\_\_

Put [x] mark where it is applicable for you.

Are you a legal expert? Yes  No

**Instruction:** Circle the appropriate score for each question given below.

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

	Evaluation questions	Rating Scales				
		1	2	3	4	5
1	User interface design					
2	Easy to learn and use					
3	Navigation of links are easy to understand					
4	The system incorporates sufficient knowledge to assist users in legal decision making. On the selected legal question.					
5	Accuracy of the system compared to human legal expert					
6	Response time of the system					
7	The system provides adequate explanation for why to ask the question.					
8	Helpful legal information providing capability, on the selected issue					
9	Can the system be used in the intended environment					
10	Can explaining the conclusion.					
11	The legal information providing capability					


## Appendix II: - The summary of evaluation to validate LDSES model

Q No	Evaluation criterion	Number of respondent					Average
		Poor	Fair	good	Very Good	Excellent	
1	User interface design	0	0	0	6	4	4.8
2	Easy to learn and use	0	0	3	4	3	4.0
3	Navigation of links are easy to understand	0	0	0	0	10	5
4	The system knowledge to assist users in legal decision making. On the selected legal question.	0	0	2	6	2	4.0
5	Accuracy of the system compared to human legal expert	0	0	2	4	4	4.2
6	Response time of the system	0	0	0	7	3	4.3
7	The system provides adequate explanation for why to ask the question.	0	0	0	7	3	4.3
8	Helpful legal information providing capability, on the selected issue	0	0	0	2	8	4.8
9	Can the system be used by any body	0	0	2	4	4	4.2
10	Can explaining the conclusion.	0	0	0	8	2	4.2
11	The legal information providing capability	0	0	0	6	4	4.4
	Overall performance out of 5	<b>4.38</b>					
	Overall performance (100%)	<b>87.6</b>					

N.B. As the scores we collected from the evaluator groups, the effectiveness of the system to provide legal information to make a reliable decision is about 96%. This is when we computed the percentage of score in the 8<sup>th</sup> evaluation criteria.

Appendix III: - The sample of the report collected from Debre Birhan wereda court

**የደብረ ብረሃን ከተማ ወረዳ ፍ/ቤት**



**አዲስ የሆኑ ፋይሎች ስታትስቲክስ**

የታተመበት ቀን ፡ 28/11/2006

የተከፈተበት ቀን ስ፡ 1/11/2003 ለስ፡ 30/10/2004 ግጠቃለያ፡ የሰበ አይነት የጉዳይ አይነት፡ ፍትሐብሔር

ግጠቃለያ	ጠቅላላ ብዛት
የተጠቀሙበትን የወ.ሀ ፍጆታ ይከፈሉ	1
የተጨመረልኝ ደሞዝ ይከፈላኝ	1
የፍርድ ከልክላ ይደረግ	1
ቅድሚያ የወሰዱትን ገንዘብ ይመልሱ	1
ዕድሜዬ ይስተክከልልኝ	1
ዬጡረታ ተቀኛኝ ገንዘብ የመለስልኝ	1
የጉዲፈቻ ሰምምነት	1
ዋስትና	1
የወለድ ክፍያ ጥያቄ	1
በክብት	1
የንብረት ጉዳት ክሳ	1
ክስ ይሰረዝ	1
የክሣ ክፍያ	1
የዋስትና ገንዘብ	1
ባደራ ገንዘብና ዕቃ	1
በጉዲፈቻ	1
በግሉ የገባዉ ግዴታ ይነሳልኝ	1
የድርሻቸዉን ንብርት ይጨስዱ	1
የዳቤ ሽያጭ ይከፈሉ	1
ሞግዚትነት ይሻርልኝ	1



**Appendix IV: - The sample of the report collected from North Shoa high court**

**የደብረ ብረሃን ከተማ ወረዳ ፍ/ቤት**

▲▲▲

**አዲስ የሆኑ ፋይሎች ስታትስቲክስ**

የታተመበት ቀን ፡ 28/11/2006

የተከፈተበት ቀን ስ፡ 1/11/2003    አስከ፡ 30/10/2004    ማጠቃለያ፡    የሰበ አይነት    የጉዳይ አይነት፡    ፍትሐብሔር

ማጠቃለያ	ጠቅላላ ብዛት
የተጠቀሙበትን የጠ.ሀ ፍጆታ ይክፈሉ	1
የተጨመረልኝ ደሞዝ ይክፈሉኝ	1
የፍርድ ክልከላ ይደረግ	1
ቅድሚያ የወሰዱትን ገንዘብ ይመልሱ	1
ዕድሜዬ ይስተክከልልኝ	1
ዬጠረታ ተቀኛኝ ገንዘብ የመለሰልኝ	1
የጉዲፈቻ ስምምነት	1
ዋሰትና	1
የወለድ ክፍያ ዋያቄ	1
በክብት	1
የንብረት ጉዳት ክፍያ	1
ክስ ይሰረዝ	1
የክሣ ክፍያ	1
የዋሰትና ገንዘብ	1
ባደራ ገንዘብና ዕቃ	1
በጉዲፈቻ	1
በግሉ የገባጠ. ግዴታ ይነሳልኝ	1
የድርሻቸውን ንብርት ይጠሰዱ	1
የዱቤ ሽያጭ ይክፈሉ	1
ሞግዚትነት ይሻርልኝ	1



## Appendix V: - The Knowledge Base for consulting about Adoption, based on Ethiopian law

```
REM=====
REM Adoption rules
REM=====
```

```
RULE [is foreigner]
If [is foreigner] = "Other, than Ethiopian"
Then [foreigner] = true
Else [foreigner] = false
```

```
RULE [checking age]
If [age>=25] = true
Then [age] = "satisfied"
Else [age] = "not satisfied"
```

```
RULE [marriage status]
IF [married1] : "Widow(husband died)." "Widower(wife died)." "Single"
Then [marriage1] = "Not Exist"
```

```
RULE [marriage status]
IF [married1] = "Married."
Then [marriage1] = "Exist"
Else [marriage1] = "Not Exist"
```

```
RULE [marriage status]
IF [married] : "Widow(husband died)." "Widower(wife died)." "Single"
Then [marriage] = "Not Exist"
```

```
RULE [marriage status]
IF [married] = "Married."
Then [marriage] = "Exist"
Else [marriage] = "Not Exist"
```

```
RULE [supplement age]
If [age] = "not satisfied" and
[marriage1] = "Not Exist"
Then [verdict] = "You are unable to Adopt; Becuase according to Article 184, to adopt a child,
the adopter minimim age is 25 years:"
```

```
RULE [supplement age1]
If [age] = "not satisfied" and
[marriage1] = "Exist" and
[your spouse age>=25] = false
Then [verdict] = "You are unable to Adopt; Becuase according to Article 184, to adopt a child,
the adopter minimim age is 25 years: The other alternative for age specification was to check
your spouse age, still, because your spouse is less than 25 years, the adoption will not be
possible according to the law. "
```

```
RULE [supplement age]
If [age] = "not satisfied" and
[marriage1] = "Exist" and
[your spouse age>=25] = true
Then [orderOne] = "go ahead"
```

```
RULE [when age >=25]
If [age] = "satisfied" and
[marriage] = "Exist"
```

Then [orderOne] = "go ahead"

RULE [when age <25]  
If [age] = "satisfied" and  
[marriage] = "Not Exist" and  
[adopted child age] = "Greater than eighteen"  
Then [verdict] = "Adoption is not possible; It is because, according to article 185, the adopted child age must be bellow eighteen years old to be adopted:"

RULE [when age <25]  
If [age] = "satisfied" and  
[marriage] = "Not Exist" and  
[adopted child age] = "Greater than Zero age (born) and Less than eighteen years of age"  
Then [orderTwo] = "go ahead"

RULE [when age <25]  
If [age] = "satisfied" and  
[marriage] = "Not Exist" and  
[adopted child age] = "Merly conceived (not born)"  
Then [orderTwo] = "go ahead"

RULE [ur spouse concent?, age satisfied]  
If [orderOne] = "go ahead" and  
[ur spouse consent?] : "Not agreed" "Not capable to manifest her/his will"  
Then [verdict] = "The adoption is not possible; It is because according to article 186(1), to adopt a child your spouse consent is mandatory"

RULE [ur spouse concent?, age satisfied]  
If [orderOne] = "go ahead" and  
[ur spouse consent?] = "Agreed" and  
[adopted child age] = "Greater than eighteen"  
Then [verdict] = "Adoption is not possible; It is because, according to article 185, the adopted child age must be bellow eighteen years old to be adopted: "

RULE [ur spouse concent?, born]  
If [orderOne] = "go ahead" and  
[ur spouse consent?] = "Agreed" and  
[adopted child age] = "Greater than Zero age (born) and Less than eighteen years of age"  
Then [orderTwo] = "go ahead"

RULE [ur spouse concent?, born]  
If [orderOne] = "go ahead" and  
[ur spouse consent?] = "Agreed" and  
[adopted child age] = "Merly conceived (not born)"  
Then [orderTwo] = "go ahead"

RULE [ur spouse concent?, merly conceived]  
If [adopted child age] = "Merly conceived (not born)"  
Then [merlyconceived] = true  
Else [merlyconceived] = false

RULE [adopted before]  
If [orderTwo] = "go ahead" and  
[adopted before] = true and  
[is adopter alive?] = true

Then [verdict] = "The adoption is not possible; It is because the child is already adopted and the adopter of child is alive. According to article 189(1), a child can not have more than one adopter. "

RULE [adopted before]  
If [orderTwo] = "go ahead" and  
[adopted before] = true and  
[is adopter alive?] = false  
Then [orderThree] = "Examine parents will"

RULE [adopted before]  
If [orderTwo] = "go ahead" and  
[adopted before] = false  
Then [orderThree] = "Examine parents will"

RULE [Parental wills ok, foreigner true and merly conceived yes]  
If [orderThree] = "Examine parents will" and  
[parent of the child] = "Both father and mother of the adopted child are willing" and  
[foreigner] = true and  
[merlyconceived] = true  
Then [Further]="Click on this link " and  
[verdict] = "You can adopt the child. But, because your Nationality is not Ethiopian, the adoption will be allowed, After the court approve your financial capability and other necessary condition for the child growth. And because, the child is not born, it is Adoption of merly conceived child according to Ethiopian Revised family code Article, 187. And you have to be aware that, under Article 187, sub article 2, it declare that the adoption agreement may be revoked unilaterally at the will of the mother within six months following the birth of the child"

RULE [Parental wills ok, foreigner true and merly conceived no]  
If [orderThree] = "Examine parents will" and  
[parent of the child] = "Both father and mother of the adopted child are willing" and  
[foreigner] = true and  
[merlyconceived] = false  
Then [Further]="Click on this link " and  
[verdict] = "You can adopt the child. But, because your Nationality is not Ethiopian, the adoption will be allowed, After the court approve your financial capability and other necessary condition for the child growth."

RULE [Parental wills ok, foreigner false and merly conceived yes]  
If [orderThree] = "Examine parents will" and  
[parent of the child] = "Both father and mother of the adopted child are willing" and  
[foreigner] = false and  
[merlyconceived] = true  
Then [Further]="Click on this link " and  
[verdict] = "You can adopt the child. But, because, the child is not born, it is Adoption of merly conceived child according to Ethiopian Revised family code Article, 187. And you have to be aware that, under Article 187, sub article 2, it declares that the adoption agreement may be revoked unilaterally at the will of the mother within six months following the birth of the child"

RULE [Parental wills ok, foreigner false and merly conceived no]  
If [orderThree] = "Examine parents will" and  
[parent of the child] = "Both father and mother of the adopted child are willing" and  
[foreigner] = false and  
[merlyconceived] = false  
Then [Further]="Click on this link " and  
[verdict] = "Based on the fact you are inputing, you can adopt the child"

RULE [Parental wills 1ok, foreigner true and merly conceived yes]  
If [orderThree] = "Examine parents will" and  
[parent of the child] = "One parent is dead/unknown/incapable to manifest her/his will.But the other parent agreed" and  
[foreigner] = true and  
[merlyconceived] = true  
Then [Further]="Click on this link " and  
[verdict] = "You can adopt the child. But, because your Nationality is not Ethiopian, the adoption will be allowed, after the court has examined and approve your financial capability and other necessary condition for the child growth. And because, the child is not born, it is Adoption of merly conceived child according to Ethiopian Revised family code Article, 187. And you have to be aware that, under Article 187, sub article 2, it declare that the adoption agreement may be revoked unilaterally at the will of the mother within six months following the birth of the child"

RULE [Parental wills 1ok, foreigner true and merly conceived no]  
If [orderThree] = "Examine parents will" and  
[parent of the child] = "One parent is dead/unknown/incapable to manifest her/his will.But the other parent agreed" and  
[foreigner] = true and  
[merlyconceived] = false  
Then [Further]="Click on this link " and  
[verdict] = "You can adopt the child. But, because your Nationality is not Ethiopian, the adoption will be allowed, after the court has examined and approve your financial capability and other necessary condition for the child growth."

RULE [Parental wills 1ok, foreigner false and merly conceived yes]  
If [orderThree] = "Examine parents will" and  
[parent of the child] = "One parent is dead/unknown/incapable to manifest her/his will.But the other parent agreed" and  
[foreigner] = false and  
[merlyconceived] = true  
Then [Further]="Click on this link " and  
[verdict] = "You can adopt the child.But, because, the child is not born, it is Adoption of merly conceived child according to Ethiopian Revised family code Article, 187. And you have to be aware that, under Article 187, sub article 2, it declare that the adoption agreement may be revoked unilaterally at the will of the mother within six months following the birth of the child"

RULE [Parental wills 1ok, foreigner false and merly conceived no]  
If [orderThree] = "Examine parents will" and  
[parent of the child] = "One parent is dead/unknown/incapable to manifest her/his will.But the other parent agreed" and  
[foreigner] = false and  
[merlyconceived] = false  
Then [Further]="Click on this link " and  
[verdict] = "Based on the fact you are entered, You can adopt the child."

RULE [Parents both alive 1ok, foreigner true and merly conceived yes]  
If [orderThree] = "Examine parents will" and  
[parent of the child] = "Both parent of the child are alive and known. But only one of the parent is willing" and  
[foreigner] = true and  
[merlyconceived] = true  
Then [Further]="Click on this link " and  
[verdict] = "According to article 191(3), if one of the parent is not willing to give his/her consent and the child is ten and above years of age, the court may approve the adoption upon hearing the opinion other parent and of the child .And, because your Nationality is not

Ethiopian, the adoption will be allowed, after the court has examined and approve your financial capability and other necessary condition for the child growth. And again, the child is not born, it is Adoption of merly conceived child according to Ethiopian Revised family code Article, 187. And you have to be aware that, under Article 187, sub article 2, it declare that the adoption agreement may be revoked unilaterally at the will of the mother within six months following the birth of the child"

RULE [Parents both alive 1ok, foreigner true and merly conceived no]

If [orderThree] = "Examine parents will" and

[parent of the child] = "Both parent of the child are alive and known. But only one of the parent is willing" and

[foreigner] = true and

[merlyconceived] = false

Then [Further]="Click on this link " and

[verdict] = "According to article 191(3), if one of the parent is not willing to give his/her consent and the child is ten and above years of age, the court may approve the adoption upon hearing the opinion other parent and of the child .And, becuase your Nationality is not Ethiopian, the adoption will be allowed, after the court has examined and approve your financial capability and other necessary condition for the child growth."

RULE [Parents both alive 1ok, foreigner false and merly conceived yes]

If [orderThree] = "Examine parents will" and

[parent of the child] = "Both parent of the child are alive and known. But only one of the parent is willing" and

[foreigner] = false and

[merlyconceived] = true

Then [Further]="Click on this link " and

[verdict] = "According to article 191(3), if one of the parent is not willing to give his/her consent and the child is ten and above years of age, the court may approve the adoption upon hearing the opinion other parent and of the child . And again, the child is not born, it is Adoption of merly conceived child according to Ethiopian Revised family code Article, 187. And you have to be aware that, under Article 187, sub article 2, it declare that the adoption agreement may be revoked unilaterally at the will of the mother within six months following the birth of the child"

RULE [Parents both alive 1ok, foreigner false and merly conceived no]

If [orderThree] = "Examine parents will" and

[parent of the child] = "Both parent of the child are alive and known. But only one of the parent is willing" and

[foreigner] = false and

[merlyconceived] = false

Then [Further]="Click on this link " and

[verdict] = "According to article 191(3), if one of the parent is not willing to give his/her consent and the child is ten and above years of age, the court may approve the adoption upon hearing the opinion other parent and of the child ."

RULE [Parents both not known, foreigner true and merly conceived true]

If [orderThree] = "Examine parents will" and

[parent of the child] = "Both the father and the mother of the child are not known/incapable to manifest their wills" and

[foreigner] = true and

[merlyconceived] = false

Then [Further]="Click on this link " and

[verdict] = "According to Article 191(4), where the child has no asendant capable of giving his consent, the court may approve the adoption agreement taking into account the interest of the child.And, becuase your Nationality is not Ethiopian, the adoption will be allowed, after the court has examined and approve your financial capability and other necessary condition for the child growth."

RULE [Parents both not known, foreigner true and merely conceived true]  
If [orderThree] = "Examine parents will" and  
[parent of the child] = "Both the father and the mother of the child are not known/incapable  
to manifest their wills" and  
[foreigner] = true and  
[merlyconceived] = true  
Then [Further]="Click on this link " and  
[verdict] = "The fact seems Irreconcilable. how could the child's father and mother is not  
known if the mother is still pregnant. I couldnt advise you. Sorry!"

RULE [Parents both not known, foreigner false and merely conceived false]  
If [orderThree] = "Examine parents will" and  
[parent of the child] = "Both the father and the mother of the child are not known/incapable  
to manifest their wills" and  
[foreigner] = false and  
[merlyconceived] = false  
Then [Further]="Click on this link " and  
[verdict] = "According to Article 191(4), where the child has no ascendant capable of giving  
his consent, the court may approve the adoption agreement taking into account the interest of  
the child."

RULE [Parents both not known, foreigner true and merely conceived true]  
If [orderThree] = "Examine parents will" and  
[parent of the child] = "Both the father and the mother of the child are not known/incapable  
to manifest their wills" and  
[foreigner] = false and  
[merlyconceived] = true  
Then [Further]="Click on this link " and  
[verdict] = "The fact seems Irreconcilable. How could the child's father and mother is not  
known if the mother is still pregnant. I couldn't advise you. Sorry!"

RULE [Parents both not known, foreigner true and merely conceived true]  
If [orderThree] = "Examine parents will" and  
[parent of the child] = "Both the father and the mother of the child are not agree for the  
adoption"  
Then [verdict] = "According to your input adoption will not be possible unless both the father  
and the mother of the child are willing for the adoption where they are alive, according to  
article 191(1)"

REM=====

PROMPT [is foreigner] MultChoice  
"What is your Nationality?"  
"Ethiopian"  
"Other, than Ethiopian"

PROMPT [age>=25] YESNO  
"Is your age greater than or equal to 25 years?"

PROMPT [married1] MultChoice  
"Select among the available option, which discribe your marriage status, now."  
"Widow(husband died)."  
"Widower(wife died)."  
"Married."  
"Single"

PROMPT [married] MultChoice

"Select among the available option, which discribe your marriage status, now."  
"Widow(husband died)."  
"Widower(wife died)."  
"Married."  
"Single"

PROMPT [your spouse age>=25] YESNO  
"Is your spouse age greater than or equal to 25 years?"

PROMPT [ur spouse consent?] MultChoice  
"Does your spouse agreed about the Adoption you are planning for?"  
"Agreed"  
"Not agreed"  
"Not capable to manifest her/his will"

PROMPT [adopted child age] MultChoice  
"What is the age of the Adopted child?"  
"Merly conceived (not born)"  
"Greater than eighteen"  
"Greater than Zero age (born) and Less than eighteen years of age"

PROMPT [adopted before] YESNO  
"Did the child you are planning to adopt now, was adopted before?"

PROMPT [is adopter alive?] YESNO  
"Did the child's previous adopter alive? "

PROMPT [parent of the child] MultChoice  
"Select Among the following lists which is applicable for the parents of the child you are going to Adopt."  
"Both father and mother of the adopted child are willing"  
"One parent is dead/unknown/incapable to manifest her/his will.But the other parent agreed"  
"Both parent of the child are alive and known. But only one of the parent is willing"  
"Both the father and the mother of the child are not known/incapable to manifest their will"  
"Both the father and the mother of the child are not agree for the adoption"

GOAL [Further]  
GOAL [verdict]

TRANSLATE TR\_NORESP = "I don't know/would rather not answer"  
TRANSLATE TR\_RESULTS = " "  
TRANSLATE TR\_HYPERLINK = " "  
HYPERLINK [Further] = "Click on this link " "AdoptionFurther.aspx"

## DECLARATION

I declare that this project is the product of my own work and that any ideas or quotation from the work of other people, published or otherwise are fully acknowledged in accordance with the standard referring practices of the discipline.

Declared By:

Name: Befrdu Seifu

Signature: \_\_\_\_\_

Date: \_\_\_\_\_

Advisor Confirmation:

Name: Solomon Atnafu (PhD)

Signature: \_\_\_\_\_

Date: \_\_\_\_\_

February, 2014

Addis Ababa, Ethiopia