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ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES
SCHOOL OF INFORMATION STUDIES FOR AFRICA

**AN EXPERT BASED ADMISSION AND PLACEMENT IN
ADDIS ABABA UNIVERSITY**



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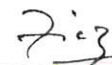
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Abstract

Screening applicants needs matching of applicants' qualification with the requirements of different departments of a university. Addis Ababa University admits applicants to various programs every year. The Admission and Placement Committee (APC) is responsible for the placement of regular students who have completed the General Freshman Program and for the admission of new applicants into the Extension program. The problem of admission into the university is constrained by the intake capacity of the departments. In addition, the university offers applicants five choices. If one of their choices fails, the others are considered.

Screening such a large number of applicants takes a considerable amount of time from highly trained faculty members. In addition, it creates a problem in accomplishing the task in a specified time. The time of the staff can be saved by developing a knowledge-based system. In this research an attempt has been done to identify the problem and design the knowledge by taking the extension program applicants as an example.

The study employed an interview and protocol analysis to acquire knowledge. Knowledge was acquired from the committee members, printed sources and manuals. Production rules has been used as a knowledge representation tool and was found to be appropriate.

In order to show the viability of the expert system a prototype was developed using KnowledgePro for Windows. KnowledgePro was found appropriate though it has some limitations with the database toolkit. The developed prototype expert system has shown that it can match both applicants and departments and provide a list of suitable applicants with summary for the committee members. This undoubtedly relieves experts from routine work.

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CHAPTER I

INTRODUCTION

1.1 Background Information

Colleges and universities admit new students every year. They attempt to provide a place on one of their programs or faculties for all applicants who meet the minimum admission requirements. However, these are not the only criteria used in most colleges and universities. In recent years, the number of applicants, in some faculties and major fields, have far exceeded the number of available places. Therefore, the university cannot admit all eligible applicants. Thus, it uses standards that demand more than the minimum requirements. These standards serve as selection criteria to identify students who demonstrate higher academic achievements and other qualities that can contribute to the objectives of the institution.

Selection of applicants is crucial to determine character and quality of educational program. The institution makes a series of decisions to accept selected applicants for proper assignments with respect to available programs. These decisions require extensive information on applicants and programs. The selection and placement processes, therefore, are a continual evaluation of applicants' quality with respect to their choice.

There are factors that determine admission to the colleges. These are:

- ◆ Available number of places and distribution by course
- ◆ Minimum educational requirements for entrance to the college and department
- ◆ Selection processes where there is an excess of candidates for admission over the available number of places.

The last factor is the most important, since it serves as a foundation for the proper understanding of selection problems. Availability of places and distribution of applicants into courses is the other problem in universities that have a number of majors and departments.

Institutions with numerous specialized undergraduate programs do selection and placement at the same time. The reason for this is that the competition for admission to certain faculties and programs is very high. Because of this, some universities with a number of departments advise applicants to apply to more than one faculty and program. If the applicant fails to meet the requirement of one department, he/she could be considered in another. Institutions of Higher Learning do this to find applicants to all the disciplines taught.

Hence, in these universities the complexity of admission and placement is affected by the following constraints.

- ◆ The number of choices per applicant
- ◆ The number of applicants per department

As it is described above, universities with numerous undergraduate programs provide a number of choices. The screening process, therefore, considers each of the choices. This creates difficulty in screening as the number of choice increases.

The number of applicants per department raises an issue of ever-increasing concern in higher education, because of the increasing competition of applicants. The complexity grows with respect to increasing number of applicants.

In most universities, a committee handles the selection process. The committee members are expected to review the applications and make decisions based on the established criteria. This task takes a considerable amount of highly skilled manpower and may lead to inconsistent screening procedures as applicants' qualifications are more or less similar and difficult to screen. Moreover, it takes so much time that it cannot be completed within the specified time. In order to tackle the above problems, universities are automating their admission processes. The Iraqi Higher Education Commission and the University of Israel are worth mentioning.

For instance, in the University of Israel, a system called Queens Tertiary Admission Center (QTAC) is used to process admission and placement in the university. And, QTAC enabled a tertiary admission system to handle massive volumes of diverse data and highly complex rules in a sophisticated, efficient and user-friendly way (McLeland 1995).

The advancement in computer technology and the ever-decreasing prices of computers have facilitated the application of the technology in many sectors. Thus, admission and placement is no exception to this situation. Currently, several programs have been developed to perform selection and placement.

Research in the area of artificial intelligence has made the development of techniques that allow modeling of information at higher levels of abstraction. These techniques allow the buildings of programs that are easier to develop and maintain. These programs are known as expert systems.

According to Grogan (1991), expert system embodies within a computer "the knowledge and decision making skills of a human expert in a particular 'domain' - a specific field - so that the system can offer intelligent advice or take an intelligent decision about a problem posed to it."

An expert system is a knowledge-intensive program that solves problems normally requiring human expertise. An expert can be an individual who is widely recognized as being solving problems in a particular field where most other people are less effective or efficient. An expert can make good guesses based on incomplete information, using heuristics to fill in the gaps. An expert system is also designed to perform many of the functions that an expert does. As the expert is more knowledgeable in specific domain, expert system works best in specific domain (Hayes-Roth, 1988).

Apart from these cognitive shortcomings, humans are expensive and if they leave the organization their scarce knowledge is lost. It takes a human expert years to learn the necessary skill, whereas an expert system can be copied on magnetic media in seconds or minutes. It continues to work consistently and predictably (Parsaye and Chignel, 1988; Murrar and Murrar, 1988; Benderand and Manders, 1993). A non-expert or outsider can make decisions regarding issues in which he has no or nearly no knowledge by using an expert system. Through expert systems this scarce knowledge is no longer limited to one or a few persons, but can be made available to all system users. This helps to economize labor costs as less experienced persons are generally paid less than experts (Zahedi, 1988).

One of the most highly developed categories is diagnosis. But the development in tools for developing expert system has made it possible to be applicable in other areas. The availability of expert system tools, such as CLIPS, has greatly reduced the effort and cost involved in

developing an expert system. This contributes for expert systems to be accepted by many in the business, industry and professional spheres as a way of making expensive tasks available wherever it is needed (Riley, 1997; Parsaye and Chignel, 1988).

The number of expert system tools and applications is doubling each year. There are now many commercial applications of expert systems serving different areas. For example, XCon, an expert system for the configuration of VAX computers (Rauch-Hindin, 1988); Analyst: An Advisor For Financial Analysis of Automobile Dealership (Michael, 1989); and Coolsys: A Cooling Systems Design Assistant in the Manufacturing Design (Friel and others 1989). It is also used in the universities, for admission screening and other purposes. The research made by Johnson (1990) at the University of Victoria (Canada) has proved the importance and application of expert system in admission.

Addis Ababa University (AAU) is the oldest and largest university in Ethiopia. It was established as University College of Addis Ababa (UCAA) in 1950, and upgraded to a university level in 1961. It has a number of colleges and faculties. The university provides diploma, degree and postgraduate programs in various departments and professions, which accept students at regular, extension and post-graduate levels.

The extension program was started in 1952 in UCAA within the Engineering College; the Extension Division of the University was established in 1962. These programs aim at serving mainly adult students who are employees of different organizations, and students who could not join the regular programs due to high competitive admission requirements.

Admission to undergraduate programs in the university is made once at the beginning of the academic year. Admission at freshman status into AAU is secured through the Ministry of Education, Higher Education Main Department (HEMD). The university allocates regular students into various departments after completion of their first year (Freshman Program). The university handles admission to Extension programs through its Admission and Placement Committee (APC). Admission to postgraduate programs is done by the Council for Graduate Studies, upon the recommendation of candidates by the respective departments.

1.2 Statement of the Problem and Justification

1.2.1 Admission and Placement

Students granted admission by the HEMD and allocated to AAU degree programs generally undertake a one-year general education program before they are assigned to the various colleges and departments. During their course of study in the first year, they are requested to fill in a form that indicates the field of study of their choice. There are 17 programs at the College of Social Sciences and 9 in the Faculty of Science. Applicants indicate their choice from 1 to 17 in the social science and 1 to 9 in the Faculty of Science, signifying their first choice as number 1, their second choice as number 2, etc.

In the case of the Extension program, however, application for admission into AAU takes place according to the program that the student would like to join. These programs are categorized under two streams. The first one is the Social Science stream, and this category is designated as category A on the application form. In this category, there are 12 degree and 9 diploma programs. The second one, which is the Science stream, is designated as category B, with 1 degree and 9 diploma programs. Applicants are expected to choose one of the categories and indicate their preference by indicating from one to five, signifying their first choice as number 1, their second choice as number 2, etc.

1.2.2 Admission and Placement Procedures

The placement of applicants in the various programs depends on the basis of the applicants' performance in the Freshman Program (General Education), the nation's manpower need, institutional capability and the requirements of faculties or departments. There are a number of criteria set by departments in relation to applicants' performance. At the same time, there are a number of decision-making processes in the placement of applicants according to the capacity of the department.

In the AAU, some of the criteria for admission and placement are the following:

- ◆ Each department has set its own minimum requirement. (For example, application into the department of Accounting degree program, a minimum of 3.00 Grade Point Average (GPA) in Ethiopian School Leaving Certificate Examination (ESLCE) is required.)
- ◆ Each department has a requirement in terms of ESLCE score in a specific subject.
- ◆ Some departments need a recommendation letter from employer organization of applicants.
- ◆ There are exceptional considerations in the case of some departments and applicants (e.g. the department of Computer Science, graduate students, visually impaired students, etc).

To allocate applicants to their desired fields of study, there are criteria like those mentioned above. The current practice is that applicants who fulfill the minimum requirements will be considered for further screening whenever there is an imbalance in the number of applicants and the capacity of a given department.

The process of placement creates a problem when there is an imbalance between the number of applicants and the intake capacity of the department. For instance, in 1999, there were 7,000 applicants whereas the intake capacity was only 2,300.

The problem is not limited only to the number of applicants but also to the number of applicants in the respective departments. It was observed that there are larger numbers of applicants in few departments whereas a few in others. According to a study by Temesgen (1996:38-39), the career choice of applicants is very strongly influenced by the perception of the job market and salaries. In addition, some disciplines result in enabling the graduates to have a better social status. Since students are traditional in social values, a high social status accorded to some disciplines influences the applicants' choice of a program of study. For instance, a comparison of the field of interest of students in the Faculty of Science has shown that the field of Technology ranks first and Biology 9th. A comparison of the number of applicants who apply for admission to programs in Technology and Biology reveals that there is a big difference. As a result of this, identification and placing applicants create problems.

To handle the process of screening an Admission and Placement Committee (APC) composed of academic staff is established. The committee has got some administrative support in a form of part-time students from the Registrar to perform the job. A new group of such students is assigned every year.

According to the preliminary survey conducted, the process of placement requires considerable time and resource. For placing a student, the committee needs to read, categorize and select. Selecting is not an easy task, because there are many applicants in some of the departments and faculties and a few in others; and the number of choices is more. Checking

an applicant with his choices takes a lot of human resource and time for searching. The other major problem is that in the Extension Program, the number of applicants is increasing from time to time.

An interview with the Admissions Officer of the University indicated that screening on the basis of ESLCE results, which cover only 5 subjects, is not enough. Considering only these criteria could lead to an inappropriate decision. There are also special considerations made. In the Department of Accounting, for example, priority is given to those applicants who have taken Examinations in Mathematics and Bookkeeping and scored higher grade point average over those who have not. The Associate Registrar noted that if the admission process is computerized, a better screening procedure could be incorporated and the above problem could be solved easily.

What is clear from the above is that matching of student choices with the program requirement is not an easy job, especially in the Social Science, which deals with up to 17 choices. This task takes experts time. Besides, since it is handled manually, inconsistency in decision making may take place.

In general, major problems encountered during the process of admission and placement are summarized as follows:

- The number of applicants is significantly larger than the number of places available in the faculties or departments.

- The staff members doing the admission and placement are changed every year and there is always a need to orient and train them, and because of this, considerable time is spent in training to avoid inconsistencies made in the decisions.
- A large number of students apply only to few departments.
- The number of options for an applicant is big, and verification of applicants vis-à-vis their choice is very tiresome and time consuming,
- Admission and placement takes a long time, which results in failure to meet the deadline for starting of classes in time.
- The number of departments is big and placing the applicants in their desired programs needs complex screening criteria.

1.2.3 Justification of the Study

Each year the university handles admission and a new team of part-time staff is employed to assist the APC in the course of the screening. The change in the staff leads to a problem in establishing a consistent selection procedure. In addition, the committee members are required to categorize and select applicants in each department. For example, there were approximately 7000 applicants in 1999. The task takes a considerable time of the committee members, who are also occupied with other assignments.

Complex problems such as admission and placement take considerable time to reach at decision in accordance with the choice of the applicant. Since the number of applicants is large and the time for admission is very short, it is not possible to complete the process in time. This causes a delay in the starting of the university program in time.

To alleviate some of the problems with respect to admission and placement in AAU, which have been described above, the use of modern technology, such as an expert system, can be made.

Expert systems are computer programs that model the human experts behavior and knowledge within a specific domain or area of knowledge. As a result, it performs with the proficiency of a human expertise. According to Gorry and Scott Morton, as cited by Kalay and Chen (1995), most of the important decisions made in an organization are semi-structured. It equally holds true for the decision made in the admission and placement.

Expert systems have shown a remarkable progress in admission screening. The research done at the University of Victoria (Canada) has shown that expert systems can save experts' time, bring about consistency in the decision making process and performing on time (Johnson 1990).

In order to develop an expert system the following conditions should be fulfilled (Ardis 1988):

- ◆ At least there should be an acknowledged expert in the area, the APC in the case of AAU.
- ◆ Sources of the expert's expertise are judgment and experience; it is rule based.
- ◆ The expert is able and willing to explain his knowledge in a systematic way that others can understand.
- ◆ Problem is well bounded.
- ◆ The problem area has a real consensus.
- ◆ Test data is essential; applicants' data is available in the Registrar.

What is clear from the above, is that the admission and placement work of the Addis Ababa University Registrar is a suitable domain area for the development of an expert system.

Addis Ababa University has been chosen because it has 31 programs, both Diploma and Degree. As a result of this, the university has faced severe problems in the admission and placement areas. Moreover, the admission and placement procedures of all other higher institutions are more or less similar and the system developed can be applied to other institutions with minor modifications.

The aim of this research is therefore, to explore the potential of expert system in admission and placement of students and minimize the current problem and improve the decision-making process by taking AAU as a case.

1.3 Objectives of the Study

1.3.1 General Objective

The overall objective of the study is to explore the potential of expert systems technology in order to enhance the decision making process in the admission and placement of students in the Addis Ababa University.

1.3.2 Specific Objectives

To achieve the above mentioned general objective the following specific objectives are drawn:

- ◆ Explore the potential of expert system technology in admission and placement;
- ◆ Study the existing system, identify its problems and information requirements and structure the information;
- ◆ Acquire required domain Knowledge and skill from experts in the area and construct the knowledge base;
- ◆ Investigate different methodologies and approaches available;
- ◆ Investigate the methods of knowledge acquisition, knowledge representation and inference mechanism;
- ◆ To develop a prototype and demonstrate the suggested solution.

1.4 Scope of the Study

Because of time limitation, the research has focused its study on Extension program applicants.

1.5 Methodology

For the successful completion of the study the following techniques were employed.

1.5.1 Review of the Literature

Related literature was reviewed for the purpose of identifying and studying expert system tools and techniques and the problem area of admission and placement.

1.5.2 Knowledge Acquiring

For the purpose of acquiring the domain knowledge and skills, techniques such as documents (procedure, manuals, criteria's, capacities) analysis, discussion with the experts were employed.

1.5.3 Prototyping

Prototyping approach was adopted for the development of expert systems. Prototyping is a common approach in expert system, because it is suitable to code knowledge base that can be tested before risking too much.

1.5.4 Programming Tools

The available software at the school is KnowledgePro for Windows, and it was used for developing the prototype.

1.6. Application of Results

Most Ethiopian higher institutions perform their admission and placement manually, and this is also the case at AAU. Since the number of applicants for admission to the Extension Program is increasing every year, the problem is exasperating. So, an expert system based admission and placement can help them in solving the problem. AAU in particular is intended to be the most beneficiary of the study.

The work can be used as input for researchers on the domain, specially work on related areas. The work may also shed light on the applicability of expert system for the other activities of the Registrar, such as scheduling of examinations and classes.

1.7 Organization of the Study

This thesis comprises six chapters. The first chapter deals with the background information, statement of the problems and justification, objectives of the study, scope and limitations of the study and the methodology used in the study.

The second chapter reviews and discusses expert system in general and its application in the admission and placement activities in particular.

The third chapter presents a discussion on system development approaches: acquiring of relevant information about the applicants, methods of representing and evaluating these information; inference mechanisms, and relevant tools for developing expert system.

The fourth chapter examines the methods for the process of admissions and placement of the applicants by the Registrar of the University and the Knowledge acquired using these methods.

The fifth chapter presents the prototype, while the last chapter contains conclusions and recommendations of the study.

CHAPTER II

EXPERT SYSTEMS APPLICATION IN ADMISSION AND PLACEMENT OF STUDENTS

2.1 Introduction

This chapter discusses the general overview of expert system, its development and current trends. The overall application of Expert Systems in different sectors is also discussed in general, and the area of admission and placement is given particular emphasis.

2.2 Expert System: Overview and Development

Artificial intelligence is the science of making machines do things that would require intelligence if done by a human (Beckman & Rogers 1988; Martin and Oxman 1988). Expert system is a branch of this technology that has got wider acceptance in business and other areas (Wilson and Burford, 1990).

Expert systems do not have one and unique definition. The definition of expert system depends upon the level of emphasis. For example:

Canter (1984) defines expert system as

“A computerized problem-solving process, which emulates human decision making and furnishes expert consultation in a well-defined domain of expertise, based on experts’ experiences and heuristic (rule of thumb).”

Martin and Oxman 1988 define Expert Systems as

“A computer based system that uses knowledge, facts and reasoning techniques to solve problems that normally require the abilities of human expertise.”

What one understands from the above definitions is that an expert system is a computer program that emulates the behavior and knowledge of an expert within a specific domain, and as a result performs with the proficiency of a human expert. In order to be able to perform like a human expert, an expert system basically consists of three components: a knowledge base, an inference engine and a user interface.

Humans develop knowledge from experience and make decisions based on accumulated past experiences. Likewise, expert systems contain knowledge base to represent the experts' knowledge. The knowledge base is made up of rules and facts that can be drawn upon by the inference engine. The role of the inference engine is to use these facts and rules to draw conclusions based on user inputs. The user interface allows communication between the user and the expert system. This interconnection among user interface, knowledge bases and inference engine results in an expert system (Ardis, 1988).

In addition to the basic components, an expert system possesses features such as:

- ❖ Interface to the external database, spreadsheet and other applications
- ❖ Explanation capability that shows how it reaches to the conclusion (that conventional programs lack)

Typically, expert systems are developed in places where human experts are in very short supply, expensive and difficult to get. Therefore, they usually are designed to represent the

human knowledge in a computer and are modeled to solve problems in a human like fashion. As a human being, expert systems contain expert's knowledge in their knowledge base, and an inference mechanism to interpret the knowledge it incorporates. However, expert systems reason from knowledge in a limited domain and can approach (in some cases can exceed) human performances, and they cannot provide solution for problems that human beings do not know how to solve. Actually expert systems contain the existing knowledge of human expert and use that knowledge to learn like a human being.

The power of an expert system lies in the knowledge it contains, not in the clever way of programming it. To reason like human beings, expert systems not only rely on factual knowledge, as do conventional programs, but also on uncertain knowledge and observations based on experience and intuition called heuristics. This is the major factor that distinguishes expert systems from conventional programming. Unlike conventional programming expert systems must often make conclusions based on incomplete, judgmental, speculative, uncertain or fuzzy information. Expert systems also include a good feature that they provide explanation about how they reach on that decision (Rauch-Hindin, 1988).

There are also other features that differentiate the conventional programming from that of expert systems. Expert systems are best suitable in problems that can be symbolically represented and problems that use heuristic search or rules of thumb (Rauch-Hindin, 1988).

In this regard, they have important and useful attributes that are different from conventional programming. That is, the program structure and mechanisms that contain knowledge, information and control the way the program infers information are separate and independent. Even the substructures that hold individual pieces of encoded program knowledge are

modular, unsequenced, and are largely independent of each other. Separation of these program mechanisms makes it relatively easy to modify one part, and to add new knowledge incrementally without affecting other parts of the program. This enables expert systems to fit with the changing demands of any organization because they are designed to handle more knowledge, and update their knowledge very easily (Rauch-Hindin, 1988).

Furthermore, unlike the conventional programming, the stored knowledge in expert systems is independent of program controls and inferencing mechanisms. These mechanisms make it easier for users (both technical and non-technical) to examine and modify the system when needed.

Research in expert systems gain more importance due to various reasons, among which the major ones are summarized below.

- ❖ Advances in AI technology have made it practical to build systems whose behavior resembles that of human intelligence. Decision-makers can benefit from expert systems as they exhibit more rather than less, intelligence. To assist in the construction of expert systems shells and integrated environments are available (Holsapple and Whinston, 1996).
- ❖ The potential benefits of expert systems are numerous ranging from operational to strategic. They give decision makers uninterrupted access to consistent advice. They relieve experts from having to give that advice. They allow an organization to formalize and retain the expertise that exists within it.

2.2.1 Components of an Expert System

An Expert system, as mentioned earlier, typically consists of three major components: the user interface, the knowledge base and an inference engine. Figure 2.1 below shows the structure and components of an expert system.

Knowledge Base

The first part of human expertise is a long-term memory of facts, structures and rules that represent expert knowledge about the domain of the expertise, for example placement rules. This analogous structure in an expert system is Knowledge base.

The database contains information from the user, as well as the intermediate results derived from the system, applicant databases in case of admission and placement.

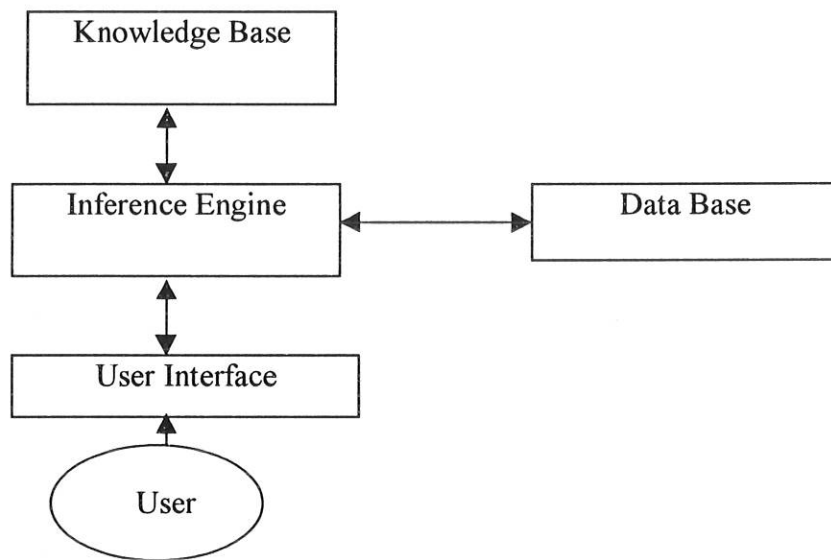
Inference Engine

This component of expert system is a method of reasoning that can use the expert knowledge to solve a problem.

User-interface

The user interface of an expert system allows users to interact with the system. The user enter information, receive advice and so on. The user interface aims to provide the same form of communication facilities provided by a human expert.

Figure. 2.1 Structure of an Expert System



2.3 Early Development of Expert Systems

In the earliest stages, the notion of an expert system was developed from that of Artificial Intelligence's first attempt to the development of GPS (General Problem Solver) developed by Herbert Simon and others in the late 1950's. This approach was an attempt to solve any problem using the GPS. However, problems that were specific to their domain were not possible to solve (Hayes-Roth, Waterman, and Lenat, 1983).

The General Problem Solver (GPS) was based on the notion that "all one has to do was define the present situation (or 'state'), define the goal state, and program the computer to take steps to reduce the difference between the two states". It was faced with a problem of dimensionality, i.e. the availability of too many optional states and too many ways to move from one to the others made it impossible for a computer to evaluate all of the choices.

Therefore, approaches succeeding GPS concentrated on 'heuristics' - to use 'rules of thumb' that applied only to specific tasks.

Although there were situations where rules of thumb didn't always work, at least ways were developed to make a problem manageable. And this approach led to the birth of the first true expert system - DENDRAL (Holsapple and Whinston 1996)- developed in the mid-1960's by Stanford group for determining the chemical structure of molecules. The fundamental contribution from expert systems during this time was that expertise could be captured from highly specific domain area in terms of 'rules of thumb'. This was in contrast to the GPS (domain independent) approaches in AI.

Further pioneering work in expert systems development continued in the early 70's and expert systems moved suddenly into prominence with the success of MYCIN (Zahedi, 1993), which is used in the medical diagnosis of infectious blood diseases and R1 (XCon). R1 is the first commercially successful expert system for aiding in computer configuration at Digital Equipment Corporation. Furthermore, the development of expert system shells that simplified the process of building the knowledge bases and inference engines also contributes to the development and prominence of expert systems.

At the earliest stage of their development high development and hardware costs confined them to remain in the laboratory. The other factor was the length of time that takes to develop the system was long because it was developed from scratch.

The application was also limited to classificatory tasks such as medical diagnosis, they were applied only on stand-alone machines that offer consultative advice and they were limited to

be implemented on expensive LISP (List processor) based hardware and software platforms. The embodiment of expert systems as a stand-alone software environment has also tended to slow their integration into other application environments such as databases.

Now hardware costs have dropped in contrast to the increase in the power of the computer processor and now there are sophisticated tools that cut the time and cost of building the system. These reasons contributed to the widespread and economically feasible of expert systems (Gupta, 1988:6). As a result, interest in the technology exploded in industries and government. The number of organizations developing knowledge-based systems has multiplied sharply.

Therefore, these days the number of expert systems tools and applications are doubling each year, mostly in the personal computer environment. There are now many commercial applications of expert systems serving all types of industries, services or other organizations (Srica, 1996). Among the many reasons for having expert systems the major ones are:

- ❖ the greater benefit in using expert systems as opposed to human experts
- ❖ the scarcity of human experts in most organizations
- ❖ the enormous increase in information production, which human experts find difficult to cope with
- ❖ the expenses and time consuming production of new experts
- ❖ the decreasing cost of knowledge based engineering hardware and software
- ❖ it quickly responds to a rapidly changing environment

2.4 Application in Admission and Placement

Application of expert systems in admission and placement is becoming common in many places around the world. This is mainly because the time and effort of highly skilled staff who have already been assigned to other jobs - teaching and research - could be greatly reduced when these kind of bulky and routine tasks are automated.

By using an expert system that applies rules and regulation of the university admission and placement policy, the following results can be achieved.

- Consistent admission procedures could be used
- Data can be encoded by clerical staff
- New members of an admission and placement committee can easily learn the procedure from the system, and cost for training of a new member (committee) is minimized
- Decision is consistent and timely. Timely decision results in attraction of applicants to know the result.
- Experts are relieved to do their job, etc.

Among some of the cases, which utilized expert systems for admission and placement, the Queens Tertiary Admissions Center is worth mentioning here. The Queens Tertiary Admissions Center has developed a system called QTAC that handles applications for entry to the 7 state funded universities and 32 technical colleges in Queens Land, Israel. QTAC is one of the cases that experienced and benefited from application of an expert system for tertiary applicants' assessment, selection and admission. The big number of course specific complex rules that are applied to select one or more (up to 8 rankings), half dozen preferences

and the potential changes (mostly unknown) that would occur soon after the new system was implemented are the factors, among others, that forced QTAC to shift from conventional systems to the state of the art technologies including expert systems (McLeland 1995).

McLeland argues that the new information technologies (expert system & the accompanying systems like Electronic Application Form, GUI, and Automatic Retrieval of tertiary results) enabled a tertiary admission system to be introduced that can handle massive volumes of diverse data and highly complex rules in a sophisticated, efficient and user-friendly way.

The other system that had similar experience with QTAC is the Graduate Admission Screening system. This was first developed for master research thesis at the University of Victoria. The system uses rules and regulations that are acquired from the committee members. It screens applications and groups the applicants into either **accept**, **discuss** or **reject** category. The applications that are in **accept and discuss** category are provided for committee members for final decision. This has reduced the time spent by the committee members in reviewing application and establishes consistent decision. The system was developed using Acquire shell, and this was chosen for its power of knowledge acquisition.

Expert systems used in admission screening have proved the technology be applied in the universities. Selecting the most competent applicants from a large number of applicants is very complicated, because it has to use a series of procedures to be applied on an individual applicant. In addition, it has to use a number of records showing the performance of the applicant. Expert systems in this situation have been applied and have shown in general that (Johnson, 1990):

- refrain experts from routine work

- enable the entire task to be accomplished with higher degree of skill in much less time
- minimize a considerable burden training new committee members (as the committee is changed regularly)
- enable to establish a consistent selection procedure which was really impossible because of the annual turnover of committee members
- reduce time, increase efficiency and consistently apply criteria

CHAPTER III

DEVELOPMENT APPROACH TO EXPERT SYSTEMS

3.1 System Development Approaches and Methodology

For any software or information systems development generally there is a well-established life cycle model. Expert System as an information system must also pass through these stages. The stages of development in expert system are the following (Zahedi, 1993):

System Analysis

In this stage problem identification, goal identification, and determination of the scope of the study, experts' identification are included.

System Design

In this stage knowledge acquisition as a logical design is included. Physical design includes software selection, hardware selection, user interface design, and physical design of the knowledge base.

Coding

In this stage coding the knowledge base and the user interface issues are involved.

Testing

Testing involves verification, validation and field tests. It is to check the performance of the system according to its intended design.

Implementation

This stage includes user training, documentation and field support

Post-implementation

This stage includes collecting field reports and statistics, learning new knowledge and discarding obsolete knowledge.

Conventionally, the phases are carried out sequentially. However, unique features of expert systems such as they are handling of unstructured and semi-structured decision problems and acquiring of domain knowledge through laborious process of knowledge acquisition and domain knowledge necessitate a new area of software engineering that is unique to expert systems only (Zahedi, 1993).

At present there are two approaches available in developing an expert system. These are the system life -cycle and prototyping approach. Both of the approaches go through the above stages of development but differently.

3.1.1 System Life Cycle Approach

This approach requires a formal process in which the system developer goes through the development stages before arriving at the implementation phase. The advantage of this approach is that it provides an orderly framework for the development of an expert system, which reduces the probability of errors and pitfalls. The disadvantage of this approach is that it takes a long time before any product with a visible outcome is produced. This makes top managers reluctant to commit financial resources to the development of the system (Zahedi, 1993).

Expert systems deal with knowledge. And knowledge acquisition is a difficult task and major bottleneck in the development of expert systems. It is difficult because the expertise is hidden in the minds of the expert. Sometimes experts do not know how to invoke their expertise or simply unable to express in a clear and unambiguous manner. In addition, knowledge acquisition methods are the least formalized. All these made it difficult to obtain a detailed analysis of the problem.

Hence, trying to get the full analysis of domain using life cycle approach becomes costly, time consuming and risky. It is risky because at the time the need is specified, the organization need may change. It has been argued that because of the above mentioned reasons life cycle approach is not suitable to expert systems development.

An alternative approach that minimizes the above problems is prototyping approach. The prototyping approach shortens the development and enables to change with the changing demand of the organization before getting too risky.

3.1.2 Prototyping Approach

Prototyping in the context of expert system is the act of building a small scale, representative or working model of the acquired knowledge to discover or verify the knowledge represented. It has shown to be a powerful tool for elicitation of further knowledge (Greenwel, 1988 as cited by Yang). Welbank as cited by Yang states that it is useful to get a system as soon as possible, because it keeps experts interested and act as focus for eliciting knowledge. Prototyping approach is useful because it enables the developer to get the support of the top management, understand the problem and its domain, and identify the scope of the system and its expansion.

Prototyping is a common approach in expert system because of the novelty and unstructured nature of problems that the system solves. The development of the prototype is far cheaper than the full version and the gradual expansion of the system gives the manager more control over the cost and extent of the system. The developer will typically go through a series of iterations and user review until they evolve into an acceptable design. Unlike the life cycle approach the developer in this approach goes through these stages in a quick and incomplete fashion, enhancing each stage in the next iteration of the prototype. It should be noted that no matter which of the two approaches are used, the life cycle or prototyping, expert system development goes through development stages described in Section 3.1 (Zahedi 1993).

In this study, a prototyping approach is employed because it is a preferred technique in accelerating systems development as it allows experts react to the prototype and to solicit their responses as to whether the designed system truly represents the intent. In addition, the domain area is new to the student researcher and prototyping is suitable for new domain area.

3.2 Knowledge Acquisition Methods

Knowledge acquisition process involves the elicitation, analysis and interpretation of knowledge from human expert in solving problems in the domain area. It uses various methods to elicit this knowledge. Knowledge acquisition method is a way of directing expert's attempts at concealing reasoning knowledge. Knowledge acquisition is considered as a major bottleneck in expert system development because of human knowledge characteristics, lack of theoretical support, and overall methodological framework for knowledge acquisition, as well as high demands on knowledge engineer skills (Shaw & Woodward, 1989).

There are two basic strategies in knowledge engineering: one may start from general and overall concepts gradually leading the expert to elicit details of a topic. This approach is known as top-down or deductive approach and the other starts from specific cases and reaches at a general concept from these specific examples. This method is known as bottom-up or inductive approach.

In top-down methods, the knowledge engineer interviews the expert in a series of meetings or asks him/her to fill a questionnaire. The interview could be structured involving a predefined series of questions, or unstructured interviews that consists of open-ended questions allowing the knowledge engineer to further explore based on the experts responses. In developing the whole system both the structured and unstructured methods can be used at various stages. As the development proceeds the interviews become more specific and structured (Zahedi, 1993).

In bottom-up method the knowledge engineer focuses expert's attention on specific cases, in order to help the expert to abstract the decision from specific case to a more generalized one. The methods that can be grouped in bottom-up are example-based methods, protocol analysis and observation of the expert's decision making process. The most commonly used in this method is protocol analysis. In protocol analysis the expert is asked to think aloud and verbalize his or her thought process while solving a set of actual or simulated problem and making decision. It is useful for the non-procedural type of problem solving where the expert applies a great deal of mental, creative and intellectual effort to arrive at a decision in each case. Observation method helps the knowledge engineer to observe while the expert is doing. This method is effective when the solution of the problem is procedural and takes place in a sequence of steps, observing the expert in action gives an insight.

One can use the method that best fits the problem area. Among the methods discussed above interview and protocol analysis are most widely used methods in knowledge acquisition (Holsapple and Whinston, 1996).

In this research top-down method was employed. In top-down method, the problem can be broken and each module can be handled separately. Interviewing method is most common in

top-down approach. Unstructured interviews (open-ended questions) were used at the beginning and structured interviews (predefined questions) later. Unstructured interview is used at the beginning because it helps to familiarize with the domain area (Zahedi, 1993).

3.4 Knowledge Representation and Inference Mechanisms

Knowledge base is the heart of an expert system. It contains the specific knowledge about the system area of expertise in the form of facts and rules. The rule uses the facts in deriving the conclusion. The effective management of knowledge is an essential ingredient of intelligent behavior. Exploration of methods of knowledge representation is an important part of artificial intelligence research. As it is well known, there is no single knowledge representation method that is best for all types of knowledge or for all problem areas (Holsapple and Whinston, 1996). There are different mechanisms for knowledge representation, which are devised by artificial intelligence researchers and used by expert system developers. Among the many semantic networks, frames, production rules are the main methods that were used (Gibb, 1986).

3.4.1 Semantic Networks

A semantic network consists of nodes and arcs (Quillian, 1968) as cited by Holsapple and Whinston (1996). Each node represents a concept, which could be some concrete entity or a more abstract notion. Each arc represents a relationship between the two nodes it connects. The arcs label such as 'is-a' denotes the nature of that relationship. This method is suitable for representation of association between attributes and hence useful for modeling complex systems such as language structures. Semantic networks tend to be difficult and costly to develop. Besides the methods do not distinguish between the class of an object and a

particular object. These and other limitations resulted in the coming of scripts and frames as a knowledge representation (Zahedi, 1993).

3.4.2 Frames

A frame is a collection of knowledge about an entity or concept. Each frame is a complex package of slots, that is data values describing the many characteristics or attributes of an entity, including its relationships to other entities. They enable knowledge representation in a much more organized and manageable manner (Rauch-Hindin, 1988). It is also possible to construct hierarchies that can develop inheritance. The frame in the lower hierarchy can inherit from the one above. This is very useful in developing a causal relationship and association among the objects. However, constructing knowledge using frames is more complicated and costly, as it does not have a language of its own. This resulted in the upcoming of objects as knowledge representation method (Zahedi, 1993).

3.4.3 Rule Based Representation

Rule based representation is one of the most popular methods of knowledge representation in expert systems (Zahedi, 1993; Holsapple and Whinston, 1996; Gibb, 1986). A rule consists of an **IF** part and a **THEN** part (also called a condition and action). The **IF** part lists a set of conditions in some logical combinations. The piece of knowledge represented by the production rule is relevant to the line of reasoning being developed if the **IF** part of the rule is satisfied the **THEN** part can be concluded, or its problem solving action can be taken. Through the development of such rules, the decision making process of human experts can be represented. Hence, the collection of rules is said to build a knowledge base.

Currently it is possible to use two or more knowledge representation structures. This is made possible with the emergence of object oriented programming in the 1980s and 1990s. Object oriented programming which makes use of objects and frames, as well as rules and other representation structures, has become a very widely used concept, where human thinking processes can often be copied more easily with objects than with just rule alone.

Rules are criticized for their inability to show a "causal relationship" and associations among objects. Even if they have limitation they are widely used knowledge representation methods.

They are widely used because

- ◆ They took a more general nature of human reasoning.
- ◆ They are easy to construct; easy to change and most importantly can be linked so that conclusion of one rule can form the conclusion of another rule.
- ◆ They are non-sequential and independently represented, they are easy to add, delete and modify the knowledge base.
- ◆ They are efficient for rule based systems.

Because of the above-mentioned reasons, the current undertaking considered rules as knowledge representation methods.

3.5 Inference Engine

It is one of the components of an expert system responsible for search and pattern matching operations during consultation. Specifically this component examines the rules within the

knowledge base in a particular sequence to seek matches in the content of the database, which consists of information from the user, as well as the intermediate results derived from the

system. Three major inference methods efficient for major searches in the knowledge base are used for deriving facts into knowledge. These are:

Forward chaining,

Backward chaining

Combination of backward and forward chaining.

The selection of the method depends on the properties of the rule set and initial facts.

3.5.1. Forward Chaining

Forward chaining which is also known as a data driven method is used when the data is the starting point. It attempts to match existing data with the condition part of the rule in the knowledge base. If one or more such rules are found, the system formulates the rules. The conclusion that derived then becomes part of the database. This process continues until either one halts the process and makes some recommendation or the system becomes unable to reach any conclusion. The drawback of this method is that the system would derive every possible intermediate conclusion regardless of the need for it. Forward chaining is better when there are few rules or facts and a number of conclusions made from that rule.

3.5.2 Backward Chaining

Backward chaining, a goal driven method, starts with a predefined goal as a starting point and looks for a rule that has that particular goal in its conclusion part. Once such rules are identified the system searches the existing database for a match with the conditions in the IF part of the rule under consideration. If a match is found, the database is updated with the conclusion derived. This match may also result in firing of some other rules, validate some sub-goals, and thus provoke an inference chain. This process continues until the goal is achieved. A drawback of this method is that a combination of sub-goals may result in an explosion of possibilities. However, sometimes backward chaining can be very wasteful - there may be many possible ways of trying to prove something, and you may have to try almost all of them before you find one that works. Backward chaining is more efficient when there are few conclusions to be inferred given a large set of initial facts, as it avoids drawing conclusions from irrelevant facts (Gibb, 1986).

The combined-methods strategy employs both forward and backward chaining search approaches. And this is usually used to analyze most complex problems.

In this study a backward chaining approach is used. Because of the nature of the domain area that there are many facts about the applicants and departments and a few conclusion to reach and it is the default inferencing engine in many of the expert system shells. It is also available in the KnowledgePro shell, the tool used to develop the prototype.

3.6 Development Tools in Expert Systems

There are two ways to develop Expert systems. It can be developed from "scratch" by using Artificial Intelligence (AI) tools such as Lisp (List Processing) that were invented in the 1950s, and PROLOG Programming in Logic that was developed in the early 1970s. AI softwares are more flexible than shells. However, they provide less with interface mechanism. Conventional programming languages (such as C, C++, etc) can also be used for developing an expert system. The advantages of these languages are that they give efficient runtime and better interface to the external application and databases. However, they lack a built-in inference mechanism and hence require additional effort to write the code or algorithm to access the data structure (Gibb 1986).

Expert system shells are special kinds of software that allows to develop expert systems. EMYCIN was the first shell, evolved from MYCIN (the first major medical diagnosis expert system) and became a general tool for developing other domain. These lessen the time of the developers.

Building expert systems by using shells offers significant advantages. A system can be built to perform a unique task by entering into a shell all the necessary knowledge about a task domain. They permit quick and easy building of a new system, and are good for prototyping. Shells have been relatively constrained and inflexible compared to programming languages. However, current shells such as KnowledgePro, LEVEL5 object have built-in procedural languages and interface to external programming language and application systems. For the reasons of easy to build and are good for prototyping and lack of experience in artificial intelligence languages the current prototype was developed using a shell, especially KnowledgePro.

CHAPTER IV

ANALYSIS OF THE EXISTING SYSTEM

4.1 Introduction

In this chapter the knowledge required in the admission and placement process are collected, organized and presented. In order to identify the information requirements of the admission and placement system the existing system was analyzed. The findings are presented in the sections below.

4.2 Knowledge Acquisition

Knowledge as to how the admission and placement works was acquired from some of the members of the Admission and Placement Committee (APC), the Academic Commission in each relevant faculties and from printed sources. The APC is composed of the heads of departments, faculty deans and the Freshman Program Coordinator, and is chaired by the Associate Registrar for Admission and Placement.

Discussions were held with the Associate Registrar for admission and placement and the members of the committee. The committee members' experience is depicted in Table 4.1

Position	Qualification	Experience
Associate Registrar for admission and placement	M.Sc in Statistics.	10 years in admission and placement
Head of department of education	M.A in education	5 years as extension program coordinator and member of APC
Head of department of Accounting	M.A in Accounting	15 years experience in teaching and 5 years in APC

Table 4.1 Committee Members by Qualification

These members were selected for the discussion because of their extensive prior experience as a committee member of the APC. The Associate Registrar was chosen because of his rich experience in the job. From the discussion held, information was collected on

- Requirements for enrollment in the department
- Major decision and procedures in the placement
- Placement process

4.3 Problem Analysis

Admission and placement into the universities need knowledge about the programs in which the applicants are qualified and place them according to their choice or desired field of study. These decisions require extensive information on applicants' qualification, desire and performance and requirements of the department.

To prepare the applicants to choose the program, the university provides an orientation program during the first half of the second semester. However, the orientation program is not sufficient to provide information that enables the applicant to decide on which department to join and the requirement needed to enroll in that department. Some of the major problems that the orientation program faces are (Fisseha, 1991):

- Information is overloaded
- applicants are overcrowded
- Presenters exaggerate their department
- The time allowed for a given speaker is not sufficient
- There is lack of method of instruction.

On the other hand, extension applicants could get proper advice or information as to how to apply. The only information they are provided with is the minimum grade requirement of the department.

A study made by Fisseha (1991) has shown that 66% of applicants base their preference on the information found from their friends. To solve problems with respect to placement and admission of applicants, Fisseha (1991) has mentioned the following points:

- ◆ Placement should involve “ the school, the community and the individual”
- ◆ It should involve “record keeping, job counseling, employment contact, supervision and follow-up
- ◆ Further involvement of vocational counseling
- ◆ Published or written documents should be prepared
 - Describing policies and procedures of student placement
 - Describing issues to be considered in making a choice of academic major fields
 - Explaining major features of departments
- ◆ Prospects and problems of joining certain departments should be discussed with applicants

All of the above listed information enables the applicants to develop skill and attributes that is expected from them to achieve their preferred programs.

4.4 Processes of Admission and Placement

Admission into institutions with numerous undergraduate programs combines selection and placement at once, this is because of differences in requirements (Dressel, 1981). AAU, an institution with a number of academic majors, also admits applicants whenever they get their academic major of their desire. This is done for extension program applicants. Applicants are admitted if they are placed in one of the departments.

Available departments and majors in the university for the Extension Program are categorized into two. Category A is the Social Science and Category B is the Science Faculty. Applicants should apply to only one category, either Category A or B and identifying their preference in order of priority from one to five. Applicants are admitted to each department based on their choice. That is if their first choice fails, their second choice is considered, and so on.

Concerning the steps followed by the office, they sort out applicants according to their Grade Point Average (GPA) and first choice. The placement committee classifies students by considering the following factors:

Factors external to the student, such as

- Quota allocated to the department and
- Criteria or special consideration of the department

Factors internal to the student, such as

- Interest and
- Academic ability

Having considered these factors admission and placement process needs to match the interest and capability of the applicant with the available place and the requirement of each department. The major processes are:

- Screening applicants if they meet the minimum requirement
- Select the best applicants among those who fulfilled the minimum criteria if the number of applicants are greater than the available place

Because the University is constrained by the limited number of available places and by the fact that some departments have too many applicants, the second process is a much more difficult task. In most cases, in some departments like Accounting, Management and Economics, the number of applicants is higher than the available places. Mostly, too many applicants are tied at the lowest grade requirement to fill for the last remaining places in the college. It is during this time that high expertise is needed to differentiate one from the other. For the purpose of identifying best "fit" applicants, in addition to the GPA requirement, the following criteria are used:

- essential subjects
- related subjects and
- desired subjects

There have been proved to be essential to the successful completion of the program. Even for the purpose of identifying the best applicants, scores on these subjects are considered as criteria. Stream or specialization of the applicants is also included.

To identify essential, related and desired subjects required for the successful completion in the department, Academic Commissions are consulted. The list of these subjects vis-à-vis the departments and other requirements are presented in Table 4.2.

Table 4.2

Minimum and Special Subject Requirements for AAU

Departments	Minimum GPA	Essential subject (3.0)	Desired Subject (2.0)	Related Subject (1.0)
Accounting	3.00	Mathematics	Bookkeeping	
Amharic	2.0			
Architecture	No extension	Mathematics	Art, Economics, Geography, History and Physics	Geology Chemistry Mechanical drawing
Business Education	2.60	Accounting		
Economics	3.00	Economics	Mathematics	
Educational Administration	2.6	Educational courses	General paper teaching subjects (Arts)	
English	2.6	English language		
Geography	2.40	Geography	History	
History	2.00	History	Geography	
Law	2.80	Literature, Economics and history	Divinity religious education	Arts and Science
Library Science	2.8	Mathematics	Arts and Science subjects	
Management and Public Administration	3.00	English		
Pharmacy	No extension	Chemistry, Physics or Mathematics	Biology, Botany and zoology	
Political science and International Administration	2.80	History	Geography	
Pre-Engineering	3.0	Mathematics and Physics	Mathematics (applied) Mathematics (Pure) Chemistry	Mechanical drawing and Building Drawing
Sociology and Social Administration	2.60		Economics	Other Arts
Statistics	2.4	Pure Mathematics	Economics Mathematics	Chemistry, Geography and physics

For the purpose of screening, information is required from applicants and departments. The necessary information, which is required from the applicants, includes:

- Grade result in the national examination or its equivalent or first year result in the case of regular students
- Stream of study
- Subjects taken and the scores in individual subject
- Preference of study
- Biographical data

In addition to these, some departments need other requirements such as:

- Work experience
- Special subject requirement (e.g. for engineering, the student must score good result in physics)
- Recommendation from the employer (for Computer Science and Law)
- Specially treated student (for example, graduate student who wants to continue with other program)

In addition to the data collected about the applicants, information is also required from departments. Information, which is collected from departments, consists of the following:

- Minimum requirement in the national school leaving examinations
- Special subject and grade requirements from such subjects
- Number of available places

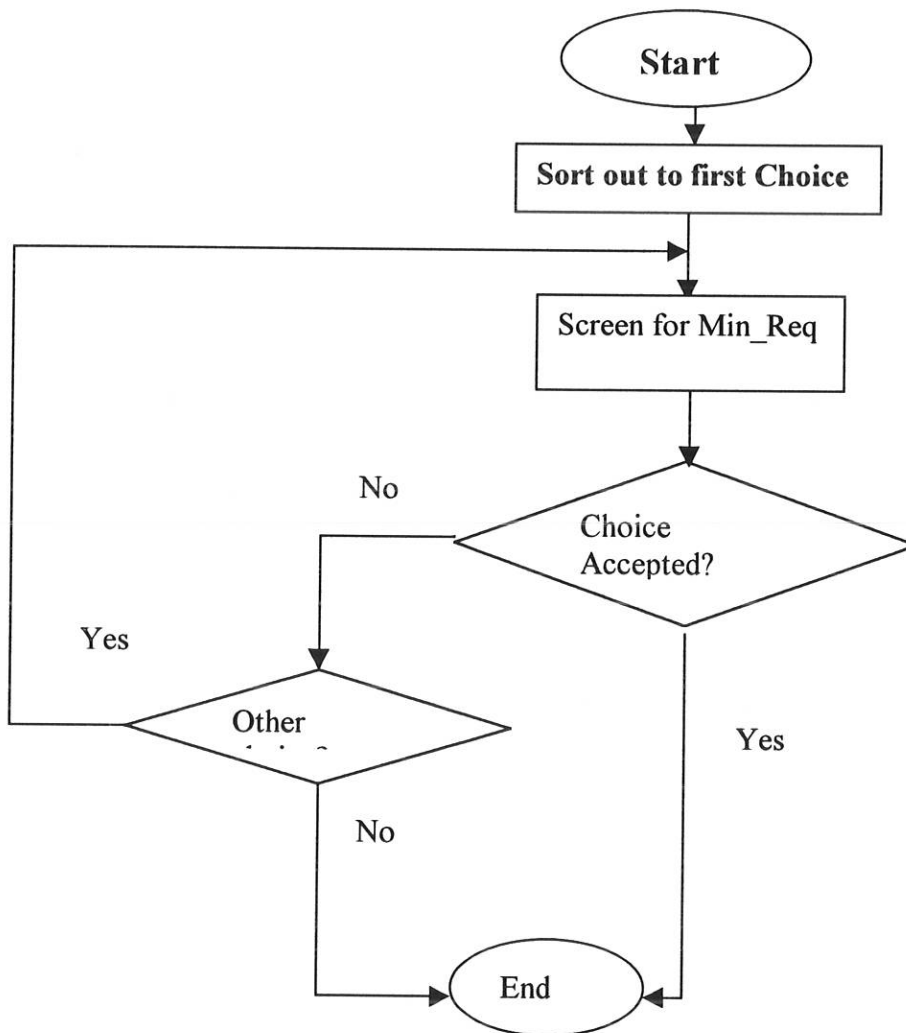
The placement process, therefore, attempts matching the interest and ability of the applicant with the minimum requirements of departments. If the applicant did not meet any of the requirements, he/she would be rejected, otherwise admitted to their first choice.

Once the applicants' records are checked against eligibility, the applicant could compete with other applicants, who are eligible for their first choice. The decision as to accept all applicants is determined with the capacity of the department to accommodate. And, the following decisions are made in accordance with the attached conditions:

- If the number of applicants who are eligible is equal or less than the department's accommodation, accept all students in that department.
- If the number of applicants who are eligible is larger than the department can accommodate, determine the cut off grade. The cut off grade is the lowest grade that is calculated from the number of applicants. If the number of places cannot accommodate all potential applicants with equal grades other factors are considered.

If the applicant is rejected from his first choice, the application is transferred to the second choice and considered in the second choice and so on until it is either rejected or accepted or all his/her choices are exhausted. The process is shown in Figure 4.1

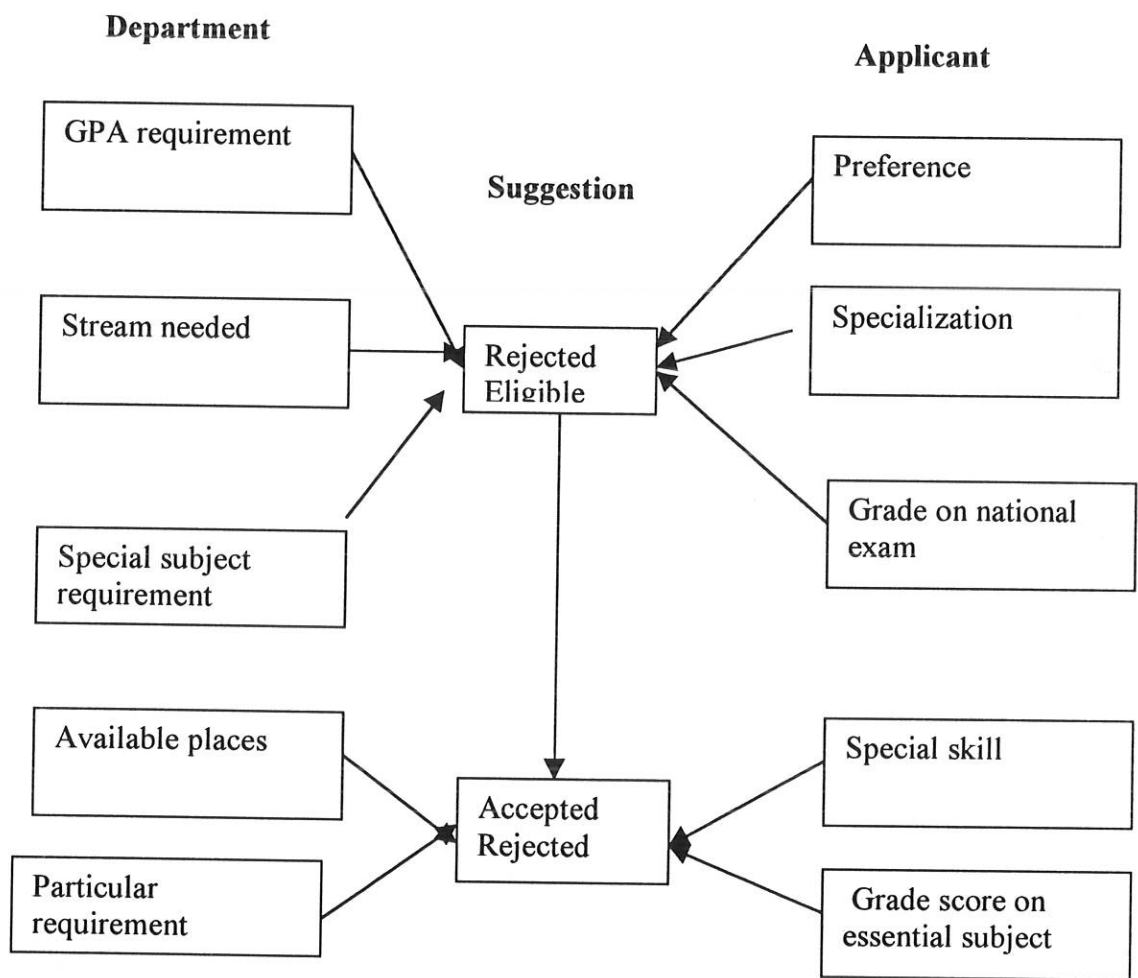
Figure. 4.1 General Placement Process



The required input to the general process is shown in Figure 4.2. This figure shows the input needed for decisions, admitting or rejecting applicants. For instance, in determining the eligibility of students GPA requirement, stream needed and special subject requirement are required from the side of the department, and preference, specialization and grade score on ESLC examinations from the applicant. From this data, heuristic rules are derived that allow us for decision making in admission process. Although the minimum requirement of each

department differs this figure shows the overall requirement in the process of admission and placement decision.

Figure 4.2 **Input Required for Admission and Placement**



The essential, related and desired subjects to the department are determined and are given weight in consultation with the concerning departments. An attempt is made to list all these requirements in all of the major fields. The GPA obtained in the ESLC examinations is also given weight to determine the best student when there are large number of students than the places.

The requirement varies from department to department. Table 4.2 shows the minimum requirement for each department. Special subject requirement needed for various departments is adopted in consultation with the faculty councils and from the study recommended by Fisseha (1991) to adopt the scheme of weighting experience from the University of Uganda.

The criteria of success of a certain applicant in his future study can be judged in terms of the following:

- The use of grades in a single subject
- The use of composite grades on a combination of subjects

It is possible to minimize waste and maximize educational benefit through improving technique for selection of candidates who are genuinely qualified for higher education. This could be done by identifying the different talents of candidates and their aptitude for varying types of preparation, helping through the related activities of guidance and counseling (Fisseha, 1991).

As shown in Table 4.2, the placement often starts from the Department of Accounting and proceeds in alphabetical order as follows:

- Accounting
- Amharic
- Business Education and etc.,

The major process in the placement activity is sorting out applicants, whose first choice is Accounting and the following decisions are made:

- Accept applicants to Accounting
- Reject applicant if Accounting is the first and only choice
- Distribute applicants to their next choice of departments

Major processes are:

- Screen all applicants in the departments to meet minimum requirement
- Select the best applicant to the department

To select the best applicant, the process checks the number of applicants who fulfill the minimum requirement with the available spaces in the respective department.

If number of applicants \leq number of available places

Accept all of them

Else if number of applicants $>$ Number of available places

Accept those that are highly competent

The process of accepting highly competent applicants involves the following tasks:

- Check grade points and determine cut off grade
- Check specially required subject grades of those applicants in the cut off grade
- Check quota for female applicants

The minimum requirements of departments could be illustrated by the following example.

Accounting

- National examination score greater than or equal to 3.00 in five subjects including Mathematics and English and three other best results
- Essential subjects in Bookkeeping, Economics, Mathematics
- Comprehensive school graduate in Accounting
- In high school the stream study could be Commerce

Computer Science

- National examination score greater than or equal to 2.80 in five subjects including Mathematics and English and three other best results
- Recommendation from employers
- Work related experience
- Essential subject better grade in Mathematics
- If graduate from university and would like to continue in this department the following applicants are given priority than any other
 - Graduates from mathematics, statistics
 - Regional workers

In order to be placed according to the desired program one has to meet the following conditions.

- Must fulfill desired and relevant subject requirement and
- Be competent enough to take the available place

The placement process continues like this. It is almost similar for all departments, apart from the differences in requirements of the departments. It also varies in its complexity from department to department and from year to year. There are three factors, which can influence admission processes

- Available places set by the department; this is set by the university in consultation with the departments
- Minimum educational standards for entrance to the college
- The balance between the number of applicants and available places

It is observed in some departments that the number of applicants is much higher than they can accommodate, and in some departments there are fewer applicants. And, screening procedures of both of the departments are not equally treated.

Even though the conditions discussed so far are directives to enable the committee to make decisions accordingly, there are cases that do not fall clearly under the guideline and which need subjective judgement. Decisions on such cases are made in consultation with the relevant authorities.

There may arise some conditions in which no mechanism is found to select one applicant from the other. At such time they use probability, simply by chance and so on. Or, there is some free space that is left simply to accommodate problems that may arise. It is left to accommodate applicants who are rejected in their pre-choice and are competent with the next choice provided that the next choice applicants are already assigned. These free space usually range from 1 to 5. If that kind of applicants appear in that range they are accepted in this department.

It is a much complex job that needs most careful decision, if an applicant's choice is not met, he/she might not accept the offer and the university might end up with a vacant slot.

A practical difficulty in the current system is that there is a short interval of time between the date of announcement of ESLC examination results and the beginning of the academic year. Apart from this, the number of applicants to be processed is too big to be handled in that short period of time. In addition, experts have other assigned jobs to undertake. In order to alleviate experts from this type of routine task and to speed-up the process, computerization is suggested.

From the overall analysis made on the existing system, the following problems are summarized.

- The selection criteria applied to different departments are different and unstructured. This makes the decision process tiresome and error prone. If we take the Economics department, for example, takes Sex, a 'B' or better grade in Economics, and 'C' or better grade in Mathematics as additional criteria. Some other departments take sex as a criterion.
- Some departments also use ambiguous terms such as ESLCE IMPROVED.
- Many students who fulfill the minimum grade criteria are not usually placed in their first choice. This is because the first choices of the majority of applicants revolve around few departments in the Faculty of Business and Economics. For example, in 1998/99 the department of Accounting accepted only those applicants whose GPA is 3.6 and above, despite the fact that the minimum requirement is 3.00.
- Placement criteria differ from year to year, resulting in inconsistent rules and regulations.

- Members of the APC also vary from year to year. As a result, the knowledge of experts is not preserved. Hence, a considerable amount of time and effort is exerted to orient new members to the work.
- Due to the complexity of the decision making process and the large number of applicants, in some cases decisions are made haphazardly or by chance. For instance, an applicant who scored a grade of 'F' in Biology in the ESLCE had been admitted to the Biology Department.
- The short interval of time scheduled for handling Admission and Placement of a large number of students is another cause for hasty decisions and incomplete judgments.
- The committee members, who are full time teachers and researchers, spend much time inspite of their crowded schedules and shortage of teaching and research staff in the university.

From the above listed problems, one can see that the necessity of a computerized system to tackle the problems. Particularly, expert systems are the most appropriate solutions for handling unstructured decision making processes. The suitability for changes can also fit to resolve the problem of changing rules and criteria every year. Furthermore, using expert systems, the knowledge and experience of the experts (committee members) can be stored and preserved, therefore, staff turnover cannot affect the system.

Therefore, the findings of the current study are in full support of the suitability of expert system application to meet the information requirements of the current Admission and Placement system as well as solving existing problems.

The APC also agreed on the fact that if they are assisted with a computer system, they would be able to add further criteria that best enables them to select the best-fit applicants. It is also believed by the committee members, if implemented, the system is to function as a guidance and advisory to the applicants.

CHAPTER V

PROTOTYPE OF THE PROPOSED SYSTEM

5.1 Introduction

The prototype was developed based on the knowledge acquired from the APC members. The prototype was also designed to maintain consistency in the decision-making processes and reduce the problems facing the existing manual system.

5.2 System Overview

The prototype contains knowledge on the following components:

- Requirement of departments
- Applicants Record
- Rules for matching
- Departments capacity
- Subject requirements

There are two types of data or facts needed to the database. These are: Applicant database and department database.

Data needed from applicants are:

- Stream of the student
- Grade on national examination
- Preference of the department
- Biography of the data
- Subject taken and their mark result

Data from departments

- Minimum GPA requirement on national examination
- Specialization needed

- Specific subject required
- Special grade required in specific subject
- Available place

Heuristic rules to apply are:

- Applicant rule
- Department rule
- Heuristic rule to match applicant rule and department rule

High expertise is needed when there are more applicants who have equal results in GPA and fewer places:

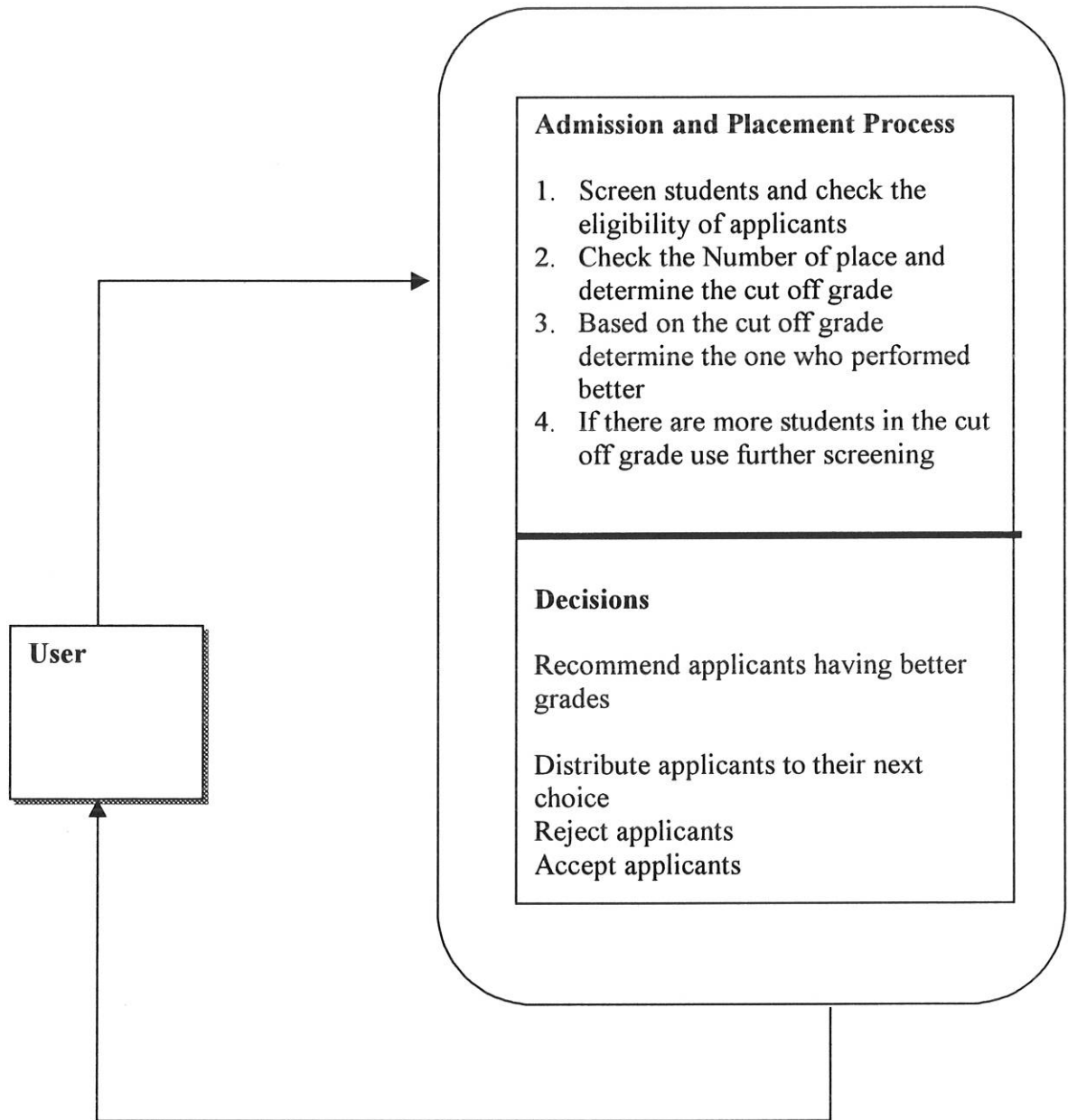
- Additional Screening
- Weighting scheme
- Detailed subject requirement

The prototype system is expected to operate by

- Taking into account the requirements that define rules for matching the applicant with his choice of department
- Interacting with the user through a user interface
- Storing subject requirements of the department
- Relating applicants interest and ability to his choice department
- Screening best applicants for each department

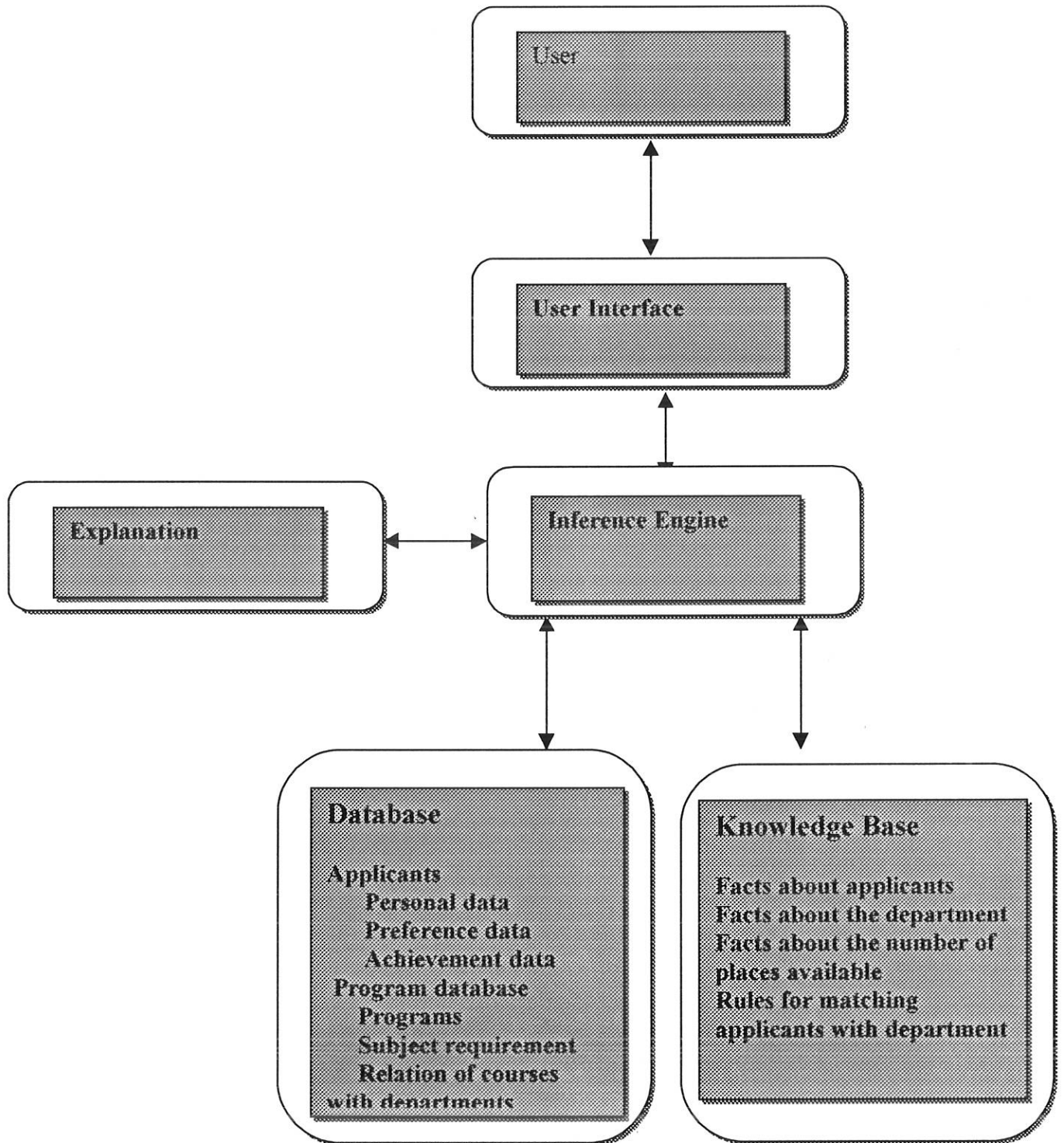
The general overview of the proposed system and the component of the proposed expert system are elaborated in Figure 5.1 and Figure 5.2 respectively. Figure 5.1 shows major processes and decisions involved in the proposed system.

Figure 5.1 The General Overview of the Proposed System



Having the above general overview of the proposed system the components of the system is shown in Figure 5.2. This figure shows the structure of the prototype system and its various components and lists the various databases and knowledge base required in the course of decision making.

Figure. 5.2 Structure of the Proposed Admission and Placement Expert System



As indicated in the above figure, the user interacts with the system through the user interface. The user interface provides a user with a series of dialog boxes to input facts, access the various decisions reached by the system and the explanations.

The inference engine performs the reasoning procedure to reach the required decision on the basis of the rules and facts contained in the knowledge base. The database contains general facts about applicants and department requirements.

5.3 Database Structures

Data needed for the knowledge base are stored in the database. The database component is made up of the following tables created using dBASE IV. The structure of the various entities or objects are:

Departments

Dept-Cod	Department Name
----------	-----------------

Minimum requirement

Dept_Cod	GPA	Sub_req	Work expx	Other_Req{Y/N}
----------	-----	---------	-----------	----------------

Department and related subjects

Dept_Cod	Ess_sub	Des_sub	Rel_sub
----------	---------	---------	---------

Applicant database

STUDID	Student Name	Birth place	Age	Grade	Sex
--------	--------------	-------------	-----	-------	-----

Qualification

STUDID	Subject taken	Year examination taken	Result
--------	---------------	------------------------	--------

Choice

STUDID	Choice	Department	Accept
--------	--------	------------	--------

The knowledge base of the system is described in the following section.

5.4 Knowledge Base

The knowledge base component of the system is organized into two parts. The first component is to determine eligibility of applicants to the specific department and the second one is for screening best applicants based on their special skills and other requirements of the department. Rules have been formulated in different sections of this chapter for the purpose of the prototype to demonstrate the proposed solution.

5.4.1 Knowledge Base for Screening Eligibility

In this section, details to determine the eligibility of the applicants are included. For example, the system interacts with the user to select the department to be screened. The departments are listed in the screen and the user selects among the options.

In order to check the eligibility of a student to a specific department the system checks

- Minimum requirements of the department
- Special requirement needed
- Special treatment

This can be accessed from the database as it is already entered for the demonstration of the prototype. The system uses these facts and other facts to determine the eligibility of an applicant. The necessary facts for the rules to determine on the eligibility are: ESLCE results in five subjects, of which English and Mathematics are compulsory, and the best scores on the

other three subjects; stream of an applicant, etc. Depending on the program additional criteria are also used.

Using backward chaining, the system searches for the value of each of the attributes used by each department. Therefore, to be eligible the applicant should fulfil the minimum criteria and for some departments background of the applicants should be relevant to the department qualification.

To decide on the minimum requirements, the system checks grade results in the ESLCE and other requirements. The minimum requirements of each department and decisions are shown in Appendix II. From this table one can formulate rules.

Following are sample rules that are grouped according to the requirement needed to screen eligible applicants. More rules are attached in Appendix III.

Programs that require GPA only

If Department is Accounting
and Grade ≥ 3.00
Min_Req is Yes.

If Department is Accounting
and program is diploma
and Grade ≥ 2.8
then Min_Req is Yes.

If Department is Accounting
and Grade < 2.8
then Min_Req is No.

Programs that demand experience in addition to GPA

If Department is Educational Administration
And program is Degree
and Grade \geq 2.20
and experience \geq '2 years'
and experience is 'Ministry of Education'
then Min_Req is Yes.

If Department is Educational Administration
And program is Degree
and Grade \geq 2.20
and experience \geq 4 years
and experience is teaching
then Min_Req is Yes

If Department is Educational Administration
And program is Degree
and Grade \geq 2.20
and experience $<$ 4 years
and experience \geq 2 years
and experience is Administration
then Min_Req is Yes

Programs that demand Subject_requirement and scores on those subjects

If Department is Library Science
and program is degree
and Grade \geq 2.40
and Subject_Req is Mathematics
and Score_Req is 'C and above'
then Min_Req is yes.

Programs that requests recommendation letter, Subject requirement and score on those subjects

If department is Computer Science
And Experience is yes
And Grade is yes
and graduate is yes
and Subject_Req is yes
and Score_Req is yes
then Min_Req is yes.

If department is Computer Science

and Experience \geq '2 years'
and Recommendation_letter is yes
and graduate is no
and Grade \geq 2.6
and Subject_Req is yes

and Score_Req is yes
then Min_Req is yes.

If an applicant satisfies the conditions in any of the above rules, he/she will be eligible.

Otherwise he/ she will be rejected. Eligible applicants are considered for further screening if the number of available places is less than the number of eligible applicants.

5.4.2 Knowledge Base for Selecting Best Applicants

Once the applicants are screened for eligibility the next process is to check whether there are enough places in the departments. As it is described in the analysis part, there are no departments that accept applicants on the basis of minimum requirements only. Selecting the best applicants is a complex task.

If there are a number of applicants who fall in the cut off grade e.g. for 100 places in a department the 100th score is 3.6. And there are 100 applicants who score this grade. Applicants that scored above this grade are accepted without further screening and applicants below this grade are also directly rejected. Only those applicants who scored the cut off grade are screened in the further screening method.

The rule structures for selecting applicants in the further screening system

If department is Accounting

and Min_Req is yes

and subject_requirement is Mathematics

and Score_requirement is A

then. further_screening is yes

If department is Accounting

and Min_Req is yes

and subject_requirement is mathematics

and Score_requirement is not 'A'

and subject requirement is Bookkeeping

and Score_requirement is A

then further_screening is yes.

If department is Accounting

and Min_Req is yes

and subject_requirement is mathematics

and Score_requirement is not 'A'

and subject requirement is Bookkeeping

and Score_requirement is not 'A'

then further_screening is No

If department is Accounting

and Min_Req is yes

and subject_requirement is mathematics

and Score_requirement is ' less that A'

and subject requirement is ' not Bookkeeping'

then further_screening is No.

If the eligible applicant (for example for an accounting department) fulfils one of the above rules, then he will be accepted, rejected otherwise.

5.5 KnowledgePro Shell as Development Tools

The prototype was developed using KnowledgePro for Windows (KPWin) Version 2.50. KPWin is a development environment, which allows building complex windows applications.

The environment is made up of (Bev and Bill, 1991):

- ◆ A rich object-oriented programming (OOP)
- ◆ List processing language debugging tools
- ◆ A multi-document editor and
- ◆ User interface options.

KnowledgePro has a built-in backward chaining feature that enables to build a rule-based system. The forward chaining capability can also be added by coding the programs. KPWin also has expert system features such as WHY, HOW and confidence factors that are the general features of many of the expert systems. This can be incorporated in the system by adding codes in the explanation list module, when the rules are fired. Adding confidence numbers calculations includes confidence factors.

KnowledgePro's main advantage for developing expert system is that it has a power of using rule-based approach with a procedural programming language. The strength of the language lies in its flexibility and the power of its combined OOP and list processing capabilities. These features make KnowledgePro a flexible, programmable expert system.

It has a multi-document and easy to use editor which allows to work on multiple source files. This environment is menu based with a file handling editing features (cut, paste, etc) and searching capabilities. It has also debugging tools with a tracing facility to examine each step of the execution and structure of the application and calls to display the topic calls in the application.

KnowledgePro lists processing functions such as topics defined in an application, built-in functions, and access to window application provides easy building of programs interface. The topic is a very flexible and powerful new paradigm upon which the whole KnowledgePro language is based. Topics can be commands, lists, rules and hypertext nodes, objects or functions. It has true object-oriented features like the ability to inherit properties from other topics.

KnowledgePro includes design tools, which can be used for screen design very easily. This design tools can generate code to be used in the KPWin environment with or without modification. Or it can be compiled into executable file and can be accessed via the external access feature of the tool. This feature was useful in designing of the user interface of the prototype easily.

KnowledgePro has several features for the user and the system to communicate. These object oriented features enabled to reuse the interface objects such as windows, menus, buttons, and checklists, list boxes, radio buttons and edit windows; and graphic objects, such as bitmaps, icons, and cursor palettes. Hypertext and hyper-regions are also provided for manipulation of texts. In the prototype, the interface objects such as windows, buttons, list boxes, edit

windows and icons were used in the design of the user interface. These objects were used to collect data from the user and display the results and explanations.

KPWin programs can be translated into C++ code and compiled to create an executable file, runtime version, which can be used in any platform without KPWin

Although KPWin is the only available shell at the School of Information Studies for Africa (SISA), it was found to be appropriate for developing the prototype because of its capabilities mentioned above.

5.6 Operating Procedures of Admission and Placement Expert System

The system performs in three stages. The first stage is screening for eligibility as shown in Figure 5.3 (a). This figure shows the flow chart for checking eligibility. The second process is selecting 'best fit applicants' and is shown in Figure 5.3 (b) and the last one is distributing applicants rejected to their next choice, depicted in Figure 5.3 (C). These processes are performed until the place is filled or the choices are exhausted.

Figure 5.3 (a) Flow Chart for Checking Eligibility

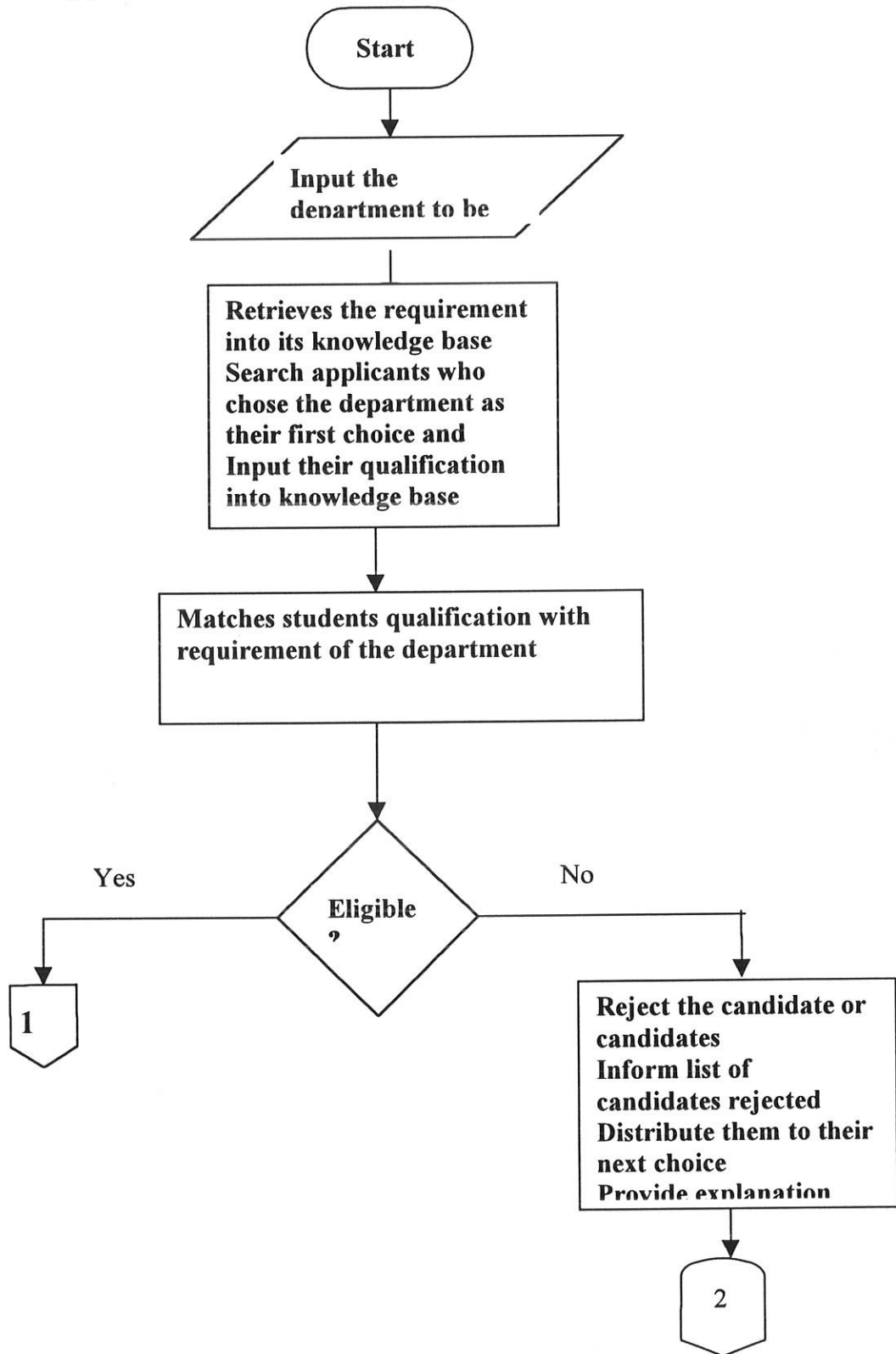
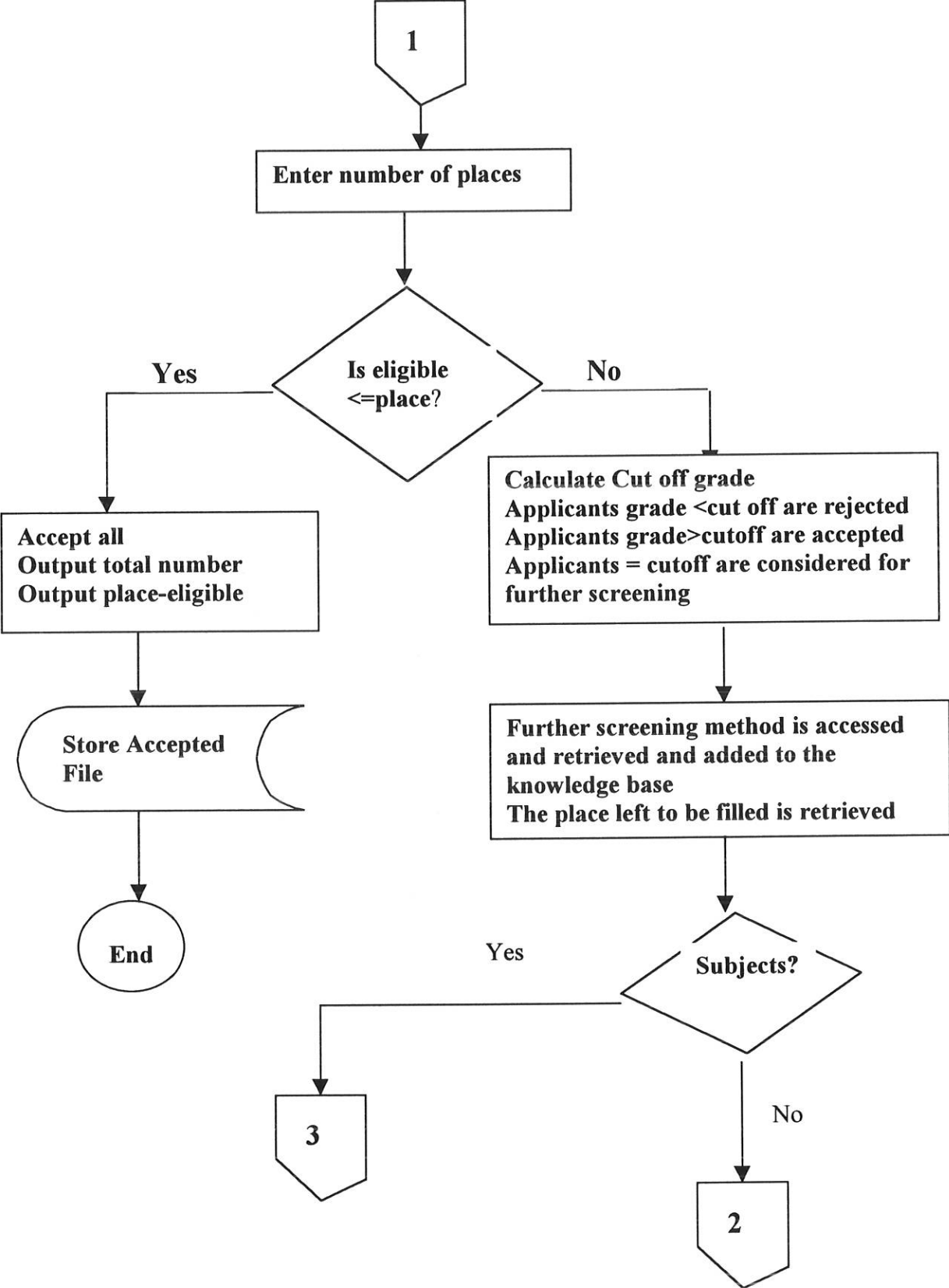


Figure 5.3 (b) Selecting Best Applicants



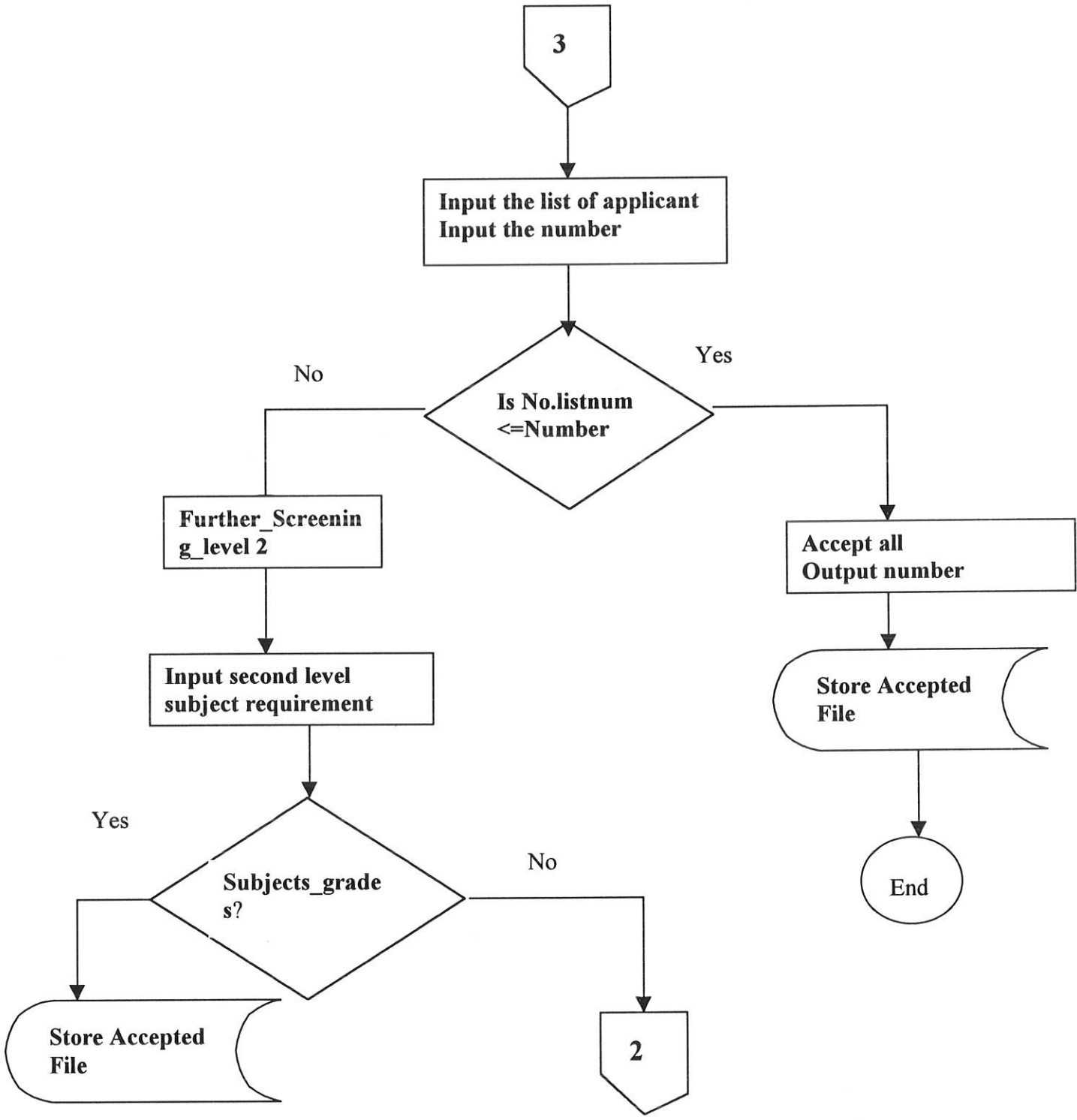
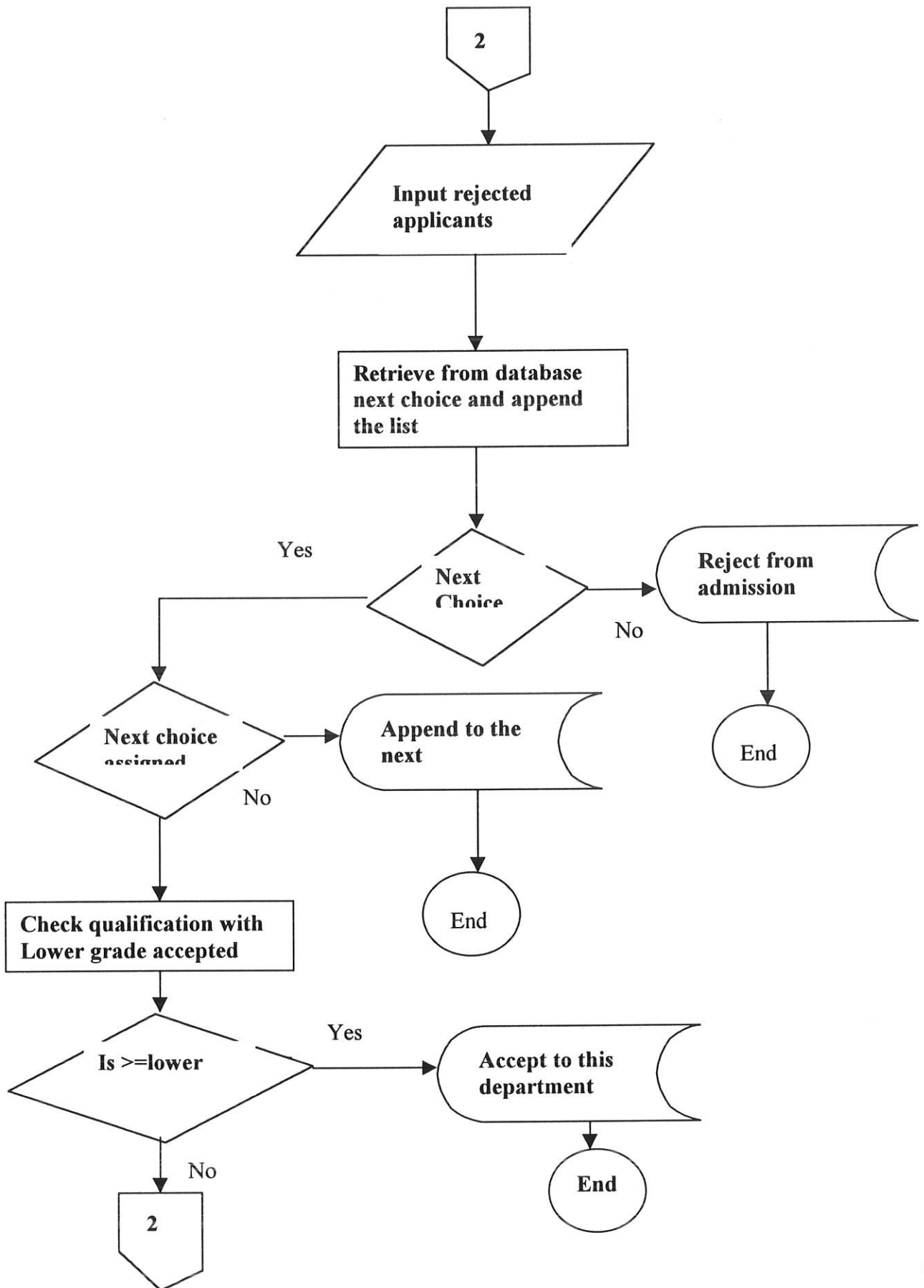


Figure 5.3 (c) Distributing Applicants into their Next Choice



5.7 Demonstration of the Prototype

To start the prototype, one has to click the Start Menu of Windows 95 and select the option, AAUAdmission, in the Programs menu. The welcome screen appears (Figure 5.4), pressing the Continue button displays the Main Menu screen (Figure 5.5). The main menu consists of three choices: Data Entry for Applicants, Advisory System for Applicants, and Admission and Placement. If the user selects the Admission and Placement option, the screen that contains the list of departments is displayed (Figure 5.6).

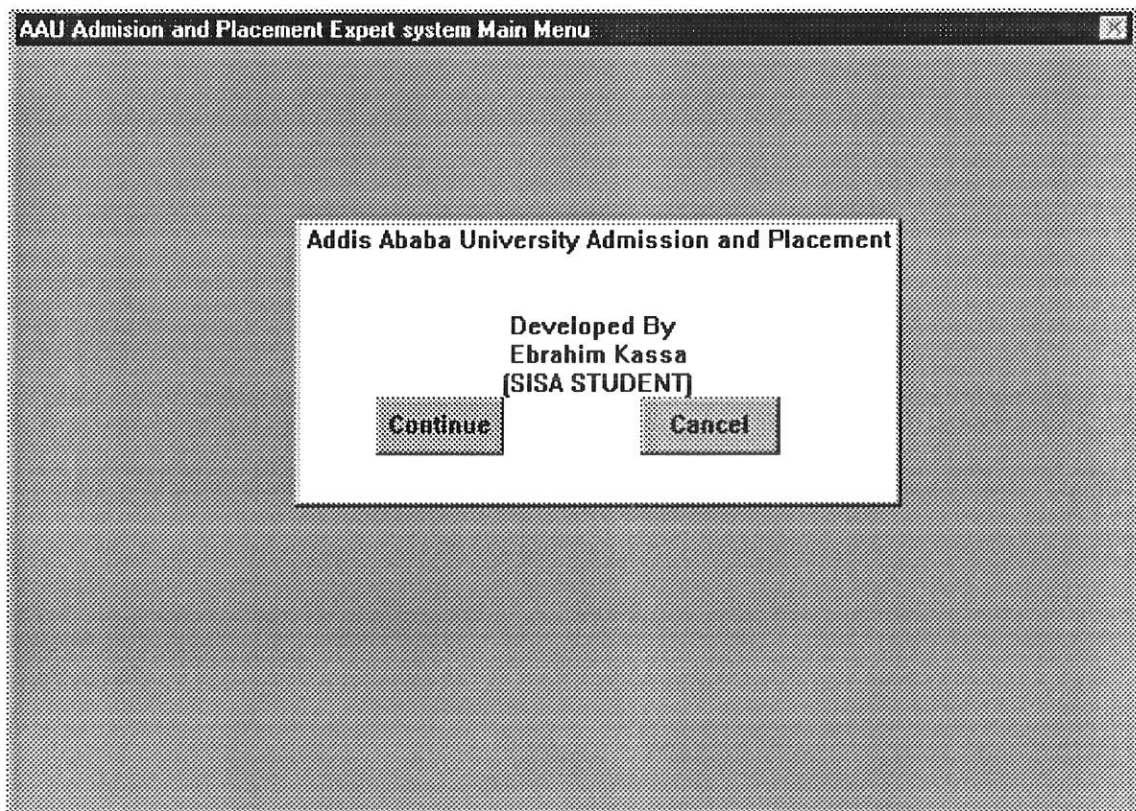


Figure 5.4 Welcome Screen of AAUAdmission

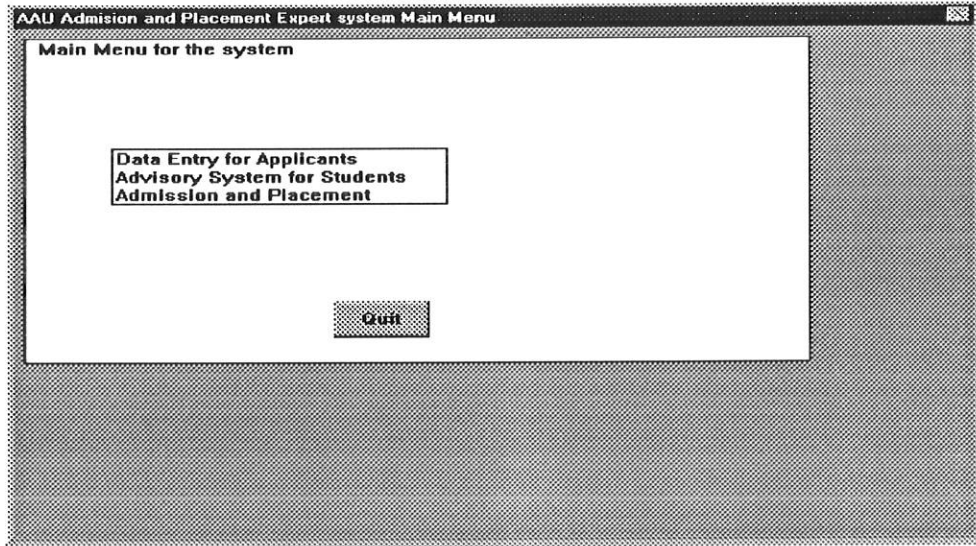


Figure 5.5 Main Menu Screen

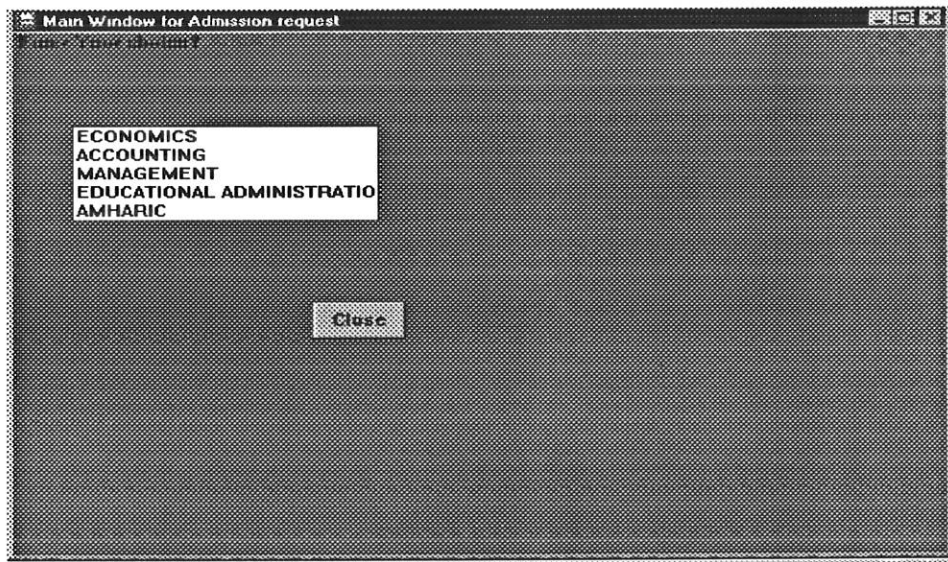


Figure 5.6 Department List Screen

From the above screen, the user can select any of the departments to start screening. If the user selects Accounting, the following screen (Figure 5.7) appears.

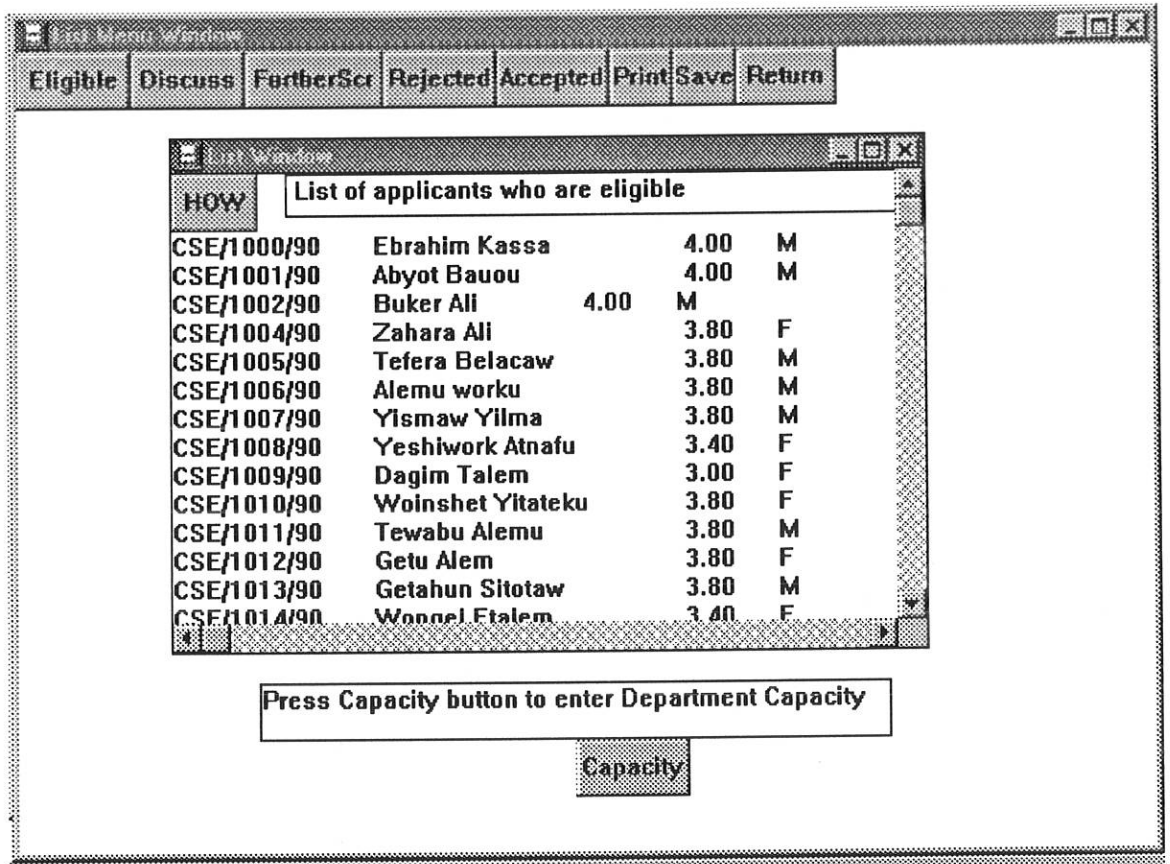


Figure 5.7 Eligible Applicants

The above window displays eligible applicants. Then the user can select the Capacity button to enter the available places of the selected department, or select other options, for example, the Return button. After the user enters the capacity of the selected department, pressing each of the buttons at the top of the screen allows the user retrieve list of applicants in the respective category (Figures 5.7 to 5.11). These options include:

- Eligible (Figure 5.7).

Lists all applicants who fulfil eligibility requirements.

- Discuss (Figure 5.8)

Applicants with the cut off point are listed. They are considered for further screening. For this example, the cut off point calculated was 3.6.

- FurtherScr (Figure 5.9)

List of applicants who meet further screening requirements of the department.

- Accepted (Figure 5.10)

List of applicants recommended for admission.

- Rejected (Figure 5.11)

Applicants, who are rejected either by eligibility process or further screening process, are listed.

In each screen, the user can access the explanations as to how the system reaches the decision by selecting the HOW button (Figure 5.12). This shows explanations given about applicants selected by further screening.

The committee members feel that accessing information in the different categories and explanations about the decisions (Figures 5. 7– 5.12) will help in speeding up the process of admission and placement. The system simplifies the routine task performed by the committee, and gives explanation at each stage, the committee could easily be familiarized and the training cost can also be minimized. Furthermore, clerks can perform the system and lists of applicants in the different categories can be provided to the committee to review the result. This undoubtedly would relieve the committee from the routine task.

HOW	List of applicants who are in Discusss Category		
CSE/1016/90	Almaz Meku	3.60	M
CSE/1017/90	Alemu Shiferaw	3.60	M
CSE/1018/90	Atnaf Yehunie	3.60	M
CSE/1019/90	Fasika Mengistu	3.60	F
CSE/1020/90	Alebacaw Teklu	3.60	M
CSE/1021/90	Yehun Alem Endesha	3.60	M

Figure 5.8 Applicants in the Discuss List

List of applicants selected in further screening			
CSE/1016/90	Alnaz Meku	3.60	M
CSE/1017/90	Alemu Shiferaw	3.60	M
CSE/1018/90	Atnaf Yehunie	3.60	M
CSE/1020/90	Alebacaw Teklu	3.60	M

Figure 5.9 Applicants Selected by Further Screening

List Menu Window			
List of applicants recommended for Admission			
HOW			
CSE/1000/90	Ebrahim Kassa	4.00	M
CSE/1001/90	Abyot Bauou	4.00	M
CSE/1002/90	Buker Ali	4.00	M
CSE/1004/90	Zahara Ali	3.80	F
CSE/1005/90	Tefera Belacaw	3.80	M
CSE/1006/90	Alemu worku	3.80	M
CSE/1007/90	Yismaw Yilma	3.80	M
CSE/1010/90	Woinshet Yitateku	3.80	F
CSE/1011/90	Tewabu Alemu	3.80	M
CSE/1012/90	Getu Alem	3.80	F
CSE/1013/90	Getahun Sitotaw	3.80	M
CSE/1016/90	Almaz Meku	3.60	M
CSE/1017/90	Alemu Shiferaw	3.60	M
CSE/1018/90	Atnaf Yehunie	3.60	M
CSE/1020/90	Alebacaw Teklu	3.60	M

Figure 5.10 Applicants Recommended for Admission

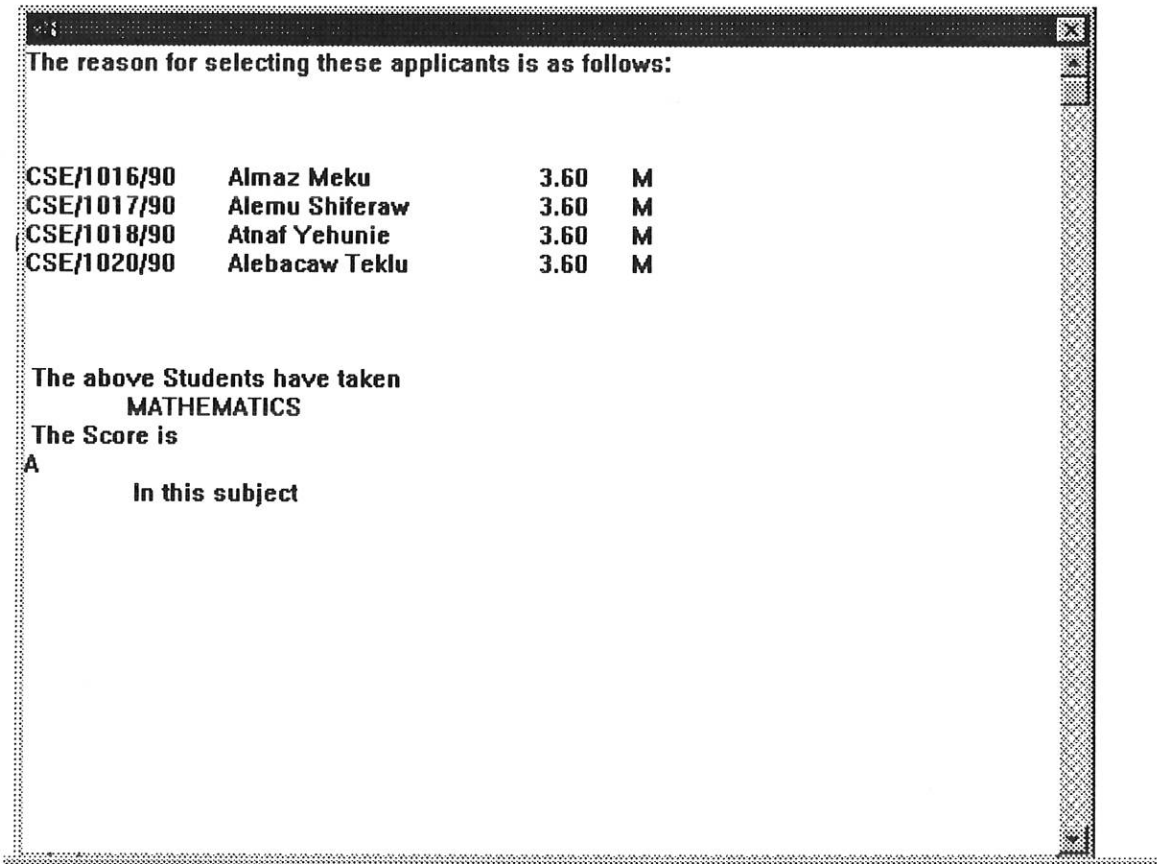


Figure 5.12 The How Window

The image shows a screenshot of a software window titled "List Menu Window". Inside the window, there is a tab labeled "List of applicants rejected". Below the tab, a table lists five rejected applicants with their IDs, names, scores, and genders.

HOW	List of applicants rejected		
CSE/1019/90	Fasika Mengistu	3.60	F
CSE/1021/90	Yehun Alem Endesha	3.60	M
CSE/1008/90	Yeshiwork Atnafu	3.40	F
CSE/1009/90	Dagim Talem	3.00	F
CSE/1014/90	Wongel Etalem	3.40	F
CSE/1015/90	Abebe kebede	3.40	M

Figure 5.11 List of Applicants Rejected

Table 5.1 Applicants Choice Data

Student Id	Choice	Program
CSE/1000/90	FIRST	ACCOUNTING
CSE/1000/90	SECOND	ECONOMICS
CSE/1000/90	THIRD	MANAGEMENT
CSE/1000/90	FOURTH	AMHARIC
CSE/1001/90	FIRST	ACCOUNTING
CSE/1001/90	SECOND	MANAGEMENT
CSE/1001/90	THIRD	ECONOMICS
CSE/1002/90	SECOND	ECONOMICS
CSE/1002/90	FIRST	ACCOUNTING
CSE/1003/90	SECOND	ECONOMICS
CSE/1003/90	THIRD	MANAGEMENT
CSE/1004/90	FIRST	ACCOUNTING
CSE/1004/90	SECOND	MANAGEMENT
CSE/1005/90	FIRST	ACCOUNTING
CSE/1006/90	FIRST	ACCOUNTING
CSE/1006/90	SECOND	MANAGEMENT
CSE/1006/90	THIRD	ECONOMICS
CSE/1006/90	FOURTH	AMHARIC
CSE/1007/90	FIRST	ACCOUNTING
CSE/1007/90	SECOND	ENGLISH
CSE/1007/90	THIRD	HISTORY
CSE/1008/90	FOURTH	GEOGRAPHY
CSE/1008/90	FIRST	ACCOUNTING
CSE/1008/90	SECOND	MANAGEMENT
CSE/1008/90	THIRD	ECONOMICS
CSE/1009/90	FIRST	ACCOUNTING
CSE/1009/90	SECOND	ECONOMICS
CSE/1009/90	THIRD	MANAGEMENT
CSE/1010/90	FIRST	ACCOUNTING
CSE/1010/90	SECOND	ECONOMICS
CSE/1010/90	THIRD	MANAGEMENT
CSE/1011/90	FIRST	ACCOUNTING
CSE/1011/90	SECOND	MANAGEMENT
CSE/1012/90	FIRST	ACCOUNTING
CSE/1012/90	SECOND	ECONOMICS
CSE/1013/90	FIRST	ACCOUNTING
CSE/1013/90	SECOND	MANAGEMENT
CSE/1014/90	FIRST	ACCOUNTING
CSE/1014/90	SECOND	ECONOMICS
CSE/1015/90	FIRST	ACCOUNTING
CSE/1015/90	SECOND	MANAGEMENT
CSE/1016/90	FIRST	ACCOUNTING
CSE/1016/90	SECOND	MANAGEMENT
CSE/1017/90	FIRST	ACCOUNTING

CSE/1017/90	SECOND	ECONOMICS
CSE/1018/90	FIRST	ACCOUNTING
CSE/1018/90	SECOND	ECONOMICS
CSE/1019/90	FIRST	ACCOUNTING
CSE/1019/90	SECOND	HISTORY
CSE/1020/90	FIRST	ACCOUNTING
CSE/1020/90	SECOND	GEOGRAPHY
CSE/1021/90	FIRST	ACCOUNTING
CSE/1021/90	SECOND	ECONOMICS
CSE/1022/90	FIRST	ECONOMICS
CSE/1003/90	FIRST	ACCOUNTING
CSE/1023/90	FIRST	AMHARIC

Table 5.2 Eligible Applicants

Student Id	Name	GPA	Sex
CSE/1000/90	Ebrahim Kassa	4.00	M
CSE/1001/90	Abyot Bauou	4.00	M
CSE/1002/90	Buker Ali	4.00	M
CSE/1004/90	Zahara Ali	3.80	F
CSE/1005/90	Tefera Belacaw	3.80	M
CSE/1006/90	Alemu worku	3.80	M
CSE/1007/90	Yismaw Yilma	3.80	M
CSE/1008/90	Yeshiwork Atnafu	3.80	F
CSE/1009/90	Dagim Talem	3.00	F
CSE/1010/90	Woinshet Yitateku	3.80	F
CSE/1011/90	Tewabu Alemu	3.80	M
CSE/1012/90	Getu Alem	3.80	F
CSE/1013/90	Getahun Sitotaw	3.80	M
CSE/1014/90	Wongel Etalem	3.40	F
CSE/1015/90	Abebe kebede	3.40	M
CSE/1016/90	Almaz Meku	3.60	M
CSE/1017/90	Alemu Shiferaw	3.60	M
CSE/1018/90	Atnaf Yehunie	3.60	M
CSE/1019/90	Fasika Mengistu	3.60	F
CSE/1020/90	Alebacaw Teklu	3.60	M
CSE/1021/90	Yehun Alem Endesha	3.60	M

Table 5.3 Applicants Screened with GPA Only

Student Id	Name	GPA	Sex
CSE/1000/90	Ebrahim Kassa	4.00	M
CSE/1001/90	Abyot Bauou	4.00	M
CSE/1002/90	Buker Ali	4.00	M
CSE/1004/90	ZaharaAli	3.80	F
CSE/1005/90	Tefera Belacaw	3.80	M
CSE/1006/90	Alemu Worku	3.80	M
CSE/1007/90	Yismaw Yilma	3.80	M
CSE/1010/90	Woinshet Yitateku	3.80	F
CSE/1011/90	Tewabu Alemu	3.80	M
CSE/1012/90	Getu Alem	3.80	F
CSE/1013/90	Getahun Sitotaw	3.80	M

Table 5.4 Applicants for Further Screening

Student Id	Name	GPA	Sex
CSE/1016/90	Almaz Meku	3.60	M
CSE/1017/90	Alemu Shiferaw	3.60	M
CSE/1018/90	Atnaf Yehunie	3.60	M
CSE/1019/90	Fasika Mengistu	3.60	F
CSE/1020/90	Alebacaw Teklu	3.60	M
CSE/1021/90	Yehun Alem	3.60	M

Table 5.5 Applicants and Subject Taken (Applicants in the discuss category)

Student Id	Subject	Score
CSE/1016/90	AMHARIC	A
CSE/1016/90	ENGLISH	A
CSE/1016/90	MATHEMATICS	A
CSE/1016/90	GEOGRAPHY	B
CSE/1016/90	HISTORY	B
CSE/1017/90	ECONOMICS	A
CSE/1017/90	ENGLISH	A
CSE/1017/90	MATHEMATICS	A
CSE/1017/90	BOOKKEEPING	B
CSE/1017/90	GEOGRAPHY	B
CSE/1018/90	AMHARIC	B
CSE/1018/90	ENGLISH	B
CSE/1018/90	MATHEMATICS	A
CSE/1018/90	PHYSICS	A
CSE/1018/90	CHEMISTRY	A
CSE/1019/90	AMHARIC	A
CSE/1019/90	ENGLISH	A
CSE/1019/90	MATHEMATICS	B
CSE/1019/90	PHYSICS	A
CSE/1019/90	CHEMISTRY	B
CSE/1020/90	AMHARIC	A
CSE/1020/90	ENGLISH	A
CSE/1020/90	MATHEMATICS	A
CSE/1020/90	GENERAL-SCIENCE	A
CSE/1020/90	PHYSICS	C
CSE/1021/90	AMHARIC	A
CSE/1021/90	ENGLISH	B
CSE/1021/90	MATHEMATI	B
CSE/1021/90	BIOLOGY	A
CSE/1021/90	CHEMISTRY	A

Table 5.6 Applicants Screened by Further Screening Method

Student ID	Name	GPA	Sex
CSE/1016/90	Almaz Meku	3.60	M
CSE/1017/90	Alemu Shiferaw	3.60	M
CSE/1018/90	Atnaf Yehunie	3.60	M
CSE/1020/90	Alebacaw Teklu	3.60	M

Table 5.7 Applicants Rejected and the Reason for Rejection

Student Id	Name	GPA	Sex	Screening Method / reason
CSE/1008/90	Yeshiwork Atnafu	3.40	F	GPA Only
CSE/1009/90	Dagim Talem	3.00	F	GPA Only
CSE/1014/90	Wongel Etalem	3.40	F	GPA Only
CSE/1015/90	Abebe kebede	3.40	M	GPA Only
CSE/1021/90	Yehun Alem	3.60	M	Further Screening
CSE/1019/90	Fasika Mengistu	3.60	F	Further Screening

Table 5.8 List of Applicants Recommended for Admission

Student Id	Name	GPA	Sex	Screening Methods
CSE/1000/90	Ebrahim Kassa	4.00	M	GPA Only
CSE/1001/90	Abyot Bauou	4.00	M	GPA Only
CSE/1002/90	Buker Ali	4.00	M	GPA Only
CSE/1004/90	Zahara Ali	3.80	F	GPA Only
CSE/1005/90	Tefera Belacaw	3.80	M	GPA Only
CSE/1006/90	Alemu worku	3.80	M	GPA Only
CSE/1007/90	Yismaw Yilma	3.80	M	GPA Only
CSE/1010/90	Woinshet Yitateku	3.80	F	GPA Only
CSE/1011/90	Tewabu Alemu	3.80	M	GPA Only
CSE/1012/90	Getu Alem	3.80	F	GPA Only
CSE/1013/90	Getahun Sitotaw	3.80	M	GPA Only
CSE/1016/90	Almaz Meku	3.60	M	Further Screening
CSE/1017/90	Alemu Shiferaw	3.60	M	Further Screening
CSE/1018/90	Atnaf Yehunie	3.60	M	Further Screening
CSE/1020/90	Alebacaw Teklu	3.60	M	Further Screening

CHAPTER VI

CONCLUSIONS AND RECOMMENDATIONS

Every year the AAU admits students to its various programs. Screening for admission needs evaluations of every document of applicants; checking them for their appropriateness, and comparing them with the points of the requirements for entrance and the need and capacity of departments. These activities are usually performed manually by few experts who are overburdened by regular tasks.

These days information technology provides solutions to almost every activity in every sector by way of providing systematic methods to accomplish tasks. The use of computers and the development of special application software reached almost all areas with solutions of its own. Computers and special application software help to overcome problems that arise from information handling thereby enabling to economize money, time and labor.

Due to the unstructured nature of the task, to use the conventional method for admission and placement was not found beneficial. It has been seen from the study that expert system can tackle much of the problems that encounter admission and placement. Hence, in the course of this study an attempt was made to develop a prototype system for admission and placement of Addis Ababa University with the semi-custom development options using the KnowledgePro development software.

In this manuscript, the development of the proposed system, examination of the existing system admission and placement, as well as the expert system technology and its tools and methods were discussed.

In this experiment knowledge that is suited to the entire problem domain is collected from various sources. The major sources were the committee members, printed materials, rules and regulations and previous experiences. Decision criteria and model were developed to organize knowledge as rules or facts.

Interviews and protocol analysis were employed in the knowledge acquisition process and the knowledge was presented in production rules. Rules as knowledge representation mechanism are found appropriate in the case of this study.

By examining the activities and problems of the Office of the University Registrar, this study has demonstrated the importance of expert systems as used for admission and placement activities. The proposed system is designed to accept list of applicants, compare the requirements of departments with the qualities of applicants, generates appropriate list of applicants, which are accepted by each department, and explains how the system reaches to the decision.

The prototype was capable of matching applicants qualification with the requirement of departments and able to select best students when there are more applicants than available places. Further screening requirements such as subjects essential, relevant and related to the programs were documented in consultation with the members of the Academic Commission in the relevant faculties.

The system provides the committee members with lists of applicants in various categories (eligible, admitted, rejected, etc.) and explanations as to how it reaches these results. The committee then could review the summarized information and use it for admission and

placement decisions. In addition, by using the reasoning power of the system, new committee members can easily be familiarized by testing different cases. This can save the time spent for training. Besides it relieves them from routine work and enhances decision-making.

Finally, as this is an academic exercise the system was developed to show the importance of expert system, and the Registrar office could review the knowledge and add more knowledge to the rules and utilize them. Having said this, further work in the area is suggested.

As it was shown in the analysis section, placement requires guidance and consultation. The orientation programs provided for students were found to be inadequate. Further research in the area of student advice is suggested and the placement can use this as an input to the process.

Admission and placement vary from year to year and level of screening procedures varies from year to year. So, to establish consistent procedures with rules may not always fit to provide solutions in all cases. So, certainty factors could be incorporated to the rules and this could make it possible to identify applicants any time. Further research in identification of rules and major decisions is also recommended

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REFERENCE

1. **Addis Ababa University. Office of the Registrar.** 1984. Undergraduate Catalogue, 1984 issue. Addis Ababa: Addis Ababa University
2. Ardis, Susan. 1988. *Expert System*. P.125-129 (photocopy article).
3. **Barta, Ben-Zion, et al (ed.)** 1995. *Information Technology in Educational Management*. London: Chapman & Hall.
4. **Belay Tefera and others.** 1991. An Assessment of Admission Policies and Procedures in Institute of Higher Learning in Ethiopia, a Research Report. Addis Ababa: Institute of Educational research.
5. **Benders, Jos and Manders, Frank.** 1993. *Expert Systems and Organizational Decision-Making*. Information Management 25: 207-213.
6. **Bev and Bill Thompson.** 1991. KnowledgePro Windows Database Toolkit USA: Knowledge Garden, Inc. 1991
7. **Bev and Bill Thompson.** 1991. KnowledgePro Windows: User manual. USA: Knowledge Garden, Inc.
8. **Bev and Bill Thompson.** 1991. KnowledgePro Windows: Reference Manual. USA: Knowledge Garden, Inc.
9. **Caldwell, Eveline M.** 1988. *The Use of an Expert System in Human Resource Management* in "Modern Trends in Information Technology" P.V.S. Rao and P. Sandanandov. p. 85-92.
10. **Canter, J. D.** 1984. *Expert Systems*. Office Systems Research Journal. 3 (11):37.
11. **Dejene Shewaye.** 1996. *Factors that Discourage Students to Major in Basic Natural Science: The Case of Kotebe College of Teacher Education*. Ethiopian Journal of Education. 16(2): 25-53.

12. **Fisseha Haile.** 1991. Recruitment and Placement to Higher Education: A Comparative Study. Prepared for the Seminar on ESLCE. Unpublished.
13. **Friel, Patricia and et al.** 1989. *Coolsys: A Cooling Systems Design Assistant in “Innovative Applications of Artificial Intelligence”* Schorr, Alain. et al editors. P. 203-212.
14. **Frey, James.** 1988. Iraq: A Study of the Educational System of Iraq and a Guide to the Academic Placement of Students in Educational Institutions of the United States. Washington: American Association of Collegiate Registrars and Admission Officers.
15. **Gibb, Forbes.** 1986. *Expert Systems in Libraries. Proceedings of a Conference of Library and Information Research Group.* P. 78-98.
16. **Grogan Denis.** 1991. Practical Reference Work, 2nd edition. London: Library Association.
17. **Gupta, Amar, et al (ed.).** 1988. Micro Computer-Based Expert Systems. New York: The Institute of Electrical and Electronics Engineers, Inc.
18. **Hayes- Roth, Frederick.** 1988. *Knowledge Based Expert Systems* in “Micro Computers Based Expert Systems”, Amar Gupta and Bandredi E. Prasad, editors. P. 5-15.
19. **Hayes-Roth, Frederick, et al (ed.).** 1988. Building Expert Systems. London: Addison-Wisley.
20. **Holsapple, Clyde W. and Whinston, Andrew B.** 1996. Decision Support Systems: A Knowledge-Based Approach. Minneapolis: West Publishing Co.
21. **Huston, Michael A.** 1989. *Analyst: An Advisor for Financial Analysis of Automobile Dealerships*, in “Innovative Applications of Artificial Intelligence” Schorr, Alain et al, editors. P.26-42.

22. **Johnson, C.** 1990. Using an Expert System to Screen Applicants for Master of Public Administration Program at the University of Victoria. Master of Public Administration Thesis, University of Victoria.
23. **Kalay, Poria and Chen, David.** 1995. "*Sheshet*"- *Decision Support System for Guidance and Placement of Enrolling High School Students*, in "Information Technology in the Higher Education" Ben-Zion et al. editors. p. 147-152.
24. **Margaret O'Neill .** 1989. *Expert Systems*. Aslib Proceeding. 4 (4): 163-168.
25. **Martin , J and Oxman, S.** 1988. Building Expert Systems. Englewood, New Jersey: Prenti-Hall.
26. **McLeland, Arvil.** 1995. *The Queens Land Tertiary Admissions Center: An Example of a Cooperative System Using State of the Art Technologies*, in "Information Technology in Education Management" Ben-Zion et al. editors. p. 134-138.
27. **Ministry of Education. Educational Management Information System.** 1995. Education Statistics, Annual Abstract, 1986 e.c. (1993/1994). Addis Ababa: Ministry of Education
28. **Muray, T. Jerome and Murray, Marilyn.** 1988. Expert Systems in Data Processing. New York: McGraw-Hill.
29. **Nelson Ford.** 1985. *Decision Support Systems and Expert Systems: a Comparison*. Information Management. v. 8: 21-26.
30. **O'Shea, Tim and Eisenstadt (ed.)** 1984. Artificial Intelligence: Tools, Techniques, and Applications. New York: Harper & Row, Publishers.
31. **Parsaye, Kamran and Chignel, Mark.** 1988. Expert Systems for Experts. New York: John Wiley & Sons.
32. **Rauch-Hindin, Wendy B.** 1988. A Guide to Commercial Artificial Intelligence: Fundamentals and Real-World Applications. Englewood-Cliffs, NJ: Prentice Hall.

33. **Richardsonson, John V.** 1995. *Knowledge-Based Systems for General Reference Work*. San Diego:Academic Press.
34. **Robert S. Englemore and Feignbaum, Edward.** 1995. *Expert Systems and Artificial Intelligence*. file: //B/General /knrep2. doc
35. **Schorr, Alain. et al (ed.).** 1989. *Innovative Applications of Artificial Intelligence*. MenloPark: AAAI Press.
36. **Temesgen Zewoter.** 1996. *A Comparative Statistical Study of Major Discipline Choice of Science Freshman Students*. Ethiopian Journal of Education. 16 (1): 38-49.
37. **Teshome G. Wagaw.** 1990. *The Development of Higher Education and Social Change: An Ethiopian Experience*. Michigan State University.
38. **Wilson, Harold O and Burford, Anna Marie.** 1990. *Artificial Intelligence and Expert Systems*. Journal of Education for Business. March (275-289).
39. **Yang, Heng-Li.** 1994. *Information/Knowledge Acquisition Methods for Decision Support Systems and Expert Systems*. Information Processing & Management. 31(1): 47-58.
40. **Yazdani, Masoud (ed.).** 1986. *Artificial Intelligence: Principles and Applications*. London: Chapman and Hall
41. **Yimer Nega.** *Admissions to Institutions of Higher Education in Ethiopia: Draft-Working Paper prepared for the Commission of Higher Education*.
42. **Zahedi, Fatemeh.** 1993. *Intelligent Systems for Business: Expert Systems with Neural Networks*. California: Wadsworth

Appendix I. Departments in the Extension Program of the AAU

Category			
Category A Social Science		Category B Science Faculty	
Degree Program	Diploma Program	Diploma Program	Degree Program
History			
Accounting	Accounting	Biology	Pre-Engineering
Amharic	Amharic	Building Engineering	
Management and Public Administration	Business Education	Computer science	
Business Education	Educational Administration	Mathematics	
English	English	Civil Engineering	
Library Science	Law	Electrical Engineering	
Geography	Library Science	Mechanical Engineering	
Economics	Supervisory Management	Chemistry	
Educational Administration	Technical teacher Education	Statistics	
Political science and International Administration			
Sociology and Social Administration			

Appendix II. Decision Table for Minimum Requirement

Department	Program	MGR	Experience	Type_of_experience	Other Req.	Letter of Rec.	Subject_Requirement	Decision
Accounting	Degree	≥ 3.00						Yes
Accounting	Diploma	> 2.80						Yes
Amharic	Degree	≥ 2.20						Yes
Amharic	Diploma	≥ 2.00						Yes
Amharic	Diploma	< 2.00	≥ 2 years	teaching	60% average in grade 12 and one year training			Yes
Biology	Diploma	≥ 2.00						Yes
Biology	Diploma	< 2.00	≥ 2 years	teaching		N		Yes
Building	Diploma	≥ 2.40						Yes
Building	Diploma	< 2.40				60% average		Yes
Building	Diploma	< 2.40				2.0 GPA		Yes
Business Education	Degree	≥ 2.60						Yes
Business Education	Degree	≥ 2.40	≥ 2 years			yes		Yes
Business Education	Degree	≥ 2.40	< 2 years					No
Business Education	Diploma	≥ 2.40						Yes
Chemistry	Diploma	≥ 2.20						Yes
Chemistry	Diploma	< 2.20	≥ 2 years	teaching		N		Yes
Civil Engineering	Diploma	≥ 2.40						Yes
Civil Engineering	Diploma	< 2.40				60% average		Yes
Civil Engineering	Diploma	< 2.40				2.0 GPA		Yes
Computer Science	Diploma	≥ 2.80	Yes			yes	Mathematics =C	Yes
Computer	Diploma	< 2.80			Graduate	yes	Score	Yes

Science							=C	
Economics	Degree	≥ 3.00						Yes
Educational Administration	Degree	≥ 2.20						Yes
Educational Administration	Degree	≥ 2.20	≥ 4 years	teaching				Yes
Educational Administration	Degree	≥ 2.20	≥ 2 years	administrator				Yes
Educational Administration	Diploma	≥ 2.00	≥ 2 years					Yes
Educational Administration	Diploma	< 2.00	≥ 2 years			TTI Graduate		Yes
Electrical Engineering	Diploma	≥ 2.40						Yes
Electrical Engineering	Diploma	< 2.40				60% average		Yes
Electrical Engineering	Diploma	< 2.40				2.0 GPA		Yes
English	Degree	≥ 2.60						Yes
English	Diploma	≥ 2.40						Yes
English	Diploma	< 2.40	≥ 2 years	teaching	60% average in grade 12 and one year training			Yes
Geography	Degree	≥ 2.20						Yes
History	Degree	≥ 2.20						Yes
Law	Diploma	≥ 2.80						Yes
Library Science	Degree	≥ 2.40					Mathematics	Yes
Library Science	Degree	≥ 2.40					Mathematics No	No
Library Science	Diploma	≥ 2.20						Yes
Management	Degree	≥ 3.00						Yes
Management (Supervisory)	Diploma	≥ 2.80						Yes
Mathematics	Diploma	≥ 2.00						Yes
Mathematics	Diploma	< 2.00	≥ 2 years	teaching		N		Yes
Mechanical Engineering	Diploma	≥ 2.40						Yes
Mechanical Engineering	Diploma	< 2.40				60% average		Yes

Mechanical Engineering	Diploma	<2.40				2.0 GPA		Yes
Pre Engineering	Diploma	>=2.60						Yes
PSIR	Degree	>=2.80						Yes
SOSA	Degree	>=2.80						Yes
Statistics	Diploma	>=2.60						Yes
Statistics	Diploma	<2.60			Graduate GPA>=2 .00			Yes

KEY

MGR : Minimum Grade Requirement

PSIR: Political Science and International relation

SOSA: Sociology and Social Administration

Appendix III. Rule Structure to Determine Eligibility of Applicants

If Department is Economics
and Grade ≥ 3.00
Min_Req is Yes.

If Department is Economics
and Grade < 3.00
then Min_Req is No.

If Department is Management
and Grade ≥ 3.00
then Min_Req is Yes.

If Department is Management
and Grade < 3.00
Min_Req is No.

If Department is 'Supervisory Management'
and Grade ≥ 2.80
Min_Req is Yes

If Department is PSIR
and Grade ≥ 2.80
Min_Req is Yes

If Department is SOSA
and Grade ≥ 2.80
Min_Req is Yes

If Department is Geography
and Grade ≥ 2.20
Min_Req is Yes.

If Department is History
and Grade ≥ 2.20
Min_Req is Yes.

If Department is Library Science
and program is diploma
and Grade ≥ 2.20
then Min_Req is yes.

If Department is English
and Grade ≥ 2.6
then Min_Req is yes.

If Department is English
and Grade ≤ 2.6
and program is degree
and Other_Req is yes
then Min_Req is Yes.

If Department is Amharic
and Grade ≥ 2.20
then Min_Req is yes.

If Department is Amharic
and program is diploma
and Grade ≥ 2.00
then Min_Req is yes.

If Department is Amharic
and program is diploma

and Grade < 2.00
and Other_Req is yes
then Min_Req is Yes.

If Department is Education
and Grade ≥ 2.6
then Min_Req is Yes.

If Department is Education
and Grade < 2.4
and Other_Req is yes
then Min_Req is Yes.

If Department is Education
and Grade < 2.4
and Other_Req is no
then Min_Req is no.

If Department is Education
and program is degree
and Grade ≥ 2.4
and Other_Req is yes
then Min_Req is Yes.

If department is statistics
and Grade < 2.0
and graduate is yes
and Min_CGPA is yes
then Min_Req is yes.

If department is Biology
and Grade ≥ 2.0
then Min_Req is yes

If department is Biology
and Grade < 2.0
and Experience \geq '2 years'
and Recommendation_letter is yes
and graduate is yes
and Subject_Req is yes
then Min_Req is yes.

If department is Chemistry
and Grade < 2.0
and graduate is yes
and experience \geq '2 years'
and Subject_Req is yes
then Min_Req is yes.

If department is Chemistry
and Grade ≥ 2.0
Experience is \geq '2 years'
and Recommendation_letter is yes
and graduate is yes
and Subject_Req is yes
then Min_Req is yes.

If department is Mathematics
and Grade ≥ 2.0
then Min_Req is yes.

If department is Mathematics
and Grade ≥ 2.0
and graduate is yes
and Experience \geq '2 years'
and Recommendation_letter is yes
and Subject_Req is yes
then Min_Req is yes.

Appendix IV. Rule Structure for Further Screening

If department is Economics

and Min_Req is yes
and subject_requirement is Economics
and Score_requirement is 'B and above'
and subject requirement is Mathematics
and Score_requirement is 'C and above'
then further_screening is yes.

If department is Economics

And Min_Req is yes
and subject_requirement is Economics
and Score_requirement is 'C and above'
and subject requirement is Mathematics
and Score_requirement is 'B and above'
then further_screening is yes.

If department is Management and

Min_Req is yes and
and subject_requirement is English
and Score_requirement is A
and subject requirement is Mathematics
and Score_requirement is 'B and above'
then further_screening is yes.

If department is Management

and Min_Req is yes

and subject_requirement is English

and Score_requirement is A

and subject requirement is Mathematics

and Score_requirement is 'B and above'

then further_screening is yes.

If department is Amharic

and Min_Req is yes

and subject_requirement is Amharic

and Score_requirement is 'B and above'

and subject requirement is English

and Score_requirement is 'B and above'

then further_screening is yes.

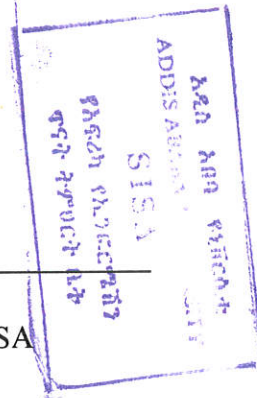
DECLARATION

The thesis is my original work and has not been presented for a degree in any other University.

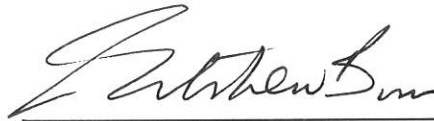


EBRAHIM KASSA

MAY, 1999.



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



Ato Getachew Birru

W/ro Woinshet Abdella

MAY, 1999