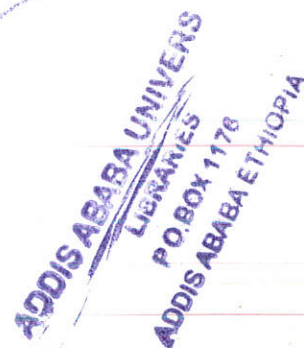
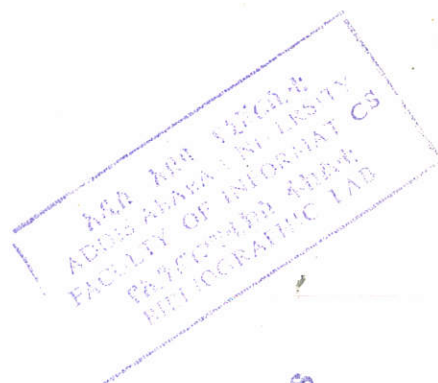


**ADDIS ABABA UNIVERSITY
FACULTY OF INFORMATICS
DEPARTMENT OF INFORMATION SCIENCE**

*An Expert Based Human Resource Management
system in dealing with Selection, Training and Performance evaluation
measures-The case of Ministry of Capacity Building*

A THESIS SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES OF
ADDIS ABABA UNIVERSITY IN PARTIAL FULFILLMENT OF THE
REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN
INFORMATION SCIENCE

By
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ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES
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Department of Information Science

AN EXPERT BASED HUMAN RESOURCE MANAGEMENT SYSTEM IN DEALING WITH
SELECTION, TRAINING AND PERFORMANCE EVALUATION MEASURES-THE CASE
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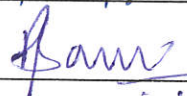
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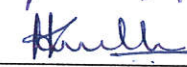
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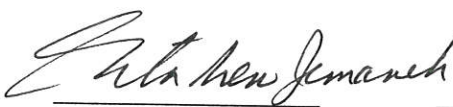


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Chairman, Faculty	Signature Date

Chairman, Graduate Council

Signature

Date

Dedication

*To my brother:
Fantahun Alemu*

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Yihun Alemu

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ABSTRACT

In practice, management problems require a high skill of managing with inter disciplinary background combining social science, business and behavioral sciences. Effective human resource management system represents the essence of production efficiency, growth processes, transparency and predictability of production, getting additional profit due to proper and quicker decision-making, keeping equal employment opportunities, and so on.

Today's human resource workers run most of the activities in the HRM system increasingly by consulting top executives and experts. With regard to Ethiopia, the process of human resource management is done manually under the control of committee members organized for the process, which is not an efficient method in measuring and evaluating an applicant's performance and skill. And consequently a number of problems are faced, like irregular evaluation mechanism, rater errors and personal bias, external influence of liking, and so on.

Literatures suggest that the success of an organization lies down on experts engaged in joining the production with its management process. And to solve such and related human resource problem, using an appropriate technology based system is paramount. A knowledge based (Expert) systems is the one, which is appropriate in solving problems regarding human resource management.

In an attempt to address such problems, the present study, specifically, explores the potentiality of applying expert systems technology in Human Resource Management problems specific to the Selection, Training and Performance evaluation measures for the Ministry of Capacity Building in Addis Ababa.

The knowledge acquired from manuals and domain experts is represented using production rules. These rules are then implemented in the Knowledge Pro Gold expert system shell using back ward chaining inference mechanism.

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

1.1.1 Human Resource Management (HRM)

The title human resource management (HRM) is a recent area representing all aspects of managing people in an organization. It is a broad based understanding of the problems of people and their management with respect to the development of behavioral science knowledge [saiyadain, 2004]. Today, professionals in human resource area are important elements in the success of an organization specially to make the working environment more structured so that workers to stay in the organization and simultaneously attract new applicants [Decenzo and Robbins, 1999].

Human resource management is the part of an organization concerned with “people” dimension [Decenzo and Robbins, 1999]. This is to mean HRM is a staff that supports functions of the organization in line with employees and production as a whole and it can also be taken as a function of every manager’s job.

In practice, management problems require a knowledge based decision support system and a skill of managing. More over, it needs inter disciplinary background combining social science, business and behavioral sciences. Today, to improve the productivity of an organization, it is compulsory to use an appropriate technology based system in every field.

To improve the morale and productivity of employee, an organization should arrange training programs, compensation, benefits and related employee job appraisal activities. It is believed that training enhances productivity and quality of work, develops skills and builds loyalty to the firm. And the training differs depending on the type of job, the size of the staff and the goal of the organization.

The modern era of science and technology is the era of expert skills in different domain areas. It is always true that, experts are scarce in many fields of study-the human

resource management is the one. Therefore to utilize human resource efficiently and properly, it is recommended to use an appropriate technology in the required field.

In general, effective human resource management system represents the essence of production efficiency growth processes, transparency and predictability of production, getting additional profit due to proper and quicker decision-making, keeping equal employment opportunities, and so on.

Inside the human resource management, there are a number of activities that need specialists, such as employment and placement managers, compensation, benefit and job analysis specialists, training and development managers and specialists, and so on. From the different activities in the HRM system this research will give attention on the training, selection and performance evaluation of the stated organization.

1.1.2 Artificial Intelligence

Artificial intelligence (AI) is a young field comprising a number of applications in different domain areas. Like any other disciplines, AI has taken many ideas, viewpoints and techniques from different subjects. Among the different subjects that contribute ideas for AI came in to being, the major ones are philosophy, Mathematics, Psychology, Computer Engineering and Linguistics [S.J..Russell and P.Norrig,1995]. Different writers define AI from different angles; the common approaches are the human centered approach and the rationalist approach:

- *“The exciting new effort to make computers think... machines with minds, in the full and literal sense” (Maugeland, 1985)*
- *“ The art of creating machines that perform functions that require intelligence when performed by people”(Kurzweil, 1990)*
- *“The study of the computations that make it possible to perceive, reason and act. “ (Winiston, 1992)*
- *“The branch of computer science that is concerned with the automation of intelligent behavior.”(Luger and stubblefield, 1995)*

The first two definitions are human centered approach and the last two are rationalist approach, and historically all the above four definitions have been followed [S.J..Russell and P.Norrig, 1995: pp5].

Now a day artificial intelligence is one of the fastest growing sub-disciplines of computer science. Unlike the conventional computer programs, which are performing computational or arithmetic operations, AI programs deals with symbols and symbolic concepts rather than numbers [W.B. Rauch-Hindin, 1986]. As stated by W.B. Rauch, the strong point for conventional computer programs is their ability to perform very complex computational operation quickly and accurately. But with regard to AI programs what are going to be solved are symbolic and conceptual problems encountered in our day-to-day activities. AI is always concentrating on building intelligent machines that think and solve human problems in a specific domain area. It is applied in different fields of study such as electronics, engineering, law, mathematics, medicine, and so on.

In the early 1960's (in its very beginning) AI was attempting only few problems like game playing (checkers), theorem proving and a very simple task problem solving. Now a day it has a wide variety of applications in different areas as stated above [C.E. Brouen and D. E. O'Leary, 1995].

1.1.3 AI and Expert System

There are, now, different sub disciplines (areas) with in the field of artificial intelligence. The basic categories of AI are: Expert (knowledge base) Systems, Natural Language (every day native language) Systems and Perception Systems for vision, speech and touch [W.B. Rauch-Hindin , 1986].

- ***Simple perception systems-*** are intelligent programs that can make inferences about the quality and physical appearance of objects.
- ***Natural language systems-*** are also computer programs that facilitate the interaction between end users and application programs by avoiding the need of formal computer languages through user-friendly interfaces.

- *Expert (knowledge Base) systems- are computer programs that are dedicated for solving problems beyond the reach of conventional computer programs [W.B. Rauch-Hindin, 1986].*

It is clear from the name that expert systems (ES) are computer programs that provide power (weight) for experts. One of the main practical successes of AI is the development and application of ES in different problem areas [Donnald Gillies, 1996].

- **DENDRAL**- The first expert system developed in the Stanford mass spectrometry Laboratory (1965). It was to explore the atomic composition of an organic compound.
- **MYCIN**- The first medical expert system developed by the Stanford Heuristic Programming projects. It was for diagnosing and treatment of blood and meningitis infections. Specifically, MYCIN was a rule- based Medical expert system yielding over 400 rules about the infection.

In general, a knowledge based systems or ES are computer programs that captures the knowledge of human experts in a specific domain areas and uses those domain knowledge in problem solving where there are no experts, since human experts are scarce, expensive and difficult to get. Some of the most important advantages in using expert systems for problem solving are:

- ES do not forget unlike that of human experts.
- Reproducing ES is possible but training new human experts is expensive and time consuming.
- ES is wider than a human expert in that it is the cumulative effect of a number of experts, and many more. [C.E. Brouen and D. E. O'Leary, 1995]

Even though ES lack sensory experience, creativity and unable to learn from the changing environments, it is an outstanding program in solving humans' day-to-day problem that needs experts. One of such problem is problems regarding human resource management.

With regard to human resource management (HRM), it is clear that a problem always arises especially in the selection, promotion, giving training facilities and performance evaluation measures. This is a problem of almost all organizations particularly in Ethiopia.

Moreover, another key feature of ES that is not supported by conventional systems is its ability to explain their reasoning process (i.e. the explanation facility) since most of us need some more justification from experts for the answers of a given problem [Keith Darlington]. And the fundamental components, mainly, in expert system is inference mechanism and the knowledge base unlike to that of conventional computer systems which are algorithms and data.

1.2 STATEMENT OF THE PROBLEM AND JUSTIFICATION

Human resource management is a big field of study containing a number of activities inside. Literatures stated that it is possible to manage the employment process from creating job positions and advertising for the candidates through the recruitment, hiring and determining compensation, benefits, developing training programs and conducting routine performance reviews. So, to improve the productivity of an organization, those activities should be performed efficiently.

Today's human resource workers run most of the activities in the HRM system increasingly by consulting top executives and experts [U.S.Department of Labor, 2004]. The idea, mostly coming from experts, leads a company in suggesting and changing its policies to attain the financial success. Accordingly, an expert based human resource management system uses a cumulative effort of experts in the domain area to improve the productivity of an organization.

With regard to Ethiopia, the process of human resource management is not moving in the right direction. For instance, in the process of screening in selection and training activities, the process is done manually under the control of the committee members organized for the process. More over, the committee members are selected based on their political stand with out considering their management skill experience. On one hand

those committee members are higher personnel and are killing their working times in the process of screening, on the other hand they are not efficient in measuring and evaluating an applicant's performance and skill with out personal biases. And in general, some of the problems encountered in the area of human resource management in Ethiopia are:

- The lack of proper follow up of employee
- The evaluation mechanism is not standardized and periodic
- Performance evaluation of the employee in most organizations is not free from personal bias
- Selections of employee are mostly done manually under the control of the managers and this may lead sometimes to erroneous results and so on.

Based on the above problems on resource management, the study will further diagnose related problems and minimizes them by incorporating appropriate technological techniques.

Literatures also suggest that the success of an organization lies down on experts engaged in joining the production with its management process. The emerging knowledge millennium will need an appropriate national, regional and global system of knowledge creation and sharing in order to attain an organization's goal. Hence to use human resources effectively and increase productivity, especially in developing countries like Ethiopia, it is better to use an expert based human resource management system.

More over, the study has aimed in minimizing the personal bias in the selection and performance evaluation of employee in an organization. With respect to this, an expert based human resource management is helpful in supporting managers and authorized personals in doing such activities by incorporating the knowledge of domain experts and simultaneously minimizes those problems.

1.3 OBJECTIVE OF THE STUDY

1.3.1 General Objective

The main objective of the study is to design a prototype Expert based Human Resource Management system specific to the Selection, Training and Performance Evaluation measures of an organization. In addition to explore the possible application of expert system in the area of resource management, the study is aimed to minimize the human resource management problems by supporting the manual works currently in practice.

1.3.2 Specific Objectives

The specific objectives of the study are as follows:

- ◆ To explore the possible application of expert system in the area of human resource management
- ◆ To investigate the domain knowledge used in human resource management
- ◆ To identify some common problems in the area of HRM and develop skills of authorized persons in resource management department.
- ◆ To develop a prototype knowledge based system for the study.
- ◆ To forward recommendations especially to develop a full fledged functional system in the area under study and to suggest for further work in other disciplines.

1.4 METHODOLOGY

1.4.1 Method of Data Collection

□ Literature Review

One of the important methods in collecting the domain knowledge for this study is reviewing related literature. Related literatures in the area of the study will be reviewed from different sources, i.e. from books, journals, and the internet and so on, to acquire the target domain knowledge in parallel with the possible applications of expert system.

□ Discussion

Another most important method of data collection in developing a Knowledge Based system is discussing with experts. Since expert system is a program that leverage experts in a given domain area, most of the time of data collection will be given for discussion with experts.

1.4.2 Method of System Development

□ Prototype Development

To develop the system the method of prototyping will be employed. Literatures recommend prototyping approach in developing an expert system since the method is a common way of developing an ES and it enables a better management for the system in the time of implementation.

□ Programming tools

Among the different types of programming tools, which can be used to build an ES, the Knowledge- pro (An expert system shell) is used. Knowledge-pro is selected as a tool because it has flexible help system and its code is easier to update and maintain.

1.5 SCOPE AND LIMITATION OF THE STUDY

Human resource management is a broad field containing a number of activities, but the scope of this study will focus on designing an Expert based Human Resource Management system specific to the Selection, Training and Performance evaluation measures. Due to time constraints, the knowledge-based system may not contain all the necessary rules in HRM. Because of this, the study is restricted on major rules of the above-mentioned activities at the Ministry of Capacity Building.

1.6 ORGANIZATION OF THE THESIS

The study is organized into six chapters. Chapter one is the introductory part, which contains the background, problems and justifications to conduct the research, objectives (general and specific) and methodology to carry out the research, and its scope and limitation.

Review of literatures on the expert systems, about its background, architecture and expert system applications in the area of resource management in general and the human resource management in particular is presented in chapter two.

Chapter three focuses on the fundamentals of human resource management in general and a detail discussion on the training, selection and performance evaluation aspects in particular. The chapter includes the human resource management system practice of the country.

Chapter four discusses the methods used in knowledge acquisition, knowledge representation and modeling processes.

In chapter five, the development of the prototype expert systems under study has been discussed. The chapter presents the application of the knowledge using sample demonstrations of the user interface. The last chapter, chapter six, highlights recommendations of the researcher accompanied by concluding remarks.

CHAPTER 2

EXPERT SYSTEM

2.1 INTRODUCTION

There are different sub disciplines with in the field of artificial intelligence. One is the Expert (knowledge base) system. In the early 1960's (in its very beginning) AI was attempting only few problems like game playing (checkers), theorem proving and a very simple task problem solving. Now a day it has a wide variety of applications in different problem areas.

Expert systems are considered as a branch of AI because the method of problem solving is predominantly based on heuristics together with the human experts' knowledge. This contrasts very much with the conventional programming paradigm that uses algorithms to solve problems. Artificial Intelligence (AI) is a broad field, with some of the application areas shown in the diagram below:

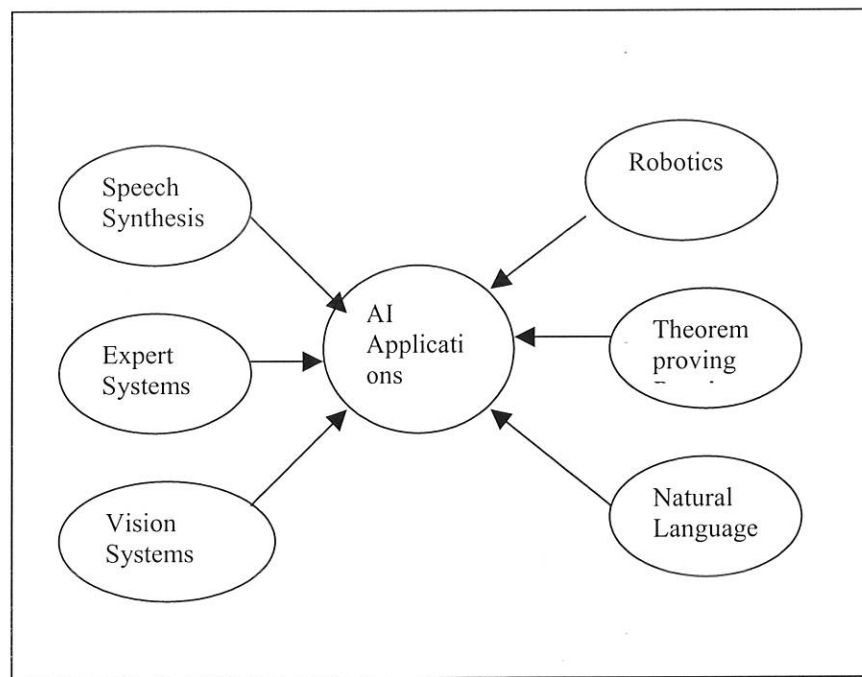


Figure2.1 some applications of AI

□ Evolutionary view of ES

Different human problems have been addressed through the help of modern technologies. One of the young disciplines of such technology is artificial intelligence. AI researches are now growing to solve a number of non-numerical human problems. Even though the emphasis for most programmers is on the development of software tools, AI languages grew out of techniques developed for managing symbolic information [Parsaye and Chignell, 1988].

Expert system and symbolic computations are the new era information processing in which computers can separate and manipulate symbolic information to generate conclusions. Thus expert systems can be taken as a new step in the evolution of programming paradigms, tools for simulating human behavior, tools for solving problems, and a new software technology.

Expert systems are computer programs on a specific domain area that acts as an expert by reducing the overall complexity of the situation in that domain specific knowledge. In contrast to the conventional softwares, which process data, expert systems process knowledge and because of this expert systems are also known as knowledge based systems (KBs) [K. Darlington]. One example to mention here is the well-known medical expert system, MYCIN, was developed in 1976. K.Darlington summarizes those characteristics that distinguish expert systems from conventional system as follows.

Table 2.1 The characteristics that distinguish expert from conventional systems

Characteristic	Expert system	Conventional system
Underlying paradigm	<i>Heuristic</i> . Usually implemented using state space search. Solution steps are implicit (i.e. not determined by programmer). Solution found is not always guaranteed correct. Usually declarative problem solving paradigm.	<i>Algorithmic</i> . Solution steps explicitly written by programmer. Correct answer given. Procedural problem solving paradigm.
Method of operation	Reasons with symbols. For example, infers conclusions from known premises in order to diagnose a patient illness. Inference engine is used to decide the order in which premises are evaluated.	Predominantly manipulate numeric data. For example Sorting. Calculating and storing data processed to produce information such as pay slips for a company payroll system.
Processing unit	<i>Knowledge</i> . This may be represented in the form of rules. Knowledge is active in that an expert system can reason with knowledge to infer new knowledge from given data.	<i>Data</i> . Typically represented in the form of arrays or records in languages like C or COBOL. Data is passive in that it does not give rise to further generation of data.
Control mechanism	Inference engine usually separate from domain knowledge.	Data or information and control usually integrated together.
Fundamental components	Expert system = inference + knowledge	Conventional system = Algorithm + Data.
Explanation capability	Yes. An explicit trace of the chain of steps underlying the reasoning processes. Would typically enable a user to find out how the system arrived at its conclusions or perhaps why the system is asking for an answer to a particular question.	No.

2.2 EXPERT SYSTEM ARCHITECTURE

Almost all expert systems have four major components. The user interfaces, the explanation facilities (system), the inference engine (mechanism) and the knowledge base.

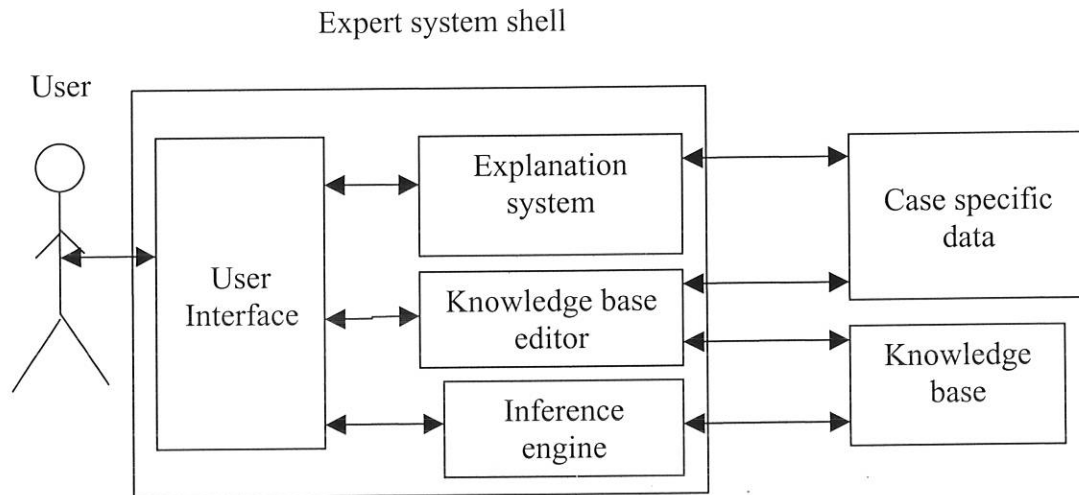


Figure2.2 Expert system architecture

- ◆ **The user** – the user is the actual beneficiary of the system's utility. The user interacts with the system through the user interface that makes access more comfortable and hides much of the system's complexity.
- ◆ **The user interface**- this is where the user interacts with the expert system. The user interface may use menus, natural language, question and answer or any other style of interaction.
- ◆ **The explanation system**- almost all expert systems have an explanation sub system. This facility allows the program to explain its reasoning and decision processes to the user. The explanation facility allows the user to ask why the system asked some question and how it reached some conclusion. The system will answer those questions based on its goals, rules being used and any existing problem data.

- ◆ **Knowledge base editor**- some systems have a knowledge base editor which help the expert or knowledge engineer to update and check the consistency of the knowledge base easily. Based on the explanation facility of the system, the knowledge base editor helps the programmer to debug the system's performance, add new knowledge to the knowledge base and correct the rule syntax accordingly.
- ◆ **An inference engine** – it is used to reason with both the expert knowledge and the data specific for a particular problem being solved. The expert knowledge is mainly the knowledge in the knowledge base typically expressed as a set of IF-THEN rules, and the case specific data includes both data provided by the user and partial conclusions (along with certainty measures) based on this data.

The real effort of expert systems is their capacity in making inferences or drawing of conclusions based on premises. For a human expert it is not enough to know and apply a domain knowledge using rules but in which order they should be applied to solve a particular problem is the remarkable question. With the same fashion, a computer expert system needs to carry out a conclusion or a set of actions based on the knowledge in the knowledge base through rules in a certain order. To do this, an expert system uses an inference engine. An inference engine is a program that interprets the rules in the knowledge base in order to draw conclusions.

The two commonly used alternative strategic of the inference process are *the backward chaining* and *forward chaining*. A particular inference engine may adopt either or both [k. Darlington].

2.2.1 Backward chaining inference

A backward chaining inference engine is sometime called 'a goal – oriented' inference in that it tries to prove a goal by confirming the truth of its entire premise.

To prove a goal, backward chaining inference mechanism starts with and focuses on the conclusion of rules and proves the goal by matching them with the fact base [Parsaye and Chignell]. Most medical expert systems work by using the backward chaining process.

A backward chaining inference, also known as *top down approach*, begins with goal and look for evidence that supports the goal. In other words, the inference engine (the rule interpreter) tries to match the 'THEN' condition instead of the 'IF' condition, for example:

To find out E from the following Rules,

Rule 1: If D then E

Rule 2: If C then D

Rule 3: If A and B then C

Rule 4: If A then B

E as a goal, we trace through the rules and we found an implicit rule 'if A then E'. Hence whenever A (the data) is true, it yields B and so on to give the final goal E.

2.2.2 Forward chaining inference

The same types of solutions can be made through a forward chaining inference mechanism. The difference is, in forward chaining a certain true situation triggers the action or consequent part of a rule [Wendy, 1988].

In some sense, forward chaining can be taken as the opposite of backward chaining since it focuses on the IF part (premises of rules) rather than the conclusions. For example, the set of rules

If A and B then C (Rule 1)

If C then D (Rule 2)

If D then E (Rule 3) yields a conclusion E for the given data A and B.

This chaining of rules yielding a certain conclusion is sometimes called *a data directed or data driver inference*. Since the data itself drive the inference from left to right in rules to generate a conclusion. According to Wendy, the difficulty of a forward chaining comes

when the rule base is very large and because of this there will be a possibility to produce irrelevant reaction.

2.2.3 Forward or Backward?

The different chaining mechanisms are appropriate for different problem domains. For example, a forward chaining based medical system may suggest relevant treatment based on the patient's medical data. On the other hand, many diagnostic systems strive to meet a goal at every step of procedure. As a result they are often suited to backward chaining techniques [Wendy, 1988].

According to Parsaye and Chignell, it is also possible to use the mixed strategy, forward and backward chaining, in controlling inference. The idea is to find some way switching between forward and backward chaining methods to produce an alternative pattern of inference, which is more efficient than the above two. Financial knowledge based systems and many equipment diagnosis systems profit from the combined inference techniques.

- ♦ *The knowledge base*- the knowledge base, which contains the problem solving knowledge for a particular application, is the heart of an expert system. There are a number of ways in representing the domain knowledge depending on the knowledge being represented and the expert system shell used.

Semantic networks- this is one of the earliest explicit attempts for knowledge representation in artificial intelligence that reflect the psychological models of the human memory and drew on the relationship between knowledge and natural language to build structure in representing words.

Semantic networks, as an early approach to knowledge representation, also introduced a number of basic concepts like inheritance of properties. Approaches to semantic networks rely on two fundamental units: *Nodes* and *Links*.

Nodes- which represent objects, concepts or events

Links - which represent relations between nodes?

Semantic networks were popular in the 1970s, but today it is used in relatively few systems since they are unmanageable as the size of the KB increases [Parsaye and Chignell, 1988].

Another early approach to KR was based on *production rules*. In this approach the knowledge is represented as a series of IF- THEN rules. In a rule-based expert system the domain knowledge is represented as a series of IF – THEN rules and is checked against the facts or knowledge of the current situation to generate a conclusion. The inference mechanism here checks the If part of the conditional statements for the current situation with the fact base and execute the THEN part of the rule in the knowledge base. Because rules are a straightforward method of representing expertise, they are used by different applications. One of the well-known early rule based expert system was MYCIN.

Frames and scripts- another way of representing knowledge is through frames and scripts. Frames and scripts represented one line of research on how to combine declarations and procedures with in a knowledge representation environment [Parsaye and Chignell, 1988]. A frame is a package of knowledge about an entity or concept. A number of frames having a complex package of knowledge can be integrated to construct hierarchies that can develop inheritances. But, according to Parsaye and Chignell, constructing knowledge using frames is a very challenging and complicated work since a frame doesn't have its own language. Scripts permit reasoning based on expectations on what should happen next. A script is an outline of a certain event that organizes a set of actions and predicts the presence of activities.

There are also other ways of representing knowledge such as the object oriented knowledge representation, which is closely related to frame and semantic networks, blackboard model of representing knowledge, which is forming a group of human experts qualified in different fields to solve a different problem, and so on.

2.3 UNCERTAINTY

We live in an uncertain world, any information we deal about may not be certainly true. In dealing with uncertainty, we are not completely sure of a fact but we have to reason

out that the fact is “probably” true. In order to handle uncertain information, we first need sufficiently expressive means to represent it and then incorporate a reasoning component into our computing system in order to derive answers from the uncertain information [Hunter and Parsons]. In general, uncertainty can be expressed as the degree of belief in the fact or rule.

2.3.1 Sources of Uncertainty

Generally, there are two ways in which uncertainty may be dealt with in the field of expert system: *imperfect domain knowledge* or *imperfect case data*.

Uncertainty due to imperfect domain knowledge implies the incomplete, insufficient or vague collection of domain. In such cases the knowledge itself is inherently imprecise, and hence the effect of actions may not always be predictable or correct. A good example is the decision making process in most organizations, decisions can be made incorrectly because of the incompleteness of the organizations rules and regulations and the knowledge gap of the decision makers.

The second case of uncertainty is due to imperfect case data. Case data may be imprecise or unreliable, i.e., it is not always that the information is inherently uncertain; it is just that we don't have the information we need. When case data are partial or unreliable, even through the answers are available in the knowledge base, the answer may not be available in practice or it may be liable for inexact conclusions.

2.3.2 Handling Uncertainty

Several methods have been proposed by different literatures for dealing with uncertain information in expert systems. Once we know how uncertainties are attached to knowledge in the knowledge base of an expert system, we should focus on the methods for dealing with uncertainty during inference. To handle uncertainty, some of the methods are probabilities, fuzzy logic, and certainty theory.

EF). In such theory, each statement or rule has a certainty factor or degree of truth expressed in number between 0 and 1.

The well-known rule based medical expert system MYCIN used certainty factor. MYCIN was designed to help the doctor to decide whether the patient has a bacterial infection, which organism is responsible, which drug may be appropriate for the infection and which may be used for the specific patient. A typical rule in MYCIN is:

IF the identity of the germ is not known with certainty.

AND the germ is gram positive

AND the morphology of the organism is "rod"

AND the germ is aerobic

THEN the germ is of type enterobacteriaceae with certainty factor 0.8

Here in the rule, the germ is aerobic with certainty factor (CF) 0.5 hence the rule interpreter recommends a conclusion with high certainty factor.

The certainty factor associated with a conclusion is calculated from the certainty factor of the premises, the certainty factor of the rule and any existing certainty factor for the conclusions [Paul Lewis, 2003].

Since the computation of certainty factor is totally modular, there is no need to consider any information that is not included in a rule. Therefore, we don't care about the certainties of other propositions and how the certainty factor of the rules was derived. These things make the certainty theory famous and have practical advantages over the probabilistic approach.

2.4 EXPERT SYSTEM APPLICATIONS

Expert systems are computer programs which assist people in performing a wide variety of functions, including diagnosis, planning, scheduling and design, decision making, crisis management, etc.

A few expert system application areas written in different literatures include:

- *Accounting & finance* – Focusing on Portfolio Construction, Financial Planner Training and Selection, Personal Tax Advisor, Credit Analysis Advisor, Bank Loan Identification, Loan Documentation, Assessment of Risk and Fraud in Financial Institutions, ...
- *Agricultural* - Irrigation and Pest Control, Crop Variety Selection and Management, Soil Characterization and Utilization for Specific Areas, Fertilizer, Climate and Soil Interaction and Analysis, Species Selection, Forest Inventory, Soil Conservation, Planning and Design of Agro forestry Systems...
- *Business* – In areas such as Advertising Copy Development, Market Advisor for Process Control Systems, Demographic and Market Assessment, Product Performance Trouble-shooting, Sales Personnel Assessment, Salary & Benefit Planning, Professional Service Selection, Pension Fund Calculator...
- *Computer* - Software System Diagnostic Modeling, Software Quality Assurance, Program Classification, Locating Component Failure & Analysis, New Technology Selection, Training Systems, Custom Hardware Diagnostics, Decision Support Systems, Fault Detection and Diagnostics of Wide Area Networks, Analysis of Statistical Data, Personal Computer Configuration, Shielding Technique Selection, Computerized Technical Service Representation, Hardware and Software Selection by Non Technical Users...
- *Many, many others* - Telephone System Configuration, Training Material & Product Selection, Manufacturing Resource Planning, Production Scheduling, Service Networking, Airline Scheduling, Cost/Benefit Analysis, Planning Implementation, Career Development, Quick Proposal Estimating, Credit Control, Product Development, Telephone Call Screening, Retirement Planning, Sales Analysis...

In general speaking, expert system is now more applicable and popular in many fields of study than the conventional computer programs since it is really more than a high level approach in solving problems.

2.4.1 Expert System and HRM

Management problems require a knowledge based decision support system and a skill of managing. More over, it needs an interdisciplinary background combining social science, business and behavioral sciences. Attracting the most qualified employees and matching them to the jobs for which they are best suited is important for the success of any organization. However, many enterprises are too large to permit close contact between top management and employees. Human resources, training, and labor relations managers and specialists provide this link. These workers have been associated with performing the administrative function of an organization, such as handling employee benefits questions or recruiting, interviewing, and hiring new personnel in accordance with policies and requirements that have been established in conjunction with top management. Today's human resources workers manage these tasks and, increasingly, consult top executives regarding strategic planning. In a small organization, a *human resources generalist* may handle all aspects of human resources work, and thus require a broad range of knowledge. In a large corporation, the top human resources executive usually develops and coordinates personnel programs and policies, and in more general appropriate technologies like an expert based management system are in use by most organizations in the world.

Knowledge based system applications are frequently implemented to capture, build and deploy human expertise. These objectives are closely related to the functions and responsibilities of the personnel departments in most organizations. New skills and talents are required to develop and maintain knowledge based systems as most literatures stated, and personnel department staffs should be familiar with these factors to be able to satisfy the requirements of the organization.

The knowledge related to human resources can be organized in highly structured form to meet the requirements for making employment information received form the various sources up-to-date. This calls for the utilization of Artificial Intelligence and Knowledge Engineering methods to represent and infer with such knowledge; information and control flows of models and data; intelligent system technology to process and display

data [US. Department of Labor, 2000]. The domain specific knowledge used in decision-making can be represented in symbolic or asymbolic format in the most explicit and formal manner. The knowledge representation scheme has been captured by means of logic. Different formal methods such as propositional logic, predicate logic, fuzzy logic, semantic networks, frames etc. and related techniques have been developed to represent various types of knowledge that can be used by expert systems in decision making and reasoning.

2.5. SELF-LEARNING APPROACHES IN EXPERT SYSTEM

A System can be said to be 'self learning', whenever an input in the form of a value does not find a corresponding condition/antecedent in the rule detail, and it asks the result for the given input. Now if a value or combination of values is not as per the expected set of conditions for any value of the rule in the knowledge base, the system is unable to take a decision. The system displays the new combination and asks for the corresponding value (rule) for the new input and adds this as a new rule in the rule master while adding the new set of conditions in the rule detail, for taking decisions for similar situations in future.

The system should be flexible to accommodate additional parameters as and when required. At present, in the study undertaken, the designed expert system has considered basic parameters required to take a decision or support decision-making.

One commonly used self-learning approach in expert system is incorporating Artificial Neural Networks Technology together with the knowledge base system.

There are two approaches to training artificial neural networks - supervised and unsupervised. Supervised training involves a mechanism of providing the network with the desired output either by manually "grading" the network's performance or by providing the desired outputs with the inputs. Unsupervised training is where the network has to make sense of the inputs without outside help.

Many application systems utilize supervised training. However, in the full-scale of self-learning sense, it is still just a shining promise that is not fully understood, and does not completely work in the area. An example is a combined artificial neural network and

expert system tool developed for transformer fault diagnosis. The knowledge base of its expert system is designed to include as many known diagnosis rules as possible. The topology and training data set of its artificial neural network (ANN) are carefully selected to extract known as well as unknown diagnosis correlations implicitly. The combination of the ANN and ES outputs has an optimization mechanism to ensure high diagnosis accuracy for all general fault types. And sample test results show that the system has better performance than ANN or ES used independently.

A new approach, known as case based reasoning, is also introduced to obtain proper concluding parameters based on old solutions. Case based reasoning views reasoning as a process of remembering one or a small set of existing instances or cases and basing decisions on comparisons between the new situation and the old one. This study finally recommends that interested individuals can expand this expert based HRM system by incorporating such kinds of self-learning approaches.

2.6. PROBLEMS AND LIMITATIONS OF EXPERT SYSTEMS

Knowledge base systems have major potential benefits such as: increased output and productivity, decreased decision making time, capture of scarce expertise, flexibility, easier equipment operation, elimination of the need for expensive equipment and so on. To make an expert system successful enough, literatures suggest the following core points:

- The level of knowledge must be sufficiently high
- There must be (at least) one cooperative expert in the domain area
- The problem must be sufficiently narrow in its scope
- The ES shell must be high quality, and naturally store and manipulate the knowledge
- The system should have friendly user interface
- The organizational environment should favor new technology adoption and so on.

Apart from the above success factors in developing an expert system, there are also problems and limitations that hinder the efficiency of a knowledge base system. Some of them are listed below:

- × Knowledge is not always readily available
- × Expertise can be hard to extract from humans
- × Each expert's approach may be different, yet correct
- × Hard, even for a highly skilled expert, to work under time pressure
- × Users of expert systems have natural cognitive limits
- × ES work well only in a narrow domain of knowledge
- × The vocabulary of experts is often limited and highly technical
- × Knowledge engineers are rare and expensive
- × Lack of trust by the end-users
- × Expert systems sometimes produce incorrect conclusions, and the like.

2.7. MEASURING PERFORMANCE OF AN EXPERT SYSTEM

Evaluation of a knowledge base system is a multi-dimensional problem, with numerous approaches and techniques. The results generated by the system must be evaluated, along with its features, the usability of the system, how easily it can be enhanced, and whether or not it has a positive impact on the people who are using the system in place of an approach which is not computer based. The system's performance must also be evaluated in light of its intended use (Valerie Barr, 1998).

A rule-based expert system is usually tested by checking its performance on a number of test cases with known solutions, and modifying the system until it gives the correct results for all or a sufficiently high proportion of the test cases. This method cannot guarantee that the rule-base ES has been adequately or completely covered during the testing process. One approach to testing of rule-based expert systems uses coverage measures to guide and evaluate the testing process. In addition, it checked domain independent properties of a knowledge base: redundant, conflicting and missing rules. They do not necessarily indicate faults in a particular system - they may be intentional or harmless - but they are suspicious and require careful examination.

In other words, evaluation of an expert system means checking the validation of the knowledge base in the system. Validation provides evidence up on which users decide

whether or not a knowledge base system is reliable. Thus validation ultimately determines the success or failure of a knowledge base system project. Validation techniques include two classes of test: verification tests (for example, whether the knowledge base of the system is consistent, according to some formal definition of consistency); evaluation tests (like, whether the system performs “reasonably”, given that a certain percentage of test cases were processed as expected by the system).

Before 1982, the field of knowledge base system validation focused up on pioneering expert system projects, including MYCIN. Typically validation involved running a set of test cases on a prototype system and evaluating the out put of the system (Alun D Preece, 1998). Regarding this research work, the performance of the knowledge base has been evaluated based on a number of test cases taken from the organization. With respect to redundant and conflicting rules, it works efficiently by giving reasonable conclusions, but it doesn't give right conclusions for every case since the knowledge base is not large enough to accommodate all the rules.

CHAPTER 3

HUMAN RESOURCE MANAGEMENT: AN OVERVIEW

3.1 FUNDAMENTALS OF HRM

The human resource management is not a field that exists in isolation; it is part of the larger field of study –management. Management in general is the process of efficiently achieving the objectives of an organization. It is natural that resources are limited, such as economic resources; and managers are responsible for the scarce resources to allocate effectively in achieving organization's goals.

In the mid 1960s and before, primary job activities for the HRM department of an organization were planning company picnics, scheduling vacations, enrolling workers for health-care coverage and planning retirement parties which are certainly changed in the past three decades [Decenzo & Robbins]. Today professionals in the area of HRM are highly prominent for the success of an organization and their duties is not as simple as scheduling vacations, but it extends from the recruiting and selection of employee through training and development to the performance appraisal activities.

Increasing organizational size, complexity, and changing from traditional to professional management, social and cultural norm changes, globalization, availability of information technology, etc changed the profile of HRM functions. Today HRM managers are changing their primitive style to cope up with the ever growing technology based management system to optimize an organization's aspiration. [Saiyadain, 2004].

Human resource information system [HRIS] – is one of the emerging areas in human resources management today. It is defined as, according to Saiyadain, a composite of database, computer application and the necessary hard wares and soft wares for collecting, recording, storing and managing, delivering and manipulating data for HRM.

Human resources professionals now a day devote much of their time in collecting a large and detailed amount of information on:

- The duties and responsibilities of every job in the organization
- Employee skills and training needs
- HR needs of the organization in the long run, and so on to increase the productivity of an organization.

According to Saiyadain, since it is possible to retrieve and process data very quickly, avoid duplication of efforts and ensures greater accuracy, the growth of computer technology strongly influences the HRM department of organizations to change their ancient paper driven method of operations to an appropriate technology based system. Today many of large organizations in the world have started using HRIS for the different human resource management needs.

With regard to technology, the problem of HRM system is similar to that of other management systems such as the decision support system (DSS). It is obvious that the essence of management in general is decision making, hence to get timely, accurate and goal-oriented human resource decision; an organization should use the integrated approach to expert system that can change the very nature of decision making process and the managerial practices of the organization (Gaddissa, 1996)

Among the different activities (sub areas) of HRM, the major ones are recruiting and selection, training and development, and employee performance evaluation.

3.2 RECRUITING AND SELECTION

Human resource management encompasses a number of practices aimed to attract, develop, reward, motivate and integrate employees. But practices differ in different organizations depending on the organization's goal. However studies assure that there are common HRM practices that deliver effective results in all types of organizations. Some of them are:

- Financial incentives for excellent performance
- Rigorous selection and selectivity in the recruiting
- High investment in training and skill development
- Promotion of employee, and so on [S.R.Kandula, 2004]

Recruitment and selection are major activities in staffing an organization. According to Bateman and Snell, recruitment activities help to increase the pool of the candidates that are going to be selected for a job. Hence recruitment is the process of attracting people to apply for a vacancy announced to a large number of people, and it is the first stage of selection.

The need for recruitment arises from two situations:

- I. Vacancies due to transfer, promotion, retirement, termination, permanent disability or death. This is caused by mobility of human assets.
- II. Creation of vacancies for the purpose of staff expansion, diversification, due to growth or job reclassification. This is caused by the growth of business in the organization [Saiyadain, 2004].

3.2.1 The Selection Process

In the overall selection process, after the stage of recruitment, the next is of course screening. But screening is mostly included in the process of selection as the first initial step. Screening is a better preprocess for selection that is important in reducing the number of applicants. The process of screening is generally done under two clauses – *eligibility* and *suitability*.

- *Eligibility* is to check whether or not the applicants fulfill the minimum qualification/criteria set by the organization. Those applicants who do not qualify will immediately discard from the selection. On the other hand, to decide on the criteria, *suitability* is a very difficult task, a high percentage of marks cannot be a guarantee

for good performance. Those who are distant from the job specifications, whatever their marks, are better to be screened out first.

There are different methods for screening, such as:

Preliminary applicants – screening based on minimum information in a preliminary (Self-prepared) application.

Tests of deselection – it is a common practice to cut – off large number applicants. Researchers suggest that the cut – off point is determined as the number of vacancies multiplied by four since it is believed that one to four ratio for selection gives enough margin for choice.

Screening interview – a short duration interview to select those who should be asked for the next comprehensive interview.

Selection is choosing a few from those who applied for a vacancy. It is a decision about whom to hire [Bateman and Snell, 1999]. According to Bateman and Snell, the major selection instruments are the following:

Interview – is one of the most popular selection tools that most organization uses. However, interviewers are recommended to be careful for what and how they ask, questions that are not job related could not be asked. Depending on the nature of the job position and the purpose of the interview, different methods of interviewing can be conducted: structured interview, unstructured interview, depth interview, etc.

Reference checks – is another commonly used selection device. Although it is one method of selection that gives sense for the employer, it is also becoming difficult to obtain and know the reality of reference information today.

Personality tests – these are not popular in many organizations since personality tests are very difficult to measure and also to defend.

Drug testing – Drug testing and genetic testing are specific selection tools for applicants who are not allowed to take illegal drugs.

Cognitive ability tests – these are among the oldest employment selection devices that measure the intellectual abilities of applicants including verbal comprehension and numerical aptitudes.

Performance tests – are the most widely used selection device that tests the eligible applicants to perform a sample of the job they are applying for. Secretarial, clerical, teaching, and related technical positions practice such type of selection device.

In general, the selection process follows a standard pattern from the initial screening to the final employment decision. Based on the applicants' background, abilities and motivation, decision makers will make a final choice on hiring employee. The flow of these activities is shown in the figure below [Decenzo and Robbins, 1998]

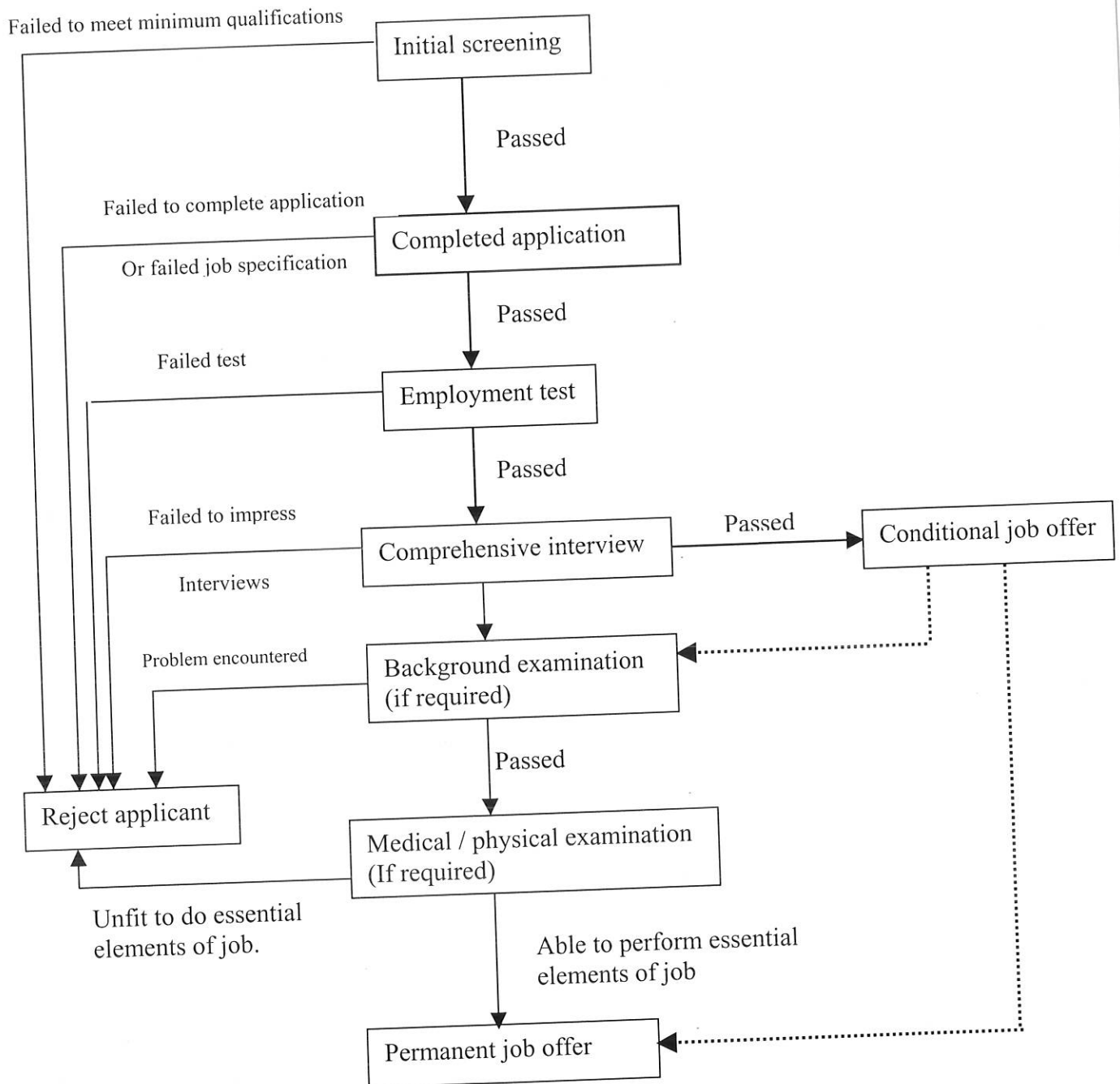


Figure3.1 The selection process.

Under the comprehensive approach, it is recommended that all the steps given in the process diagram should be completed before a hiring decision.

3.2.2 Reactions to selection devices

The different tools for selection process are discussed above, based on the above selection tools an applicant will be accepted or rejected and at the same time managers give their decision on the selection process. Therefore one important question in the selection process is “How do applicants and managers respond to the selection method?” This question is a determining factor in the methods and reasoning of the selection process.

Applicant reactions to selection devices: Applicants demand fair selection devices and their reaction to selection methods can influence their attraction and value to an organization. For example, most applicants believe that personality traits are not job relevant and they also respond negatively for cognitive ability measures.

Manager reactions to selection systems: on the other hand managers need a quick, easy and goal oriented selection system that deliver the required result for the organization. Researches suggest that an organization should balance the traditional measures of reliability and validity with the applicants and managers reactions in determining the use of selection methods [L.R. Gomez – Mejia, 2003].

Hence, in the process of selection what have to be considered are the quality criteria which are assumed to be representative for most applicants and the organization’s goal too.

3.3 EMPLOYEE TRAINING

Among the different activities in HRM, training and development is the one. To up grade the skills and performance of employees and managers, training is paramount. In other words, the main objective of training, as stated by Saiyadain, is to establish a match between employee and his/her job. The productivity of an organization is mainly dependent on the skills, knowledge and attitude of employees.

Training has different phases:

Phase one: Need assessment

Analysis should be conducted on the jobs and employees for which training is necessary.

Phase two: Design

Based on the needs assessment, the training program will be designed with its contents and objectives.

Phase three: Decision on training method

Training can be carried out either *on-the-job* or *off-the-job* depending on the nature and objectives of training.

Examples of on-the-job training include job rotation, apprenticeships, and internships. Where as off-the-job training, which is an effective alternative of on-the-job training, includes formal courses, simulations, and role-playing exercises.

Phase four: evaluation

The final stage of training is evaluating the program's effectiveness in terms of the employee reactions and their reflection of the training on their job.

Training and development are, of course, used in conjunction for the success of an organization, but the two terms are not synonymous. Training typically focuses on enhancing individuals' skills where as development focuses on future job of the organization. Gomez-Mejia, 2003, summarizes their difference as follows:

Table3.1 Training vs. Development

	Training	Development
Focus	Current job	Current and future jobs
Scope	Individual employees	Work group or organization
Time frame	Immediate	Long term
Goal	Fix current skill deficit	Prepare for future work demands

3.3.1 Training and Equal Employment Opportunities (EEO)

One of the most important HR issues is the equal employment opportunity (EEO). This is the one that mostly affect the managers' day-to-day behavior on decision specially in countries like Ethiopia, the EEO laws are almost forgotten and everything in HR activities, including selection and training measures, are done through the control of the managers.

It is globally accepted that employment decisions should not be based on characteristics such as race, sex, age, religion or disability. The EEO laws cut across almost every other issue in the HR practices. The major EEO laws are:

Table 3.2 U.S.EEO Laws

Act	Major provisions	Enforcement and remedies
Equal Pay Act (1963)	Prohibits gender-based pay discrimination between two jobs substantially similar in skill, effort, responsibility, and working conditions.	Fines up to \$ 10,000, imprisonment up to 6 months, or both: enforced by equal employment Opportunity commission (EEOC); private actions for double damages up to 3 years wages, liquidated damages, reinstatement, or promotion.
Title VII of Civil Rights Act (1964)	Prohibits discrimination based on race, sex, color, religion, or national origin in employment decisions: hiring, pay, working conditions, promotion, discipline, or discharge.	Enforced by EEOC; private actions, back pay, front pay, reinstatement, restoration of seniority and pension benefits, attorneys fees and costs.
Executive Orders 11246 and 11375 (1965)	Requires equal opportunity clauses in federal contracts; prohibits employment discrimination by federal contractors based on race, color, religion, sex, or national origin.	Established Office of Federal Contract Compliance Programs (OFCCP) to investigate violations; empowered to terminate violator's federal contracts.
Age Discrimination in Employment Act (1967)	Prohibits employment discrimination based on age for persons over 40 years; restricts mandatory retirement.	EEOC enforcement; private actions for reinstatement, back pay, front pay, restoration of seniority and pension benefits; double unpaid wages for willful violations; attorneys fees and costs.
Vocational Rehabilitation Act (1973)	Requires affirmative action by all federal contractors for Persons with disabilities; defines disabilities as physical or mental impairments that substantially limit life activities.	Federal contractors must consider hiring disabled persons capable of performance after reasonable accommodations.

Even though EEO is most prevalent in hiring processes, it also affects other HRM activities like training, selection and promotion. It is the responsibility of the organization to ensure that selection, training and promotion criteria are purely job related. If, for example, some protected groups frequently fail to pass training programs than the majority group, this might indicate dissimilarities in the training criteria and selection process, which is against EEO.

3.4 EVALUATING EMPLOYEE PERFORMANCE

Performance evaluation is the core means to the success of an organization. Two decades ago, performance evaluation was designed mainly to give feedback to employees how they had done their work and what pay raise they would be getting, but today performance evaluation should also address development and documentation concerns [Decenzo & Robbins, 1998].

Bateman and Snell, 1999 also write it, as performance appraisal (PA) is the assessment of an employee's job performance based on two basic purposes:

- I. It serves an administrative purpose in providing information about salary making, promotion and lay off decisions.
- II. It serves a development purpose to diagnose training needs, career planning and the like

Therefore performance appraisal is the key activity in the development and existence of an organization.

3.4.1 Performance Appraisal and EEO

Since PA is an integral part of most organizations, it should properly be developed and implemented to achieve the goals of an organization.

The EEO laws strongly requires the HRM practice of an organization to be free from personal bias, this means performance evaluations must be objective and job related, reliable and valid, and should measure reasonable performance success (Decenzo and Robbins, 1998)

The most common sources of information used frequently by managers to measure actual performance are personal observation, statistical reports, oral reports and written reports. These sources of information are also used in our country Ethiopia, but the decision is not actually based on the information. Hence, to avoid managerial bias, technology based means of measuring evaluation could be a good alternative. According to Decenzo and Robbins, the appraisal process has six major parts shown in the figure below:

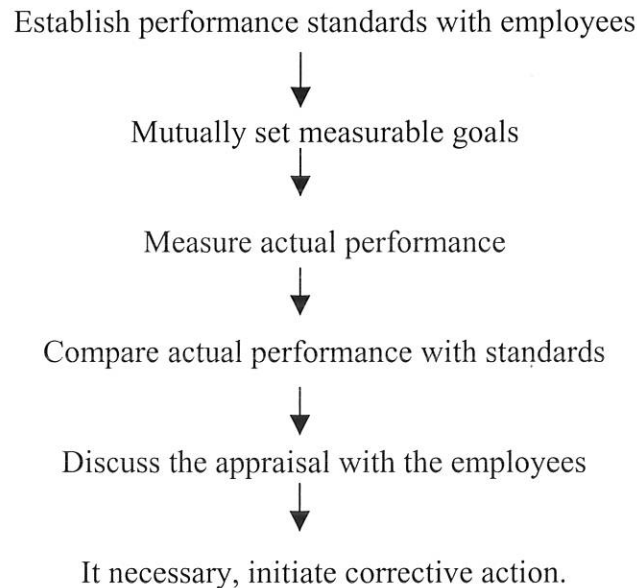


Figure3.2 the appraisal process

➤ **Benefits of performance appraisal**

Some of the benefits from a good PA are:

From employer perspective:

- Despite imperfect measurement techniques, individual difference in performance will make a difference to organization's performance.
- Documentation of PA and feed back may be needed for legal defense
- It provides a rational basis for a bonus or merit system, and so on

From employee perspective:

- Performance feed back is needed and desired for future improvement.
- Improvement in performance needs an assessment
- Assessment and recognition motivate workers and soon.

3.4.2 Factors affecting appraisal

The performance evaluation system in general should be free from personal bias according to EEO laws. But since it is not possible to make the performance evaluation completely error free, some organizations minimize those errors like the personal bias on the basis of objectivity measures.

On the other hand, even though objectivity minimizes the dysfunctional behavior of evaluators, it may also be harmful to the achievement of organizational goals. Thus it is recommended to use direct performance criteria, which are measurable and reasonable as much as possible.

A complete error free performance appraisal is an ideal case; this is because of the barriers that stand in the direction of managers decisions. Some of the barriers are:

- ◆ Rater errors and bias – which are the consistent biases on the part of the rater.
- ◆ The influence of liking
- ◆ Organizational politics
- ◆ Whether to focus on the individual or the group.
- ◆ Legal issues, etc.

3.5 HRM SYSTEM PRACTICE IN ETHIOPIA

The human resource management department in the Ministry of Capacity Building is performing different activities under the control of the Federal Civil Service Commission of Ethiopia. In line with the global practice of HRM, some of the HRM practices

performed at the ministry of capacity building in Ethiopia include employment, employee transfer, career structure, performance evaluation, training, and others (HRM training manual, 2004).

In the actual case, the big problem of HRM practice in many of the organizations in Ethiopia is implementation. Even though such activities are undergoing in many organizations of the country, their implementation is with out the knowledge of the employee most of the time.

On the other hand, specifically the selection, giving training opportunities and the measurement of performance evaluation are influenced by the government politics and willingness of the managers.

In general, most of the HRM practices in our country are not free from personal bias, this is to mean that managers have the “right” to select or deselect an employee with out considering the criteria set for the selection process. Hence, the implementation is poor even though the measurement criteria for each activity are listed on paper. Moreover, the activities are totally manual which are done by committees developed at each step in the process of the HRM activities, and this liable to the influence of liking.

In addition to the above, the decision of selecting an employee for training / or an applicant for a job requires an extensive information on applicants, like qualification, experience relation, education type, education level and relevancy, performance evaluation, etc. Depending on this information and the requirement set by the organization, decision will be made by the selection and training committee of the organization, which is difficult to take each measuring criteria into account.

3.5.1 Analysis of the Existing System

As stated above, the practices of HRM activities exist in most of the organizations of Ethiopia with certain implementation deficiency.

Regarding the ministry of capacity building, the HRM office (Civil Service Personnel) is responsible for those activities. The activities have been done manually through different committees and this manual practice has several problems. Some of the problems are:

Regarding selection:

- Selection of employee with qualification different from the one stated on the vacancy.
- Taking applicants with irrelevant experience, those with under qualified /over Qualified status
- Preparing a low standard and only one type of measurement, like interview only.
- Problem of setting minimum criteria
- Problem of decision for selecting and listing of waiting employees, and so on.

Regarding training:

- Avoiding some target groups
- Specifying additional criteria to help some selected individuals
- Giving opportunities for those who do not fulfill the minimum criteria, and the like.

And regarding to the measure of *performance evaluation*, some of the problems listed by a study at the ministry of capacity building civil service commission includes:

- Filling the performance with out the knowledge of the employee
- Giving unwanted and unreasonable rating (like good for one employee in all measures and excellent for other employee)
- Including criteria which are difficult to measure, like “job initiation”
- Problem of human errors like the Halo effect, i.e. tendency to influence the evaluation of other traits because of one trait, and so on.

To sum up the problems faced on the existing system, the organization is better to have measurable criteria for those activities and should change the manual way of documentation in to a data base system which is convenient for the use of expert based HRM practice. Moreover, the employee-employer relationship must be close in achieving the organization’s goal, establishing the standard criteria measures, discuss the appraisal problems, etc.

CHAPTER 4

THE KNOWLEDGE BASE

4.1 INTRODUCTION

The knowledge base is the heart of any expert system applications. It is the collection of knowledge in the domain area through different methods of acquiring and representing knowledge. Similar to traditional databases, it stores information, but the knowledge base differ significantly from the conventional database in the types of information it stores, the types of interrelationships between data, and the kind of training needed for the person represented to update the stored information.

Knowledge bases, specifically stores *cause and effect* knowledge, rules, and probabilistic information. The two most crucial stages in developing a knowledge-based system are the *knowledge acquisition* and *knowledge representation*.

4.2 KNOWLEDGE ACQUISITION

Knowledge acquisition is the process of acquiring the domain knowledge from different sources and transferring such problem solving expertise to a program. Mainly the knowledge acquisition process is done through discussion with experts, and additional knowledge is also collected from different manuals, guidelines and related written documents.

4.2.1 Knowledge Acquisition Methods

The knowledge acquisition process involves *knowledge elicitation* and analysis and interpretation of knowledge from experts. The different kinds of knowledge may require a variety of techniques drawn by the knowledge elicitation, some of the techniques include, introspection, direct observation, structured interviews, case histories of reference works, verbal protocol analysis, discourse analysis, multi dimensional scaling, and concept sorting /classification (Richardson, 1995).

- *Introspection*- a method in which the expert serves as the knowledge engineer that interviews himself and writes down the process
- *Direct observation* – refers that the knowledge engineer observes the expert in the day-to-day work environment.
- *Structured and unstructured interview* – the most familiar technique to quickly generate a lot of knowledge from domain experts
- *Case histories or studies* – familiar method in which knowledge is generated from case histories (literatures) of the domain
- *Verbal protocol analysis* – similar to observation but here the expert is asked to give a verbal report while solving a set of problems.
- *Discourse analysis*- refers to developing the expert's analytical model by reading literatures. This is a good method only if the domain is well understood and compiled.
- *Multi dimensional scaling* – is sorting the concepts identified under protocol analysis in to a number of multi dimensional scales.
- *Concept Sorting/Classification*- a more general and complex method using a combined procedures like building initial set of concepts, writing one concept per card and ask an expert to sort them and so on.

For the purpose of this research, the primary sources of knowledge are the training and selection procedure guidelines prepared by the Civil Service Commission of Addis Ababa and the HRM experts at the ministry of capacity building, and the knowledge engineer is responsible for acquiring the relevant knowledge from those sources through different mechanisms.

For the process of knowledge acquisition, detail discussions were held with chief personnel department officers of the ministry of capacity building and additional knowledge were collected from printed sources and manuals. The personnel are selected because of their experience and education.

Depending on the nature of the problem, there are two basic strategies of knowledge engineering,

- i. Top-down (deductive) strategy
- ii. Bottom-up (inductive) strategy

In *top-down approach*, the knowledge engineer interviews (both structured and unstructured) the expert through frequent meetings or asks him/her to fill a questionnaire. Such approach started from general concept leading to particular and detail topics of the domain.

In *bottom-up strategies* the knowledge engineer will make the expert to focus on specific cases and goes on to generalize them. The common examples on this approach are protocol analysis and observation (Ibrahim.1999). Different literatures argued that interview and protocol analysis are the most widely used methods of knowledge acquisition in general. Under this research, a top-down approach of knowledge engineering is employed through a detail discussion (using structured and unstructured interview) with experts.

4.2.2 Knowledge Modeling

After having concepts discovered through interviewing of experts and studying the procedural guidelines, the acquired knowledge is structured to build a model of the domain using a hierarchical tree structure. In such method, since top-down method is employed, a goal is located at the top level of the hierarchy that goes down to the factors determining the decision of the goal.

4.2.2.1 Decision tree in selection

In the process of selection, eligibility is done according to the tree structures given below and the decision table is also given in table4.1 as follows:

Table4.1 Decision table for eligibility

Adequate education level	Condition			Action
	GPA	Education	Experience	Eligible
Yes	< 2.50	NR	-	No
Yes	< 2.50	R	NR	No
Yes	< 2.50	R	R	Yes
Yes	< 2.50	NR	NR	No
Yes	< 2.50	NR	R	Yes
Yes	< 2.50	R	-	Yes
No	-	-	-	No

Where NR-Not Relevant

R-Relevant

The structure for checking eligibility in selection has different parameters, such as adequate education level, education relevancy, experience relation etc. and is given in figure4.1 below:

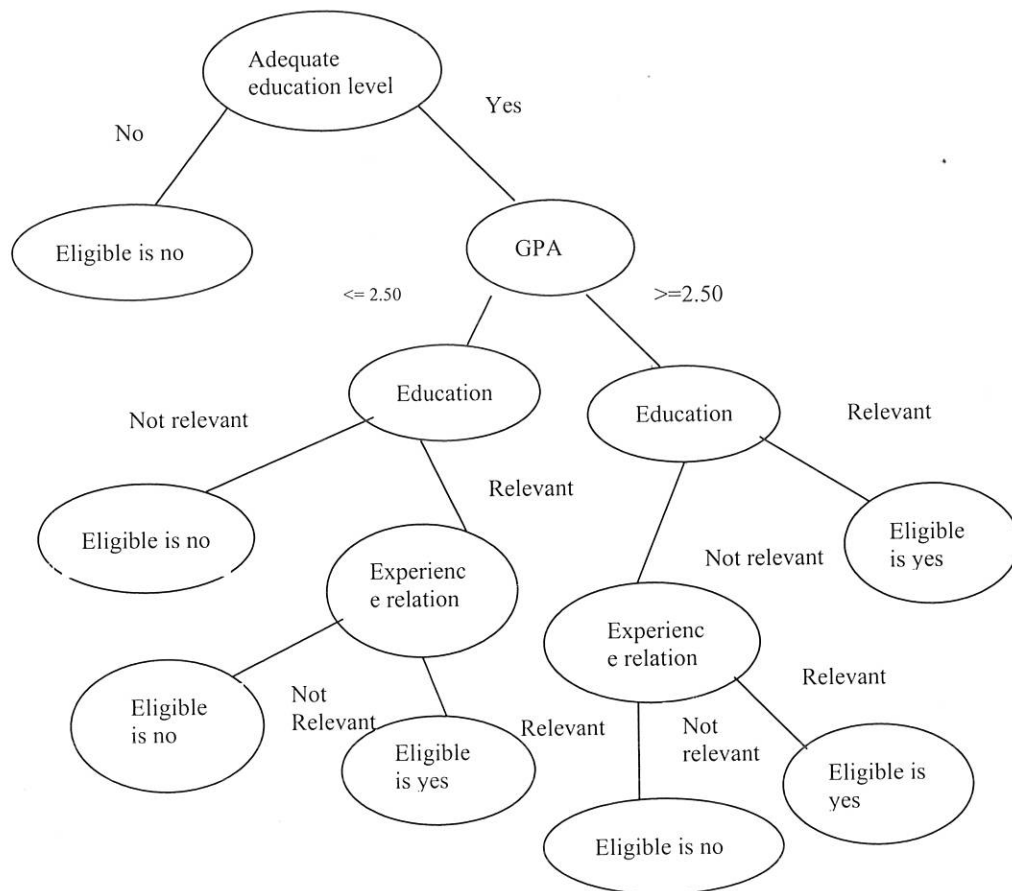


Figure4.1 Decision tree for checking Eligibility in selection

Experience relation is one of the parameters for deciding eligibility in selection. Its tree structure is also given below:

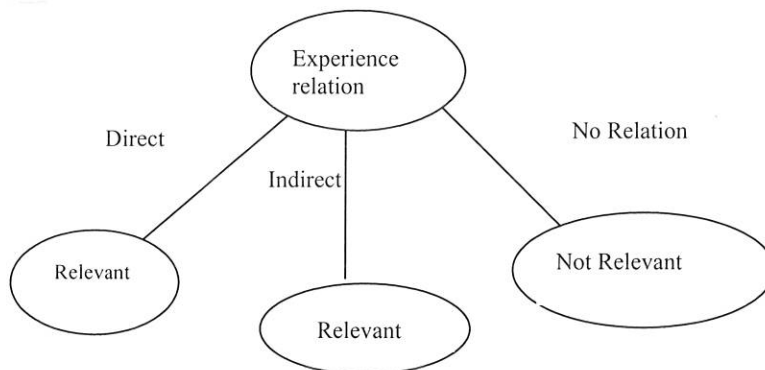


Figure4.2 Decision tree for experience relevancy

In similar fashion, the tree structures for all the attributes are designed in such a way that they are easy to be written as a rule structure in the knowledge base.

The other attribute in the process eligibility checking is adequate education level. This attribute has different sections; the following is decision tree for checking adequate education level in the different job grades:

Figure4.3 below is tree structure for checking adequate education level for job grade "PS1"

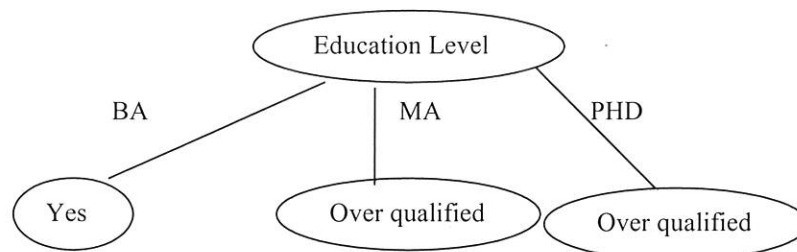


Figure4.3 Decision tree for adequate education level (job grade "PS1")

Similarly, the tree structure for job grade “PS2” is given below:

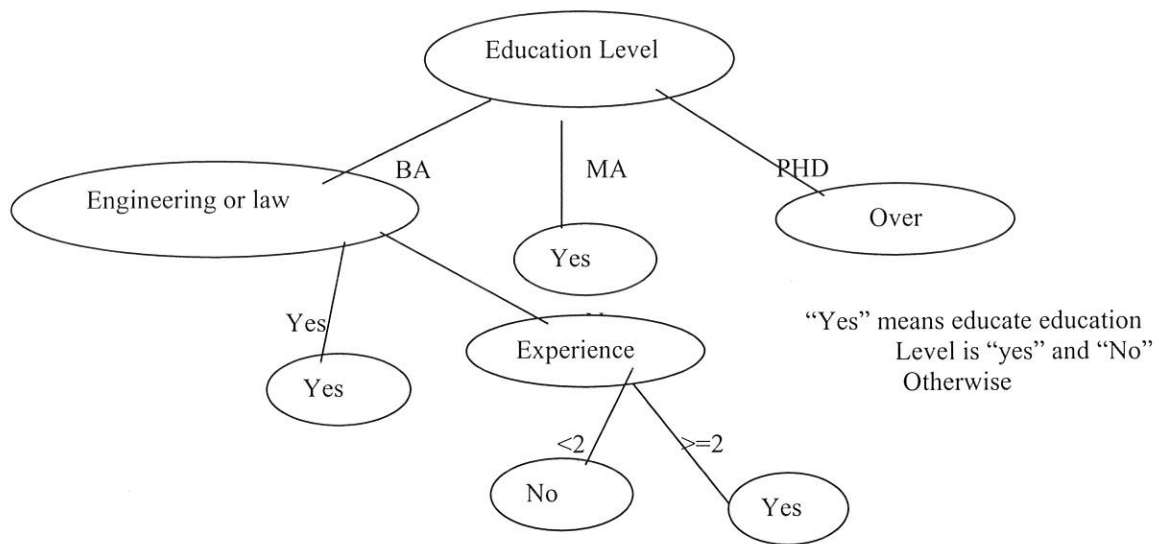


Figure4.4 Decision tree for adequate education level (job grade “PS2”)

And the third sub section of the job grade in checking adequate education level is “job grade PS3” in which its tree structure is given by figure4.5

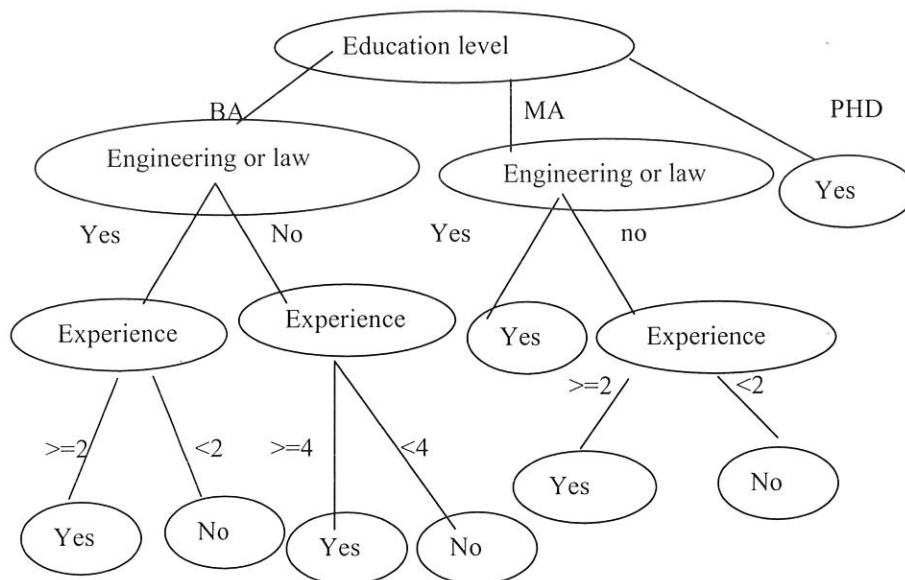


Figure4.5 Decision tree for adequate education level (job grade “PS3”)

In the process of employee selection, the minimum requirement, education level and base salary is classified by the civil service commission of Ethiopia, and the job classification is given below:

Table4.2 Job classification in Ethiopia.

Classification	Grades
Professional and scientific service (PS)	PS1 – PS9
Administrative service (AD)	AP1 – AD9
Sub professional service (sp)	SP1 – SP12
Clerical and fiscal service (CF)	CF1 – CF12
Trades and crafts service (TC)	TC1 – TC 10
Custodial and manual service (CM)	CM1 – CM5

For instance, the job classified under AD4 (Administrative service grade 4) has an initial base salary of Birr 895 with the following minimum requirement:

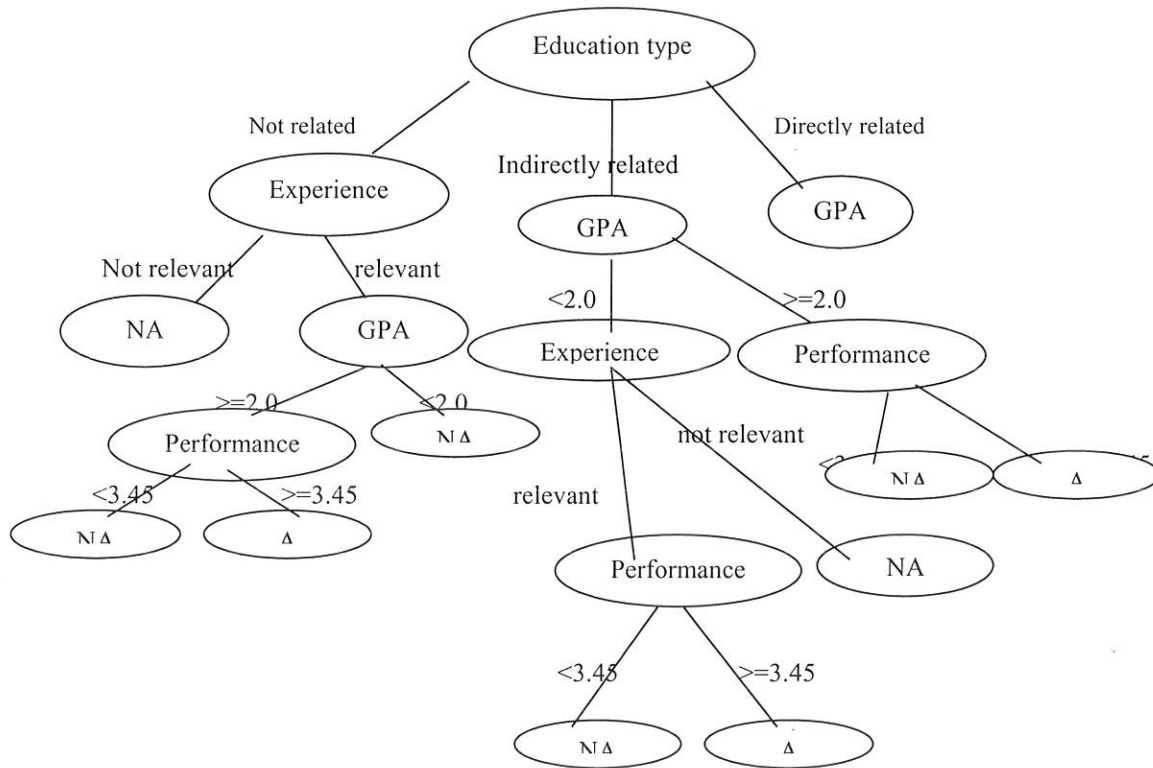
- College Diploma and 6 years of related experience or
- 12 + 3 and 6 years experience or
- 12 + 4 and 4 years experience or
- Bachelor degree in related field and 2 years experience or
- Masters degree in related field and 0 years experience

The job classified under PS3 (Professional Science grade 3) has an initial base salary of birr 1040 with the following minimum requirement:

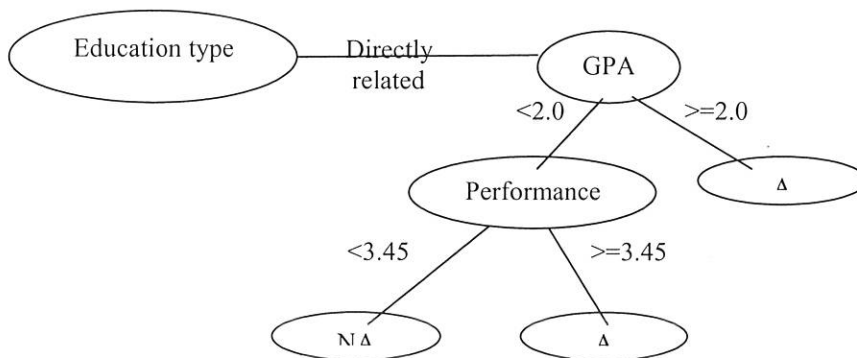
- Bachelor degree with 4 years experience or
- Masters degree and 2 years experience or
- Doctorate degree and 0 years experience or
- Bachelor degree in Law or Engineering and 2 years experience or
- Masters degree in Law or Engineering and 0 years experience

4.2.2.2 Decision tree in training

Similarly, for the acceptance of training, the decision tree and the decision table are given below: The decision tree given by figure4.6 shows the process of screening employees for a training to be given by the organization



For directly related education type, the above decision tree is expanded below:



Where NA means applicant is not accepted for training
A means applicant is accepted for training

Figure4.6 Decision tree for training Acceptance

The above tree structure for training acceptance can also be given in table form below (table4.3) which makes the production of rules very easy.

Table4.3 Decision table for training

Condition				Action
Education type	GPA	Experience	Performance	Training
Indirect	<2.0	Relevant	< 3.45	NA
Indirect	<2.0	Relevant	>=3.45	A
Indirect	< 2.0	Not relevant	-	NA
Indirect	>=2.0	-	<3.45	NA
Indirect	>=2.0	-	>=3.45	A
Direct	<2.0	-	<3.45	NA
Direct	<2.0	-	>=3.45	A
Direct	>=2.0	-	-	A
Not related	<2.0	Relevant		NA
Not related	>=2.0	Relevant	<3.45	NA
Not related	>=2.0	Relevant	>=3.45	A
Not related	-	Not relevant	-	NA

NA-Not Accepted

A-Accepted

Education type is one parameter in the process of screening applicant employees for training, the tree structure given below is useful in deciding education type as direct, indirect or not related

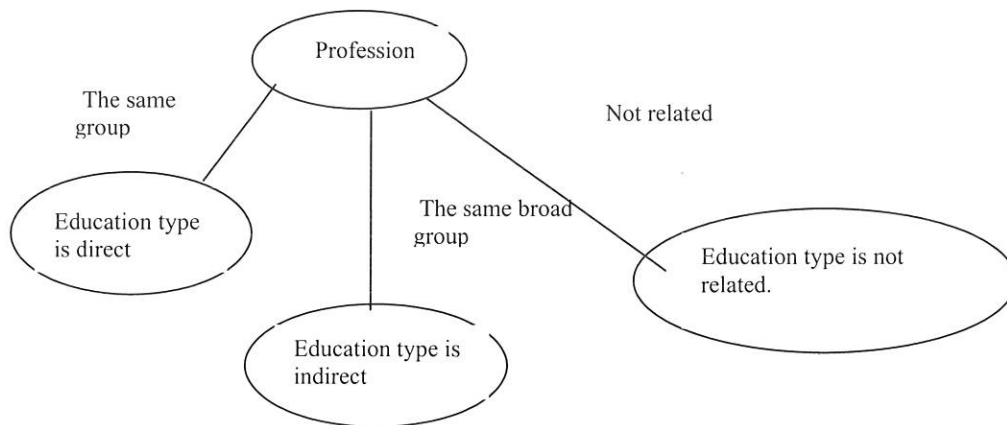


Figure 4.7. Decision tree for deciding education type.

In deciding education relation, the same group means the profession of the employee is in the same group to the training type which is going to be given.

The major processes in the selection and training procedure under the ministry of capacity building are:

- ◆ Screening applicants that meet the minimum requirement (eligibility criteria), and
- ◆ Selecting the best candidates.

The procedures for the selection and training process are the same in most organizations.

4.3 KNOWLEDGE REPRESENTATION

This section focuses on representing of knowledge developed using the top-down approach in the previous section. Knowledge representation concerns the different ways in which the collection of domain specific information are organized and processed [Boden, 1996]. It is one of the major problems in building an expert system so that computer understands the knowledge represented by the knowledge engineer.

4.3.1 Knowledge Representation Methods

There are several methods used to represent knowledge in building a knowledge base, the most widely used knowledge representation techniques includes semantic networks, frames and rules.

□ Semantic networks

Collection of facts like “a causes b”, “b is a kind of c” and “d can be used to treat c” have a close relationship with semantic networks. Originally, semantic networks were developed to represent meanings of English words [Allison Cawsey, 1998].

Semantic networks are a method of knowledge representation about objects and relations between objects in a graph structure. The nodes of a semantic network represent concepts and arcs represent relationships. An example of a semantic network is given below.

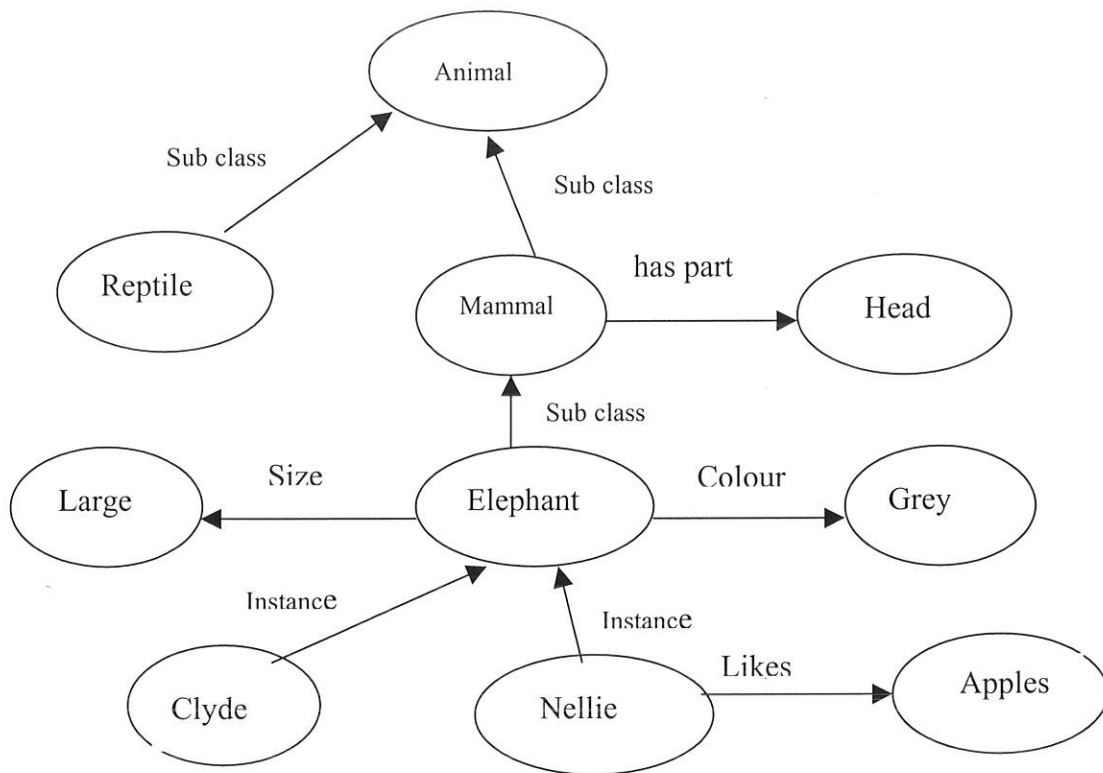


Figure4.8 Sample Semantic Networks

The above semantic network typically represents the fact that mammals and reptiles are animals, an elephant is a large and gray mammal and specifically Nellie is an elephant likes apples. From these relationship types, it is possible to say that semantic networks use the principles of inheritance, for example Nellie inherits all the properties of its parent class – Elephant. Semantic networks mostly used to represent knowledge about a specific community, like mammal, as precisely as possible and it is difficult when there is multiple inheritances between objects in the knowledge.

□ Frames

Frames are variants of semantic networks that are popular way of knowledge representation in an expert system development [Allison Cawsey, 1998]. In frame based knowledge representation, all information relevant to a particular concept is stored in a single complex entity called *a frame*, and each frame will have a number of objects, properties (slots), etc that inherit some behavior from their top class.

Semantic networks and frame based knowledge representation are closely related. Nodes in semantic networks are objects in frame system; links become slots and so on. The choice of the two representation techniques is largely dependent on the way the information is visualized. An example of a frame for the elephant sub class of a mammal is given below

Mammal:		
	Subclass	Animal
	Has part:	Head
Elephant:		
	Subclass:	Mammal
	Color:	gray
	Size:	large
Nellie:		
	Instance:	elephant
	Likes:	applies

Figure4.9 Elephant Frame

Both the semantic network and frame based knowledge representation techniques uses the principle of inheritance, pointers between nodes and links, and they are much related to record data structures. And since frame based systems grouped related knowledge together, they are good in organizing knowledge in a manageable manner than rule based system do.

□ Rules

Rules are the most applicable and relatively easier way of knowledge representation in the development of an expert system. A rule-based system consists of a set of IF-THEN rules, a set of facts and an interpreter controlling the application of the rules, given the facts.

An example, illustrated by Cawsay 1998, explaining the situation is given below:

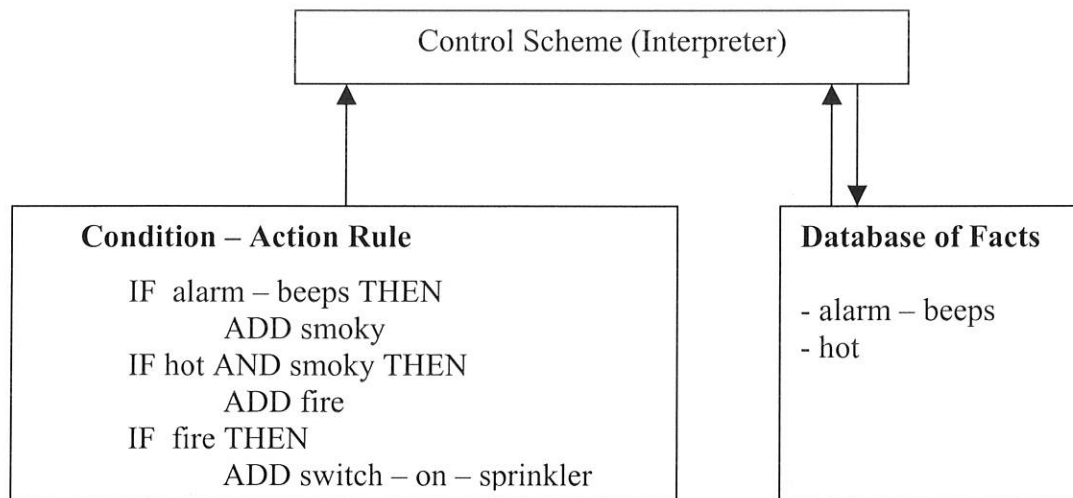


Figure4.10 Rule based system architecture

Here the interpreter is either a forward chaining or a backward chaining system.

A rule – based system gives more flexible and sometimes it allows arbitrary procedures with in the rules. The knowledge represented as a set of IF – THEN rules are more or less independent or condition – action rules. In this research, the rule based knowledge representation system is employed and how the knowledge has been represented through a rule-based expert system using the knowledge pro Gold is shown in the sample below

Sample rules for eligibility in selection:

```

if adequate education level is no
then Eligible is NO.

if education level is yes
and GPA is <2.50
and education is not relevant
then Eligible is NO.

if education level is yes
and GPA is <2.50
and education is relevant
and experience relation is not relevant
then Eligible is NO.
  
```

if education level is yes
and GPA is <2.50
and education is relevant
and experience relation is 'relevant
then Eligible is YES.

Sample rules from screening for training:

if education type is not related
then Training is NOT ACCEPTED.
if education type is indirectly related
and GPA is <2.00
and performance is <3.45
then Training is NOT ACCEPTED.
if education type is indirectly related
and GPA is <2.00
and performance is ≥ 3.45
then Training is ACCEPTED.
if education type is indirectly related
and GPA is ≥ 2.00
then Training is ACCEPTED.

On the other hand, according to Cawsey, frames and semantic networks are useful in representing declarative type of knowledge about objects / concepts related to each other, specifically where there is a clear class hierarchy, and clear inheritance to infer class and sub class. But they are unlikely to be good to draw a wide range of inferences, and not just inferences based on inheritance. In such cases logic based approach is powerful.

Moreover, literatures add some more methods of knowledge representation like propositional logic, predicate logic, processes and scripts.

4.4 THE EXPLANATION FACILITY

Most expert systems have explanation facilities that allow user to ask *why* a question is asked and *how* the system reached a conclusion. The system will answer those questions based on its goals, the rules being used, and any existing problem data [Alison, 1994]

The explanation facility of an expert system just mentions the exterior/surface knowledge programmed in the rules rather than the deep knowledge about the domain area, that means the system will say that the action is concluded to be, say, 'a' because of rule 35, but it will not explain the whole idea of rule 35. An example, by Alison (1994), is given below:

System: Is there gas in the fuel tank?

User: Yes.

System: Is it true that the engine turns over?

User: No.

System: Is it true that the lights come on?

User: Why?

System: I am trying to prove: problem with battery.

It has been established that it is not the case that the engine turns over.

Therefore if it is not the case that the lights come on then there is a problem with battery.

Is it true that the lights come on?

User: No.

System: I conclude that there is a problem with the battery.

User: How?

System: This follows from Rule 2

In this research the 'How' feature is incorporated in the prototype in such a way that the main criteria used to measure employees in the selection and training process are going to be explained. This feature gives explanation to the user on how the system reaches a decision based on the information feed by the user.

CHAPTER – 5

DESIGN AND DEVELOPMENT OF THE PROTOTYPE

This chapter deals with the design, testing and evaluation mechanisms of the system. The chapter also presents results of the prototype based on sample data given to the system.

5.1 USER INTERFACE

The user interface is the first window displayed to the user to interact with the system. It displays the topic of the research work with three buttons linked to the successive working windows-The **Next** button, **Help** button, and **Exit** button.

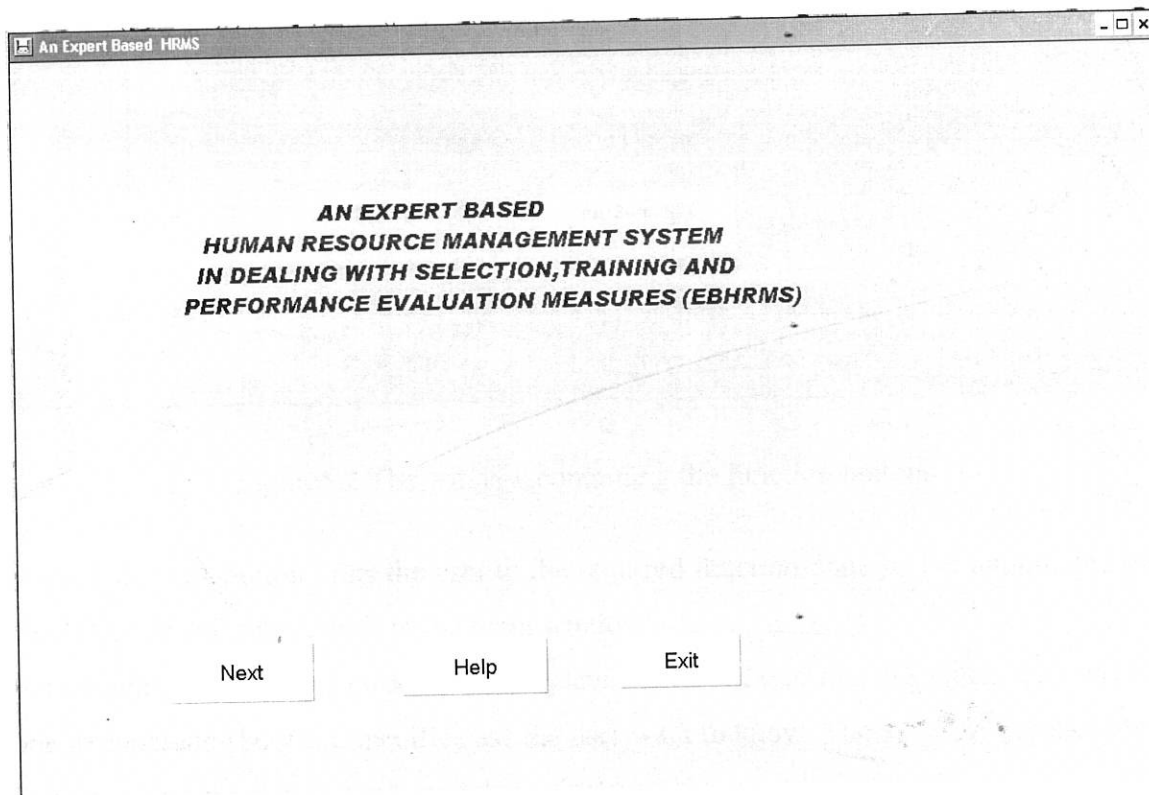


Figure5.1 The main window

5.1.1 The selection module

Clicking the selection button displays the following series of questions based on the information feed by the user

- a. What is your job grade?

The window displays this question with its choices given below

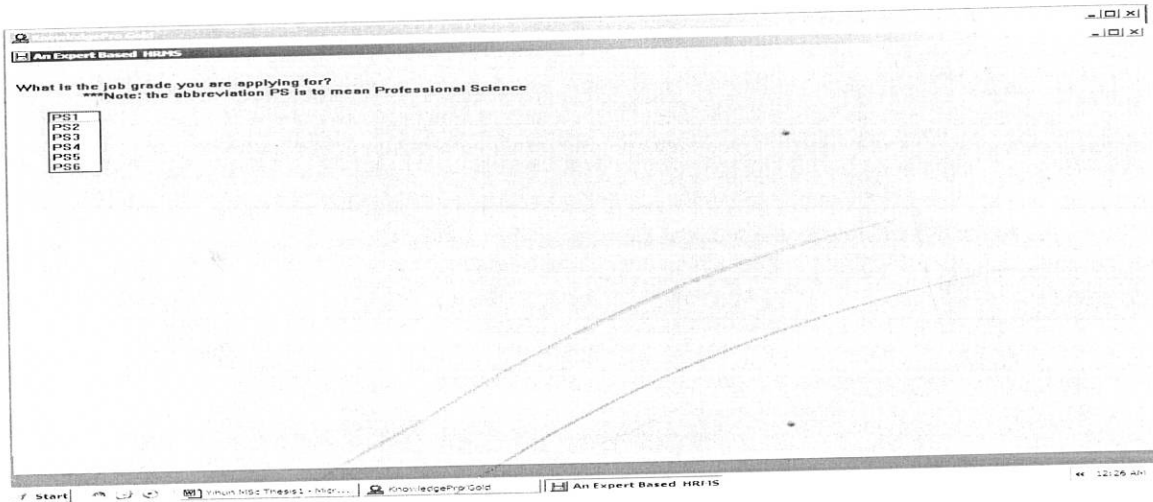


Figure5.3 Question window 1

Clicking one of the choices for question 'a' opens another window containing the next consecutive question.

- b. Indicate your education level

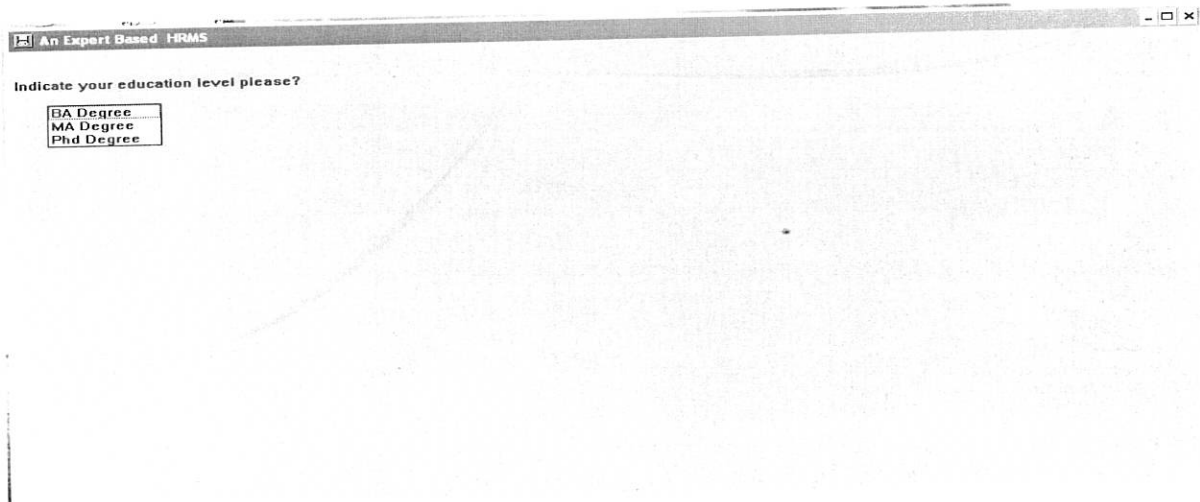


Figure5.4 Question window 2

5.1.1 The selection module

Clicking the selection button displays the following series of questions based on the information feed by the user

- a. What is your job grade?

The window displays this question with its choices given below

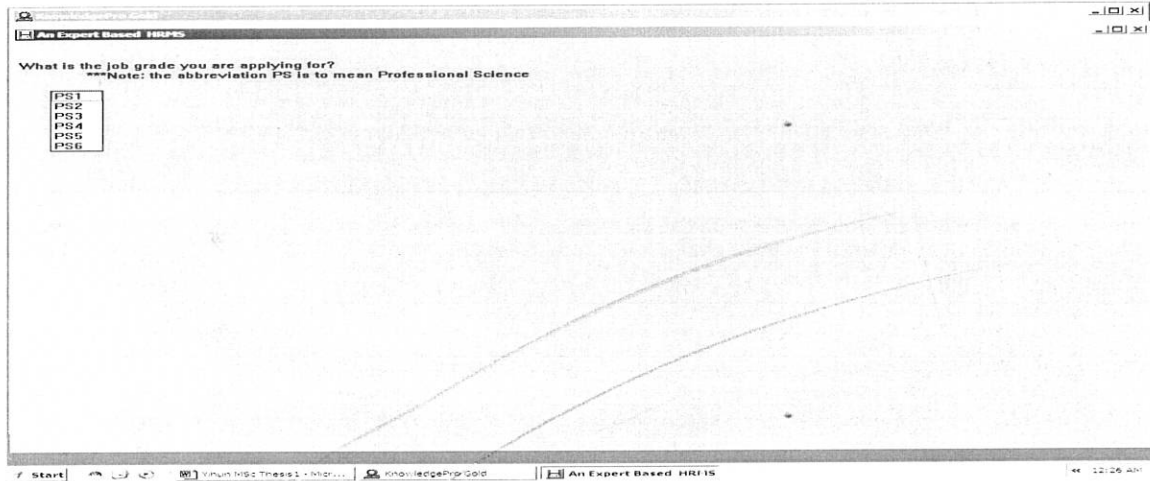


Figure5.3 Question window 1

Clicking one of the choices for question 'a' opens another window containing the next consecutive question.

- b. Indicate your education level

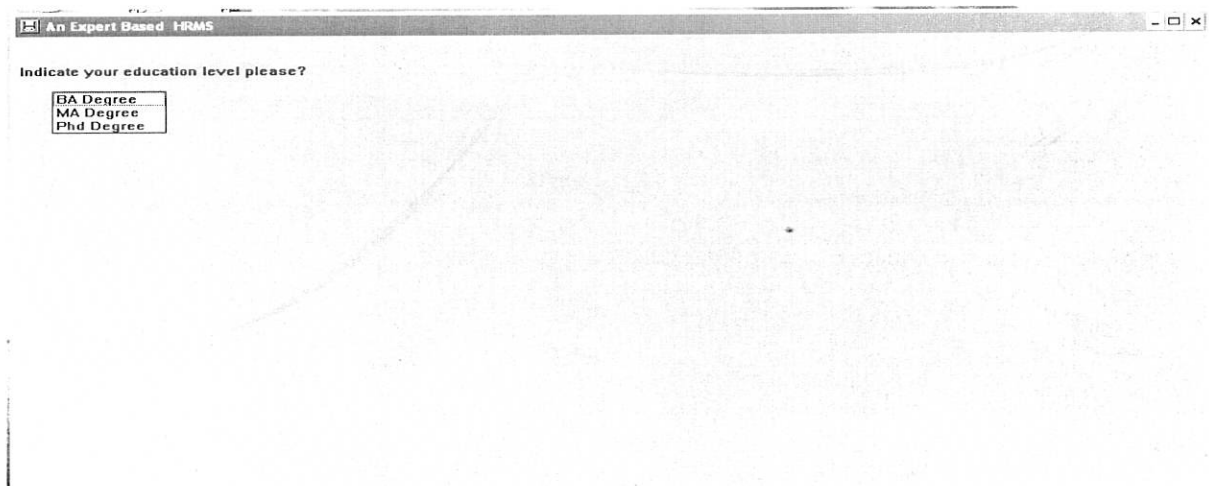
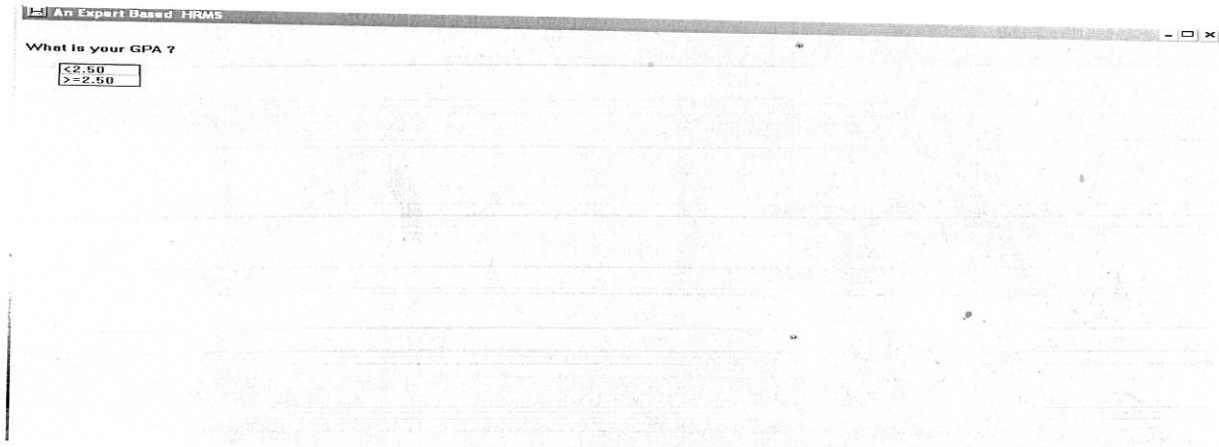


Figure5.4 Question window 2

Based on the choices given in question 'b' another window asking the GPA of an applicant will be displayed.

c. What is your GPA?



An Expert Based HRMS

What is your GPA ?

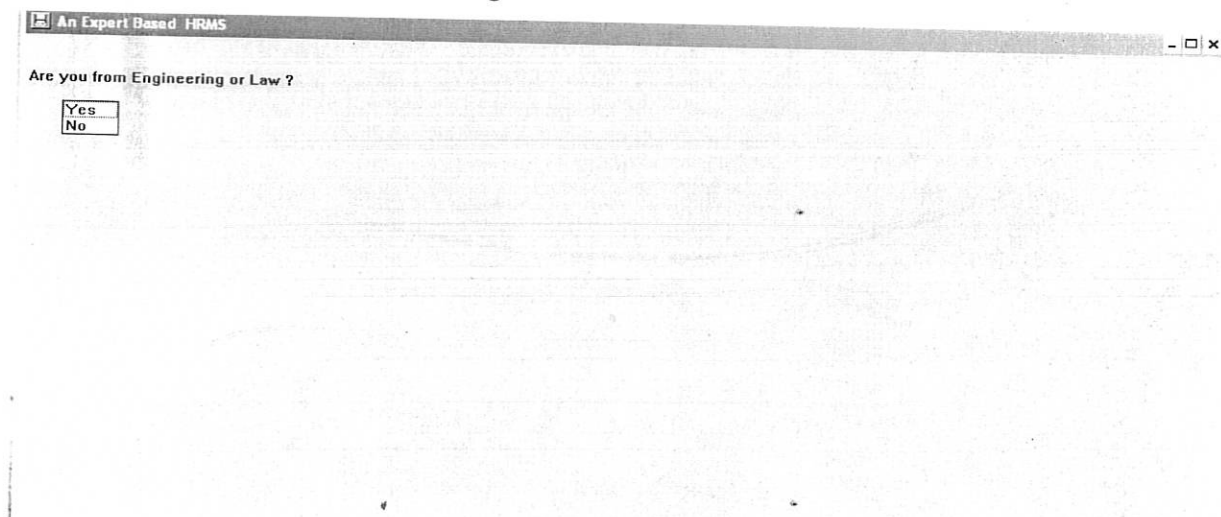
☐ <2.50

☐ >=2.50

Figure5.5 Question window 3

The successive questions may vary depending on the response of the user. For instance, if the job grade is PS2 and the education level is MA another additional question will be displayed asking whether the applicant is from engineering or law background.

d. Are you from Engineering or Law?



An Expert Based HRMS

Are you from Engineering or Law ?

☐ Yes

☐ No

Figure5.6 Question window 4

If the answer for questions d is yes, it will skip to the question of GPA (question 'c') and continues like wise. If the answer is no, another question of experience will popup.

e. How long is your year of experience?

An Expert Based HRMS

How long is your year of experience ?

*** Note : The choices ≥ 4 and < 4 are only for BA applicants with no Engineering or Law

≥ 2 years
< 2 years
≥ 4 years
< 4 years

Figure5.7 Question window 5

Based on the above series questions, the system decides whether an applicant is eligible or not by the following window.

An Expert Based HRMS

Eligible is OVER QUALIFIED for this applicant.
To check Eligibility for another applicant, click the continue button.
If you need an explanation about the decision,click How

Continue How

To know the total score of the applicant, click the result button
If you need to go back to training or performance evaluation functions,click Back

Result Back

Figure5.8 Window containing 'How' and 'Result'

The buttons, shown in figure5.8, incorporate the result and how features. The result feature gives you the total score of a specific applicant and the how button explains the

weights given to each requirement in calculating the total score for the decision undertaken by the system.

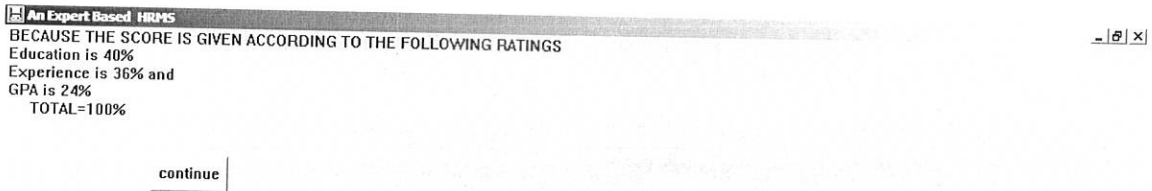


Figure5.9 Score Window

Moreover, in the main window (figure5.1), clicking **Help** displays a list of hypertexts, which up on clicking take the user to the information referred to the hypertext. The help option gives information on how the system works, the main operational procedures, knowledge base upgrading, and so on. And the **Exit** button is used for closing the program.

5.1.1.1 Score rating in selection

□ Education score

The score rating for education is given by the tree structure below based on education relation and level of education of the applicants.

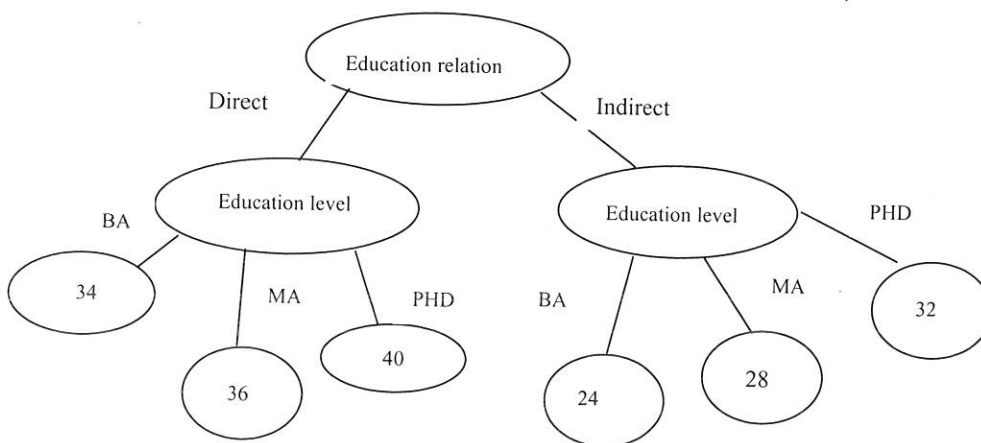


Figure5.10 Education scores

-Education is direct if it is one of the required education lists and indirect when it is in the same group with one of the required lists.

-The above score is only for the professional science job grade (PS)

□ GPA score

The value given to GPA is: GPA multiplied by 6

□ Experience score

Similarly, the tree structure in figure5.11 below is used for calculating experience score

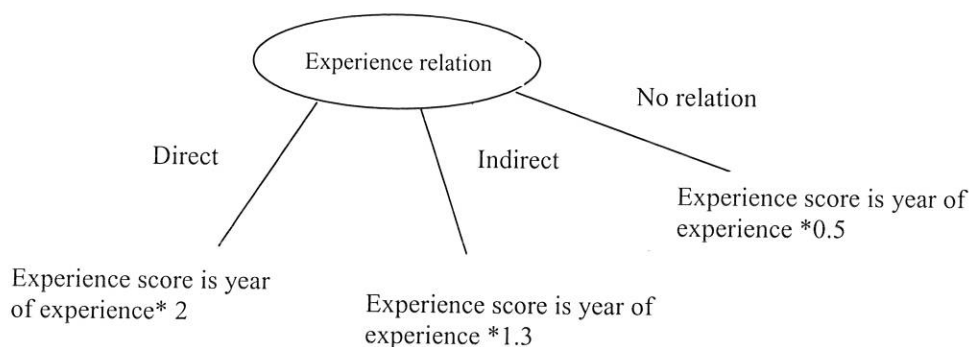


Figure5.11 Experience score

In general, the weights are given based on the following standard:

Education – 40 %

GPA – 24 %

Experience – 36 %

○ *Sample case for selection*

I. Job Title-----Planning and Program Expert

Job grade-----PS3

Amount-----2

Base salary----- Birr 1245

Minimum requirement:

Education--Economics or Statistics

Education level--BA degree with 6 years of experience or

MA degree with 4 years of experience

Criteria----- education 40%, experience 36% and GPA 24%.

Based on the information given, the system selects those applicants according to their order of score ratings by calculating their total score on education, GPA and experience.

Sample results are as follows:

Table5.1 sample results in selection

<i>Applicants</i>	<i>Education type</i>	<i>Education level</i>	<i>Education relation</i>	<i>Total score</i>
1.	<i>Economics</i>	<i>BA degree</i>	<i>Direct</i>	<i>61.20</i>
2.	<i>Statistics</i>	<i>BA degree</i>	<i>Direct</i>	<i>69.20</i>
3.	<i>Mathematics</i>	<i>BA degree</i>	<i>Indirect</i>	<i>48.30</i>
4.	<i>Statistics</i>	<i>MA degree</i>	<i>Direct</i>	<i>63.00</i>
5.	<i>Sociology</i>	<i>BA degree</i>	<i>Indirect</i>	<i>49.30</i>

II. Job Title – Marketing Expert

Job Grade-PS2

Minimum requirement

Education – Management or Economics or Statistics

Education Level and Experience – BA degree with 2 years of experience or MA degree with 0 years of experience

The applicants were screened out based on the minimum criteria set by the organization and the total scores were calculated according to the weights given.

5.1.2 The training module

When the user clicks the training button the following list of questions will popup with their corresponding windows.

- a. Your profession can be categorized under

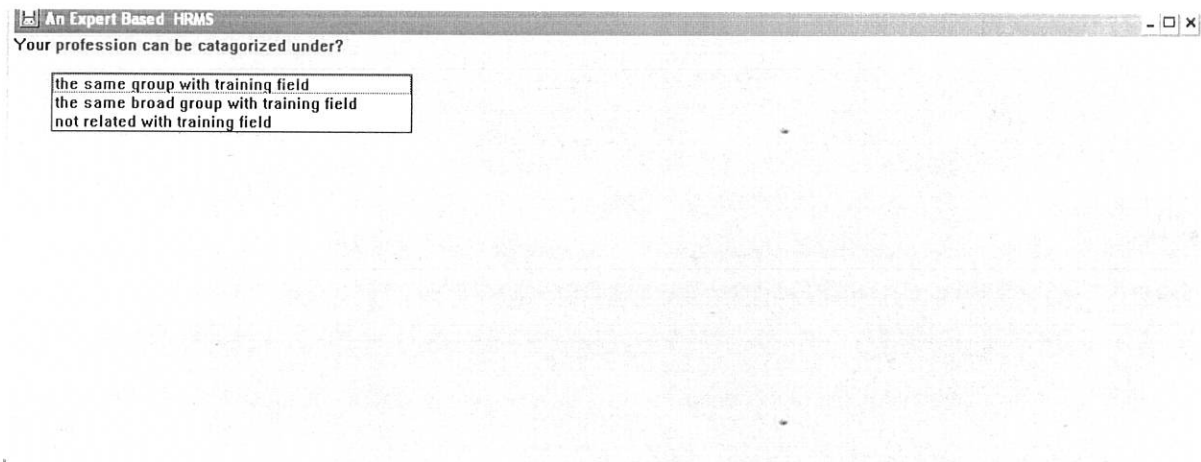


Figure5.12 Question window 6

The next question depends on the choice of question 'a'. If the choice of the user is, for instance, '*the same broad group with training field*', question on GPA will popup.

b. What is your GPA?

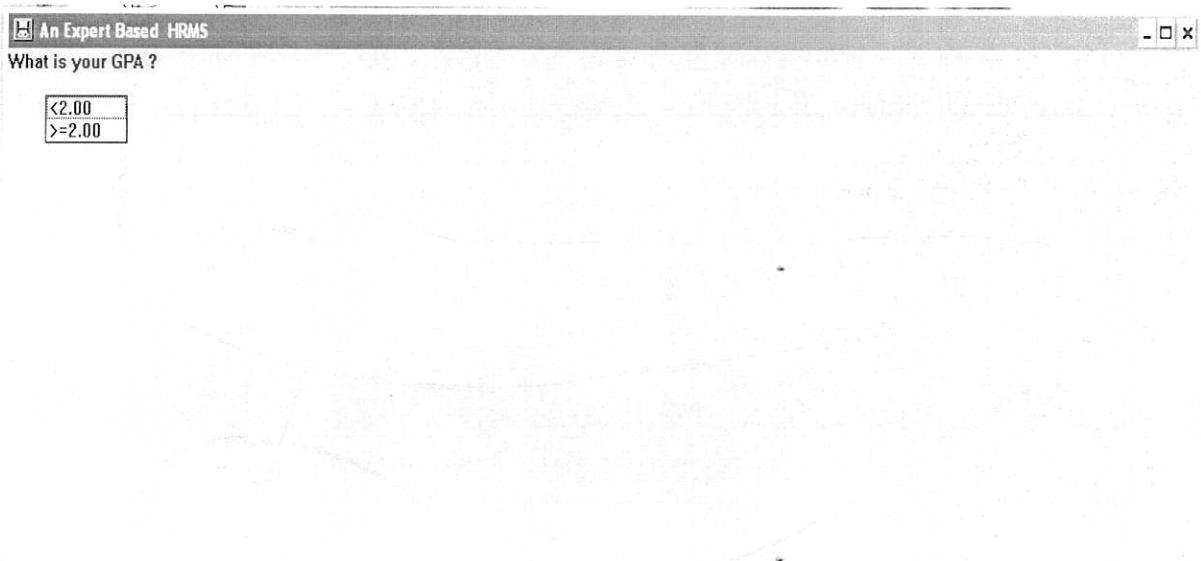
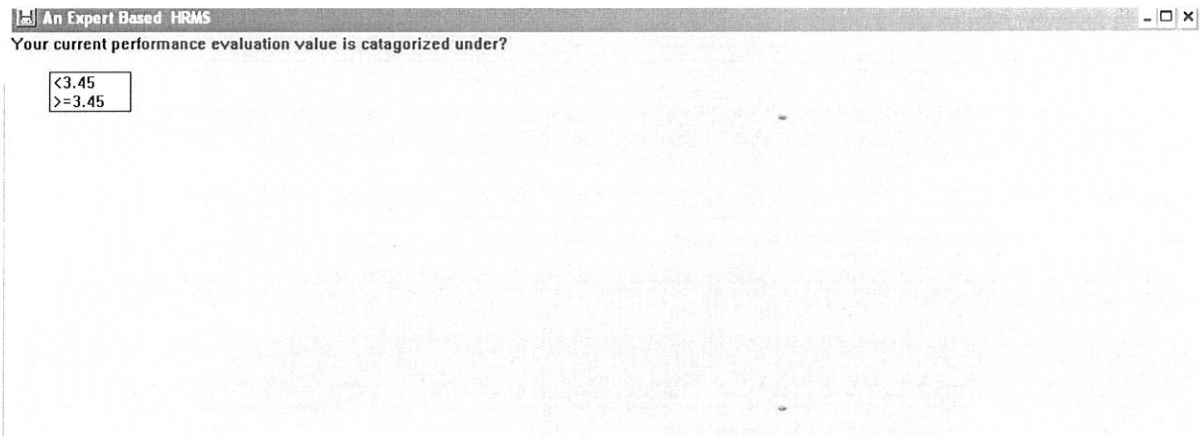


Figure5.13 Question window7

When the GPA of the employee is < 2.00 , he will be asked about performance evaluation.

c. Your current performance evaluation value is categorized under



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Your current performance evaluation value is categorized under?

☐ <3.45

☐ >=3.45

Figure5.14 Question window8

Based on the choices given for question 'c', if the value is < 3.45 , the employee will not be accepted for the training and if it is ≥ 3.45 the employee will be accepted for training.

The training requirements, with their corresponding weight, are given as follows:

Education – 30 %

GPA – 20 %

Experience – 20 %

Performance evaluation – 30 %

Note: the score ratings may vary based on the type and nature of training.

5.1.2.1 Score rating in training

- **Education**

The score rating for education depends on the education relation of an employee whether it is direct or indirect as follows

Direct	Indirect
BA = 25	BA=19
MA = 28	MA = 20
PhD = 30	PhD = 22

In general, the weights given for each education level by the civil service commission of Ethiopia for the training process is given in the table below

Table5.2 Weights for education

Education level	Weight	
	Directly related	Indirectly
12 complete / 10 complete after 2000	13	13
College 1 st year law certificate or Diploma in music art or 10+1 or 10+2 after 2000	16	14
College 2 nd year, technical college diploma, 10+2, 10+3	18	16
College 3 rd year, college diploma	20	17
College 4 th year 3 years advanced diploma	23	28
Bachelor degree	25	19
Masters degree	28	20
Doctorate degree	30	22

- **GPA**

For calculating GPA, the procedure is multiplying the GPA of an employee by 5. GPA of an employee is the cumulative GPA of the last three years in ESLCE/EGSCE for 12 complete or 10 complete respectively and CGPA of college/university transcript for graduates.

- **Experience**

Experience is direct, indirect or no relation and the score rating is given accordingly:

Direct Experience = Year of experience*1

Indirect Experience = Year of experience*0.5

Experience no relation to the training area = year of experience *0.25

- **Performance evaluation**

The immediate boss and the manager of the organization will fill the performance evaluation of an employee in the first hand.

Value of performance = performance *6.

○ *Sample case for training*

I. Training field-----Training course in *Network Building and Monitoring Technology*

Education and experience-----MA degree with related field or BA degree with two years of related experience or college diploma in Computer Science or Engineering

Criteria----- Education = 30%
GPA = 20%
Experience = 20%
Performance evaluation = 30%

Based on the information given, the system selects those permanent employees according to their order of score ratings by calculating their total score on education, GPA, experience and performance evaluation. And the Sample results are as follows:

Table5.3 sample results in training

<i>Applicants</i>	<i>Education score</i>	<i>GPA score</i>	<i>Experience score</i>	<i>Performance score</i>	<i>Total score</i>
1.	25	16.25	2	27.6	70.85
2.	20	15	7	29.34	71.34
3.	20	17.5	5	27.9	70.40
4.	19	13.75	2	28.5	63.25
5.	25	14	2.5	28.8	70.30

II. Training field-----planning of health education and health promotion interventions

Education and experience-----MA degree with related field or BA degree with two years of related experience

Criteria----- Education = 30%
GPA = 20%

Experience = 20%

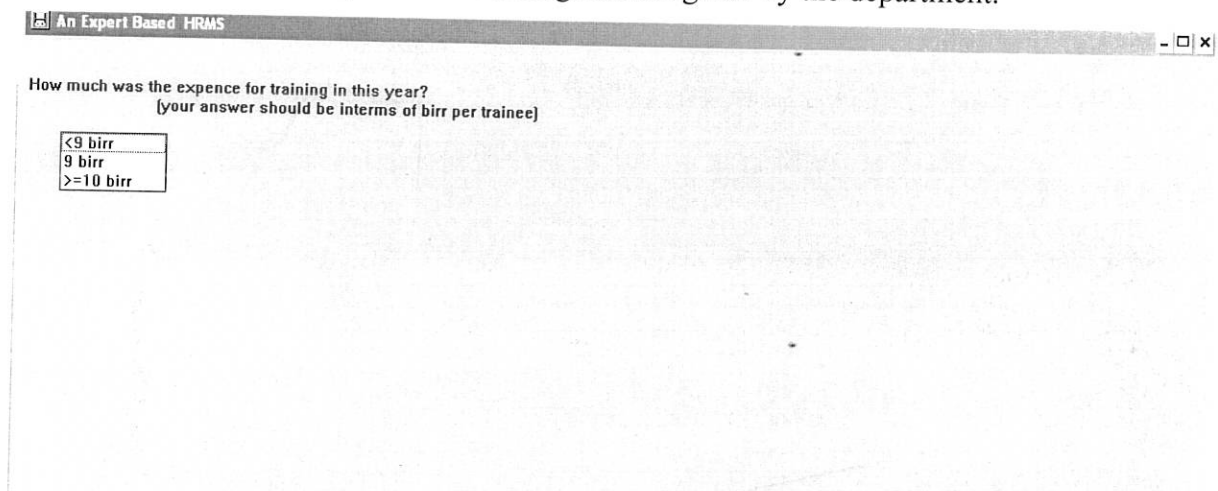
Performance evaluation = 30%

Again based on the information given, the system selects those permanent employees according to their order of score ratings.

5.1.3 The performance evaluation module

Performance evaluation in result oriented working situation is specific for each individual, which means there is no universal measuring guide lines for all employees. For example the evaluation measure for the human resource management head of the organization contains the following questions:

- a. The expense for training courses given by the department.



An Expert Based HRMS

How much was the expense for training in this year?
(your answer should be in terms of birr per trainee)

☐ <9 birr
☐ 9 birr
☐ >=10 birr

Figure5.15 Question window 9

The next windows contain the questions on the number of participants in a training given by his/her office and the time that the department head delivers his work report.

- b. Average number of participants in a training

An Expert Based HRMS

Give the average number of participants in the training

<8
between 8 and 10
>10

Navigation icons: back, forward, search, etc.

Figure5.16 Question window 10

Clicking the first option of question window 10 takes the user to the next question window

c. Work report delivery question

An Expert Based HRMS

When did you deliver your work report of the last month ?

1st week of this month
2nd week of this month
3rd week of this month
4th week of this month

Navigation icons: back, forward, search, etc.

Figure5.17 Question window 11

According to the questions given to each employee the system will categorize the performance standard of each employee as poor, medium high or very high. For example choosing the option “first week of this month” yields the following result window:

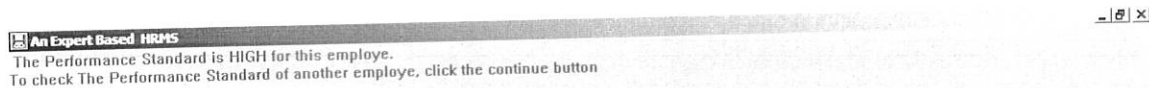


Figure5.18 Performance Standard window

At the end of the decision for one applicant/employee, a continue button appears and the system asks the user if he/she wants to check another applicant. If the user clicks on continue, the system will recycle again by resetting all the previous values.

5.2 TESTING AND EVALUATION

The prototype has been built based on the major properties of the selected human resource management activities (selection, training and performance evaluation), and it is primarily designed to be free from logical conflict and redundancy of rules.

Conflict means giving inconsistent conclusion/s/ for a consistent input, and redundancy refers to the presence of unnecessary logical structure. Irregularities and possible conflicts have been cleared from the knowledge base.

To check the validity of the prototype, sample vacancy and training announcements have been used with similar parameter included in the knowledge base. The sample cases are attached in the appendix part of the thesis.

One major problem in the testing of the system is it doesn't give possible decisions for those cases out of the rule and doesn't give the probability of an applicant to pass/fail the minimum requirement.

5.3 KNOWLEDGE BASE MAINTENANCE

The ultimate factor determining the value of decisions reached by an expert system is the quality of knowledge in the knowledge base. Hence care should be given to the knowledge acquisition and knowledge representation processes, since these two stages are the most important parts of the knowledge base for further maintenance.

The knowledge base will require regular updating based on the newly emerging ideas in the human resource management activities. For this process the system is designed in such a way that the help system has a link to give access to the rule base so that management professionals or assigned coordinators can extract up-to-date knowledge from relevant sources and easily keep the system in pace with the rapidly changing knowledge.

5.4 DESIGN REQUIREMENTS

□ Hardware and Software Requirement

According to KPWin (Gold Version 3.0), it is suggested that Knowledge-Pro for Windows (KPWin) could be used in PCs having at least 4MB system memory and processor speed of 133 MHz. However, 8 MB memory at least for use with Visual C++ environment is recommended.

To work on this version of KPWin, there is a need for at least the most modern versions of Microsoft C/C++ (V7.0) or Borland C++ (V3.1), or the Windows version of C++, i.e. Microsoft Visual C++.

In the network environment, the new system requires a network operating system, if possible Windows NT 4.0 and at least Windows 95 operating system on client PCs.

CHAPTER – 6

CONCLUSION AND RECOMMENDATIONS

6.1 CONCLUSION

Knowledge-based systems are computer programs that capture knowledge of human experts in a certain domain area to solve a specific problem in place of experts.

The objective of this research work is mainly to explore and apply the possible applications of knowledge based (or expert) system specifically in the field of human resource management. The human resource management department in most organizations is responsible for the success of the organization with respect to employee and production management.

In Ethiopia, there are a number of service delivery government organizations- one is the ministry of capacity Building. This study is made in an effort to explore the major problems in the human resource management department of the organization under study and propose the possible solutions using the application of the knowledge-based systems. The prototype of the proposed system assists mainly the managers and concerned personnel's specifically in the process of selection, training and performance evaluation measures of employees.

In developing the proto type, the knowledge acquisition is done by referring standard manuals of the civil service commission of Ethiopia and a thorough discussion with experts of the domain area. A rule based knowledge representation is used in accordance with the hierarchical structure of knowledge modeling. To develop the knowledge base, the Knowledge pro Gold expert system shell version 3.0 has been used through a backward inference mechanism.

The prototype is able to screen out eligible applicants and employees and simultaneously calculates the total score of each applicant/employee, which is very important in taking those top scorers according to the criteria set by the organization.

Finally, the result from the system have shown that the knowledge based system can also be applicable in solving human resource management problems, and it is believed that this research will initiate organizations to use the knowledge based problem solving approach especially in the area of human resource management.

6.2 RECOMMENDATIONS

Based on the findings of this research work, the researcher would like to make the following recommendations for further work to enhance the functionality of the prototype and develop a new system especially in the field of human resource management.

- In this research work, attempt has been made to assess the applicability of knowledge-based system in supporting the problem related to selection, training and performance evaluation measures. However it is open for interested researchers to consider additional human resource management activities such as career management, pay plans and rewards, and soon.
- The knowledge base should be expanded to include more and more rules through a through extraction of knowledge from related documents, and through the participation of large number of experts to make the system more practical.
- The prototype system works only for one step screening of employees/applicants based on the given criteria, further more emphasis should be given for a continuous screening procedure with their corresponding measures to make the system fully functional with our additional manual works.

- A method should be searched to integrate such knowledge-based system to a fully functional data base system of the department of human resource management in related organizations of the country.
- The system doesn't hold all the necessary rules and is not self-learning at this stage. But, even though it would be a huge task in the field, attempt should be given for further work to develop a dynamic self-learning system in that whenever there is no rule matching to a case, it would include the rule to fill the gap.
- This prototype system is developed only by using the knowledge based (expert) system approach. A more sophisticated and integrated system can be developed in collaboration with other approaches like the artificial neural network to solve some problems, which still problems of expert system such as the lack of sensory experience and creativity.

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APPENDIX

Sample Rules from the Knowledge Base

On Selection

topic 'Eligible'.
set_number_of_values ('Eligible',1).

if '?adequate edu level' is 'no'
then 'Eligible' is 'NO'.

if '?adequate edu level' is 'yes'
and '?GPA' is '<2.50'
and '?education' is 'not relevant'
then 'Eligible' is 'NO'.

if '?adequate edu level' is 'yes'
and '?GPA' is '<2.50'
and '?education' is 'relevant'
and '?experience relation' is 'not relevant'
then 'Eligible' is 'NO'.

if '?adequate edu level' is 'yes'
and '?GPA' is '<2.50'
and '?education' is 'relevant'
and '?experience relation' is 'relevant'
then 'Eligible' is 'YES'.

if '?adequate edu level' is 'yes'
and '?GPA' is '>=2.50'
and '?education' is 'not relevant'
and '?experience relation' is 'not relevant'
then 'Eligible' is 'NO'.

if '?adequate edu level' is 'yes'
and '?GPA' is '>=2.50'
and '?education' is 'not relevant'
and '?experience relation' is 'relevant'
then 'Eligible' is 'YES'.

if '?adequate edu level' is 'yes'
and '?GPA' is '>=2.50'

and ?'education' is 'relevant'
then 'Eligible' is 'YES'
else 'Eligible' is 'OVER QUALIFIED'.

topic 'adequate edu level'.
set_number_of_values ('adequate edu level',1).

if ?'job grade' is 'ps1'
and ?'edu level' is 'BA Degree'
then 'adequate edu level' is 'yes'.

if ?'job grade' is 'ps2'
and ?'edu level' is 'BA Degree'
and ?'Engineering or Law' is 'yes'
then 'adequate edu level' is 'yes'.

if ?'job grade' is 'ps2'
and ?'edu level' is 'BA Degree'
and ?'Engineering or Law' is 'no'
and ?'experience' is '>=2 years'
then 'adequate edu level' is 'yes'.

if ?'job grade' is 'ps2'
and ?'edu level' is 'BA Degree'
and ?'Engineering or Law' is 'no'
and ?'experience' is '<2 years'
then 'adequate edu level' is 'no'.

if ?'job grade' is 'ps2'
and ?'edu level' is 'MA Degree'
then 'adequate edu level' is 'yes'.

if ?'job grade' is 'ps3'
and ?'edu level' is 'BA Degree'
and ?'Engineering or Law' is 'yes'
and ?'experience' is '>=2 years'
then 'adequate edu level' is 'yes'.

if ?'job grade' is 'ps3'
and ?'edu level' is 'BA Degree'
and ?'Engineering or Law' is 'yes'
and ?'experience' is '<2 years'
then 'adequate edu level' is 'no'.

if ?'job grade' is 'ps3'
and ?'edu level' is 'BA Degree'

and '?Engineering or Law' is 'no'
and '?experience' is '>=4 years'
then 'adequate edu level' is 'yes'.

if '?job grade' is 'ps3'
and '?edu level' is 'BA Degree'
and '?Engineering or Law' is 'no'
and '?experience' is '<4 years'
then 'adequate edu level' is 'no'.

if '?job grade' is 'ps3'
and '?edu level' is 'MA Degree'
and '?Engineering or Law' is 'yes'
then 'adequate edu level' is 'yes'.

if '?job grade' is 'ps3'
and '?edu level' is 'MA Degree'
and '?Engineering or Law' is 'no'
and '?experience' is '>=2 years'
then 'adequate edu level' is 'yes'.

if '?job grade' is 'ps3'
and '?edu level' is 'MA Degree'
and '?Engineering or Law' is 'no'
and '?experience' is '<2 years'
then 'adequate edu level' is 'no'.

if '?job grade' is 'ps3'
and '?edu level' is 'Phd Degree'
then 'adequate edu level' is 'yes'.

topic 'job grade'.

ask ('#e#n #n What is your job grade?

***Note: the abbreviation PS is to mean Professional Science','job grade',

['ps1','ps2','ps3']) .

end. (* job grade *)

topic 'edu level'.

ask ('#e#n #n Indicate your education level please?','edu level',

['BA Degree','MA Degree','Phd Degree']) .

end. (* edu level *)

topic 'Engineering or Law'.

ask ('#n #n Are you from Engineering or Law ?','Engineering or Law',

['Yes','No']) .

end. (* Engineering or Law *)

topic 'experience'.

ask ('#n #n How long is your year of experience ?

*** Note : The choices ≥ 4 and < 4 are only for BA applicants
 with no Engineering or Law 'experience',
 [' ≥ 2 years', ' < 2 years', ' ≥ 4 years', ' < 4 years']) .
 end. (* experience *)
 end. (* adequate edu level *)

topic 'experience relation'.
 set_number_of_values ('experience relation',1).

if ?'experience type' is 'direct'
 then 'experience relation' is 'relevant'.

if ?'experience type' is 'indirect'
 then 'experience relation' is 'relevant'.

if ?'experience type' is 'no relation'
 then 'experience relation' is 'not relevant'.

topic 'experience type'.
 ask ('#n #n Which one is your experience type ?', 'experience type',
 ['direct', 'indirect', 'no relation']) .
 end. (* experience type *)
 end. (* experience type *)
 topic 'GPA'.
 ask ('#n #n What is your GPA ?', 'GPA', [' < 2.50 ', ' ≥ 2.50 ']) .
 end. (* GPA *)
 topic 'education'.
 ask ('#n #n Give your education relevancy please ?

***Note : Your education is relevant only if it is one of
 the required education list or in the same group with one of
 the required list, 'education', ['relevant', 'not relevant']) .
 end. (* education *)
 end. (* Eligible *)

On Training

topic 'Training'.
 set_number_of_values ('Training',1).

if ?'education type' is 'not related'
 then 'Training' is 'NOT ACCEPTED'.

if ?'education type' is 'indirectly related'
 and ?'GPA' is ' < 2.00 '

then 'training evaluation' is 'satisfactory'.

if '?expense per trainee' is '>=10 birr'
and '?number of participant' is '>10'
then 'training evaluation' is 'good'.

if '?expense per trainee' is '9 birr'
and '?number of participant' is '<8'
then 'training evaluation' is 'satisfactory'.

if '?expense per trainee' is '9 birr'
and '?number of participant' is 'between 8 and 10'
then 'training evaluation' is 'good'.

if '?expense per trainee' is '9 birr'
and '?number of participant' is '>10'
then 'training evaluation' is 'very good'.

if '?expense per trainee' is '<9 birr'
and '?number of participant' is '<8'
then 'training evaluation' is 'good'.

if '?expense per trainee' is '<9 birr'
and '?number of participant' is 'between 8 and 10'
then 'training evaluation' is 'very good'.

if '?expense per trainee' is '<9 birr'
and '?number of participant' is '>10'
then 'training evaluation' is 'excellent'.

topic 'expense per trainee'.

ask ('#e#n #n How much was the expense for training in this year?
(your answer should be in terms of birr per trainee)', 'expense per trainee',
['<9 birr', '9 birr', '>=10 birr']).

end. (* expense per trainee *)

topic 'number of participant'.

ask ('#e#n #n Give the average number of participants in the training', 'number of
participant',

['<8', 'between 8 and 10', '>10']).

end. (* number of participant *)

end. (* training evaluation *)

topic 'recording method'.

set_number_of_values ('recording method', 1).

if '?report delivery time' is '1st week of this month'

then 'recording method' is 'excellent'.

if '?report delivery time' is '2nd week of this month'
then 'recording method' is 'very good'.

if '?report delivery time' is '3rd week of this month'
then 'recording method' is 'satisfactory'.

if '?report delivery time' is '4th week of this month'
then 'recording method' is 'poor'.

topic 'report delivery time'.

ask ('#e#n #n When did you deliver your work report of the last month ?', 'report delivery time',

['1st week of this month', '2nd week of this month', '3rd week of this month', '4th week of this month']) .

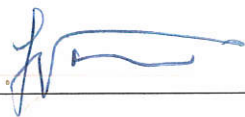
end. (* report delivery time *)

end. (* recording method *)

end. (* Performance *)

Declaration

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



Yihun Alemu Bogale

March 2006

The thesis has been submitted for examination with my approval as university advisor



Prof. Bandaru Rama Krishna Rao

March 2006