A Rule-Based Higher Institution of Learning Admission Decision Support System

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Abstract
Higher education management is key to the development of any nation. Some of the challenges that are often managed include examination, admission, and record problem. In this work, we focused on the admission system in higher schools of learning because it is fundamental to solving other problems. We studied the application of Decision Support Systems in Schools and came up with a new Decision Support Tool for admission processing. The system relied on rules generated from information gathered from admission administrators. The significant of the work lied in the fact that uncertainty in admission process and unnecessary time wastage are eliminated.

Introduction

The task of "deciding" pervades all administrative organizations, especially education. Decision-making is a major responsibility of all school managers. Decision-making as a very important duty of manager can be defined as the receiving and analyzing of relevant information about managerial problem, for the purpose of making the most suitable choice among alternative choices of actions.

An understanding of the decision- making process is crucial to all school managers, because the education sector, like all formal organizations, is basically a decision-making structure. Although, the level and nature of decisions may vary in a number of ways, there will always be needs to make right decisions within a given situation. It seems imperative then that every school manager makes provision for decision making; decisions needs to be rendered continuously.

Decision Support Systems is the area of Information Systems (IS) discipline that is focused on supporting and improving managerial decision-making (Arnott & Pervan, 2005). DSS has moved from a radical movement that changed the way information systems is perceived in schools, to a main stream IT movement that all organizations engage.

A Decision Support System (DSS) is any tool used to improve the process of decision making in complex systems, particularly where information is uncertain or incomplete (Tessella, 2005). These systems are designed to help mid-level and senior managers make those difficult decisions about which not every relevant parameter is known (Sodiya, 2009). There are a number of approaches to DSS systems, each of which assist the process in a different ways. A DSS then provides decisions based on algorithms derived from an understanding of the application domain.

The concept of a **decision support system** (DSS) is extremely broad and its definitions vary depending on the author's point of view (Druzdzel and Flynn 1999). On the one hand, Finlay (1994) and others define a DSS broadly as "a computer-based system that aids the process of decision-making". In a more precise way, Turban (1995) defines it as "an interactive, flexible, and adaptable computer-based information system, especially developed for supporting the solution of a non-structured management problem for improved decision making. It utilizes data, provides an easy-to-use interface, and allows for the decision maker's own insights."

Other definitions fill the gap between these two extremes. For Keen and Scott Morton (1978), DSS couple the intellectual resources of individuals with the capabilities of the computer to improve the quality of decisions. "DSS are computer-based support for management decision makers who are dealing with semi-structured problems." For Sprague and Carlson (1982), DSS are "interactive computer-based systems that help decision makers utilize data and models to solve unstructured problems."

According to Power (1997), the term Decision Support System remains a useful and inclusive term for many types of information systems that support decision making.

Statements of the Problem

The making of decisions, is at the very centre of the process of school management. School managers are faced with problems in their day-to-day managerial activities; these problems come in different categories and different solution in which the existing circumstances differ significantly from the desired situation.

These problems come from the phases inherent in admissions decision-making process: application, examination, assessment and evaluation and selection of students, where there are no clear-cut parameters for remedy.

At application and examination levels, school managers' are faced with myriad of challenges while deriving/extracting consistent patterns or trends from previous or present admission application and examination records. This may either be for predictive or any other purposes.

At the level of assessment and evaluation, school administrators' often face semi-structured problems trying to gather the statistics associated with admission criteria, which may in turn; determine how selection of students would be done.

The last phase of admissions process is **selection of students**. This is where the main problem lies; because the number of qualified prospective candidates always exceeds the available capacity. Also, admissions requirements of various faculties and their respective departments have to be referenced. During this phase, at one point or another, parameters such as state of origin, sex, UTME score, Post-UTME score may need to be applied, and all these can be quite challenging.

Aim and Objectives

The aim of this study is to design and implement a rule-based admission decision support system for higher institution of learning.

To achieve the said aim, the following objectives will be accomplished:

a) Review of literature on DSS, information integration theory, decision modeling and decision theory, as well as survey of methods used in decision making.

b) Extraction of knowledge and Information gathering from School Managers and Education Administrators.

c) Development of a Rule-Based Admission Decision Support Tool for School Managers.

Motivation

The motivation of the proposed system is to help school managers make better decisions by building a better **Information System** (IS) for them to use.

Research Methodology

In order to achieve objectives of this research, the following system development methods will be used: Analysis, Design, Construction, and Testing

Review of Related Work

Mbilinyi et al (2005) aim was to develop a GIS-Based DSS that use remote sensing (RW), limited field survey and GIS to identify potential sites for rainwater harvesting (RWH) technologies. Problem: the researchers wanted to maximize the water availability and land productivity in the semi-arid areas, since the necessary biophysical data and infrastructure are often lacking. The researchers used the following methodologies: (1) data collection; data about soil texture, soil depth, topography etc. were collected from Bangalala and Mwembe villages in Tanzania, (2) data processing and analysis; data obtained were processed in a GIS environment to produce contour map and to construct digital elevation map (DEM), (3) testing and validation of the DSS; testing aimed at checking the quality suitability and reliability of the system. Validation was done to prove the validity of the system.

Result: the study demonstrated the capabilities of RS, GIS and field of data for identifying potential sites for RWH technologies that may be used for development and management of RWH programmes. The application of the developed DSS shows that it works efficiently to identify potential sites for RWH technologies in semi-arid areas.

Limitation: despite the fact that the developed DSS is valuable tool for site selection remote areas. To increase its usefulness, more works can be carried out to refine the model and to include other ancillary data.

The aim of Siddiqa et al (2000) work was to develop an ICT tool to assist non-specialist biologist researcher users in performing analysis of large amount of data by applying simple simulation techniques. Problem: the shortcomings faced researchers for their analysis at present include lack of user-friendly interface, and learning complicated statistical tools for not only analyzing the data but also interpreting the data. Therefore, there is need to use tools which are more intuitive and user friendly, such as agent-based modeling simulation techniques.

The methodologies used are: (1) data collection and conversion; data were collected from breast cancer patient from two major onco-referral hospitals. The data was originally in paper format which was digitized based on different citations and oncologist's guidelines. (2) Data filtering fusion: the filtering and integration of data and knowledge collected from disparate sources by different methods into a consistent, accurate, and useful whole (3) System implementation: utilization of agent-based simulation models on the filtered data in order to order non-specialist end-users (biologists).

Result: the study demonstrates the standardized conversion process of data from medical practitioners to DSS end users. Provide tools for easy analysis of data by trickling data down to results of queries.

Limitation: the researchers developed a hybrid DSS based on a novel methodology of using agent-based modeling and simulation tools as a black box. In the future, the researchers hope to develop more advanced DSS based on data collected from HIV and other diseases.

Vinnik et al (2005) aim was to contribute to the next generation of academic DSS based on the Data Warehousing Technology with incorporated Data Mining and Knowledge Discovering functionalities. Problem: the researchers saw academic resource planning as a highly complex administrative procedure based on extensive analysis of the entire data related to educational framework. Unavailability of the data in the appropriate form and lack of tools and approaches for it evaluation prompted the move towards more systematic and efficient management of universities asset.

The following methodologies were used: (1) Educational Capacity Analysis; it measures the available teaching capacities and describes the consumption of school's academic services. (2) Model development; the researchers performed University Structure Modelling, the hierarchical structure consists of faculties, degrees and courses. (3) Model Implementation; the researchers chose a solution which is a database-enabled web-application since it best fulfils the requirements of a DSS with high availability and a differentiated multi-user access.

Results: the system integrates data from heterogeneous University's systems. Decision Support functionality is realized by offering reporting tools for solving particularly capacity-related tasks as well as by allowing users to navigate through the data and query it, generate interactive visualizations and explore those for retrieving interesting details.

Limitation: the future work of the researchers will be directed towards improving the data integration routines and enhancing the user interface to enable intuitive and interactive visual exploration of accumulated data with incorporated data mining techniques for expert trend analysis.

The aim of Nazari (2005) study was to proposed DSS framework particularly for construction consultants that involves in the preparing the feasibility study in order to improve the effectiveness of the decision-making process. Problem: A feasibility study is an important tool that investors can rely on to help them make management and development decisions. Where there is uncertainty as to which events might occur, the logic of the decision process should include necessary information. Feasibility study needs a lot of information and the process to analyze the information is very tedious and time-consuming. The DSS is an attempt to simplify the analyzing process and the time needed in preparing the study.

The researcher methodologies were divided into three stages. Stage 1: introduction of the research field; Stage 2: data collection –this stage is the guideline to acquire the data needed to achieve the objective of his research. Stage 3: data analysis and interpretation that have been obtained from the Stage 2 was conducted.

Result: the data collected were verified, edited and then analyzed to the aim of the research. The following results were identified and developed: (a) decision making process of feasibility study (b) cost estimation of DSS and (c) DSS Framework for feasibility study.

Limitation: this research covers only the feasibility stage, further research on the implementation of DSS on other stage in the development of construction project can be explored.

Nakakawa (2006) aim was develop a Spatial Decision Support Tool for landfill site selection for municipal solid waste for Kampala and neighbouring districts in order to improve waste disposal crisis in these districts. Problem: effective management of solid waste was a major problem of Kampala. The situation may be due to several factors, including a poorly managed and uncoordinated approach to waste management practice and landfill. There exist mostly dump sites, which are poorly sited and lack of management to ensure proper operation.

The following are the methods the researcher used: (1) identification of parameters (geographical and social parameters) that decision makers considers when locating landfill sites and collection of dataset (2) architecture design for the Spatial Decision Support Tool (3) development of a computer-based prototype Spatial Decision Support Tool for identifying and selecting a suitable landfill sites (4) tool evaluation –adjustment of weights assigned to parameters was done.

Results indicated the system provides the functionality of selecting features from GIS database, which was use to select only potential landfill sites from the entire overlay map.
The limitation of the tool is as follows: (a) ground water level was not included in the tool (b) it does not contain digital map of the entire country (c) further research can be done to incorporate the opinions of other stakeholders.

Transforming Education Decision-Making

The day-to-day administration of schools involves considering large amount of records and management data, which have to be collected, stored, and selectively retrieved, updated and statistically analyzed.
Utilizing a decision support system is a proactive way to use data to manage, operate, and evaluate education institutions. Depending on the availability and quality of the underlying data, such a system could address a wide range of questions by distilling data from any combination of school records systems. School decision-making can be transformed by Extraction, Transform and Loading (ETL) functions.

Extract, Transform and Loading (ETL) Process

The extract, transform, and load (ETL) process is necessary when source data in a decision support system reside in separate, non-interoperable databases. As the name implies, **ETL** is a three-stage process designed to move data from legacy source systems into an interoperable format in the decision support system. In the first step, an "extract" function reads from a specified database and pulls out the desired data. In step two, a "transform" function uses predetermined business rules to convert the extracted data into a format that is interoperable with other system data. Finally, in step three, a "load" function moves the edited and cleaned data to a database repository within a decision support system.

Reason for Support Systems in Schools

Many education stakeholders want access to more data to help them decide how best to operate, manage, and evaluate our schools. But they do not want just any data—they want better data. They want real-time data they can use to run their schools more efficiently today; up-to-date information that permits them to compare school inputs, processes, and outcomes during the current grading period; and longitudinal information that enables them to anticipate their schools' needs in the future. In other words, they want data to be useful, accurate, well organized, and readily accessible to those who need it to make decisions about the operation and management of the education enterprise.

DSS: The Functional Components

A DSS typically contains the following: user interface, knowledge acquisition interface, knowledge base and inference engine. The functional architecture is depicted in the figure below.

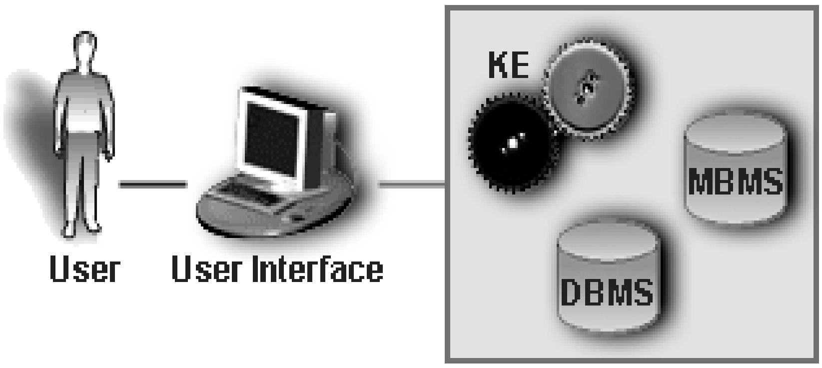


Figure 1: Functional components of DSS
Source: Haettenschwiler (1999).

DSS: The Framework

The DSS consists of three major subsystems, namely, (a) the dialogue subsystem, (b) the input management subsystem and (c) the knowledge management subsystem which is consistent with the general architecture of DSS.

The dialogue subsystem serves to integrate various other subsystems as well as to be responsible for user-friendly communications between the DSS and the decision maker; the subsystem coordinates all functions or commands selected by the decision maker. The input management subsystem organizes and manages all the inputs for solving the IS project problem; the type and the quantity of data inputs for solving the problem vary typically from one problem to another. The knowledge management subsystem manages all the multi-criteria analysis methods available in the DSS.

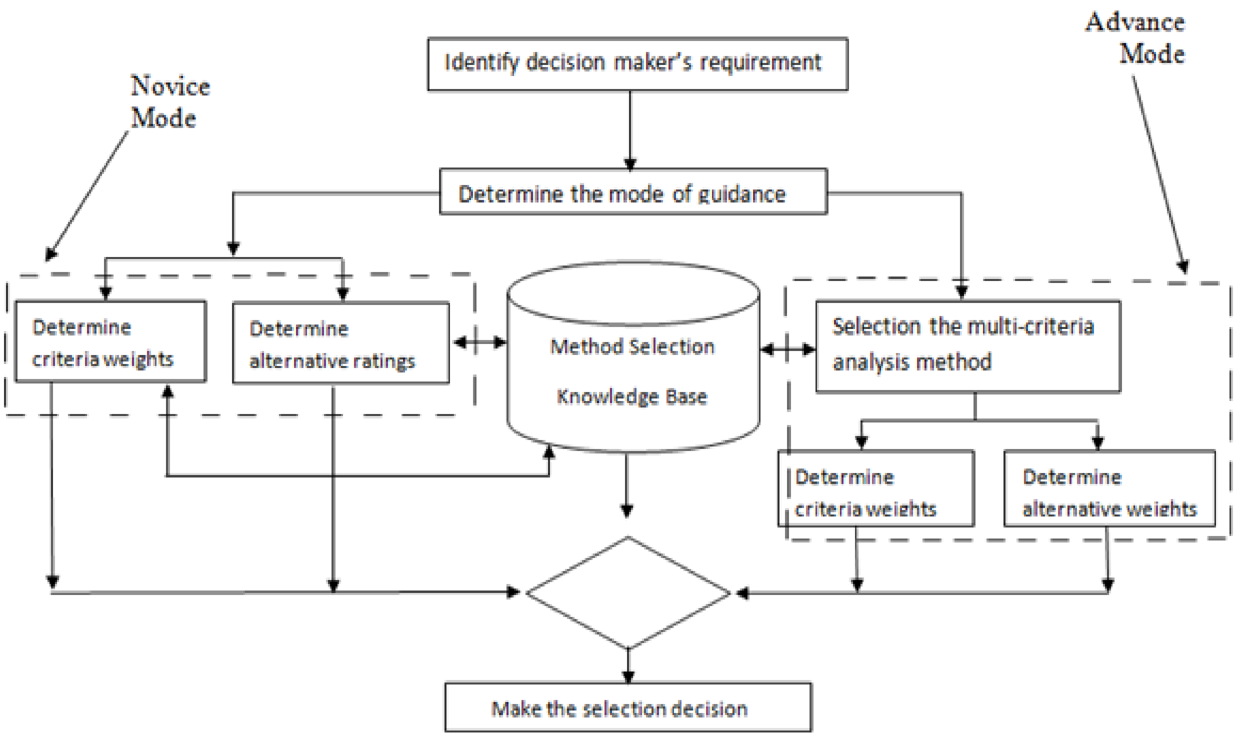


Figure 2: The DSS framework
Source: Deng and Wibowo (2008).

Rule-Based System

A rule-based system is a 'knowledge based system', which works as a production system in which rules encode expert knowledge. Most decision support systems are rule-based. It is a DSS based on a set of rules that a human expert would follow in solving a problem. A classic example of a rule-based system is the domain-specific expert system that uses rules to make deductions or choices.

A rule-based system consists of if-then rules, a bunch of facts, and an interpreter controlling the application of the rules, given the facts. If-then rules are one of the most common forms of knowledge representation used in decision support systems. Systems employing such rules as the major representation paradigm are called rule based systems. Some people refer to them as production systems.

Design Methodology

In any software development project, it is very important to select and utilize the correct combination of design methodologies. For the purpose of this study, we use a blend of four development process design methodologies, namely Analysis, Design, Construction and Testing.

System Study and Design

System Study - Information Gathering and Analysis

The first phase of any software engineering process is analysis and specification of requirements.
This phase involved acquiring a general understanding of the problem and formalizing the expert knowledge. Questionnaire, interviews and discussions with the domain expert (Admissions Officer) were used to gather information and formulate rules based on the current practice. The researcher found out the kind of admissions requirements that were being used as parameters in the admissions process.

Systems Design

A system design is a conceptual representation of the components/modules that are required by a system. The system design includes the DSS database design, user interface design, the associations among the modules of the system, and the rules which govern operations on the system modules. A model of the decision support tool was designed using Unified Modelling Language (UML) use case diagram.

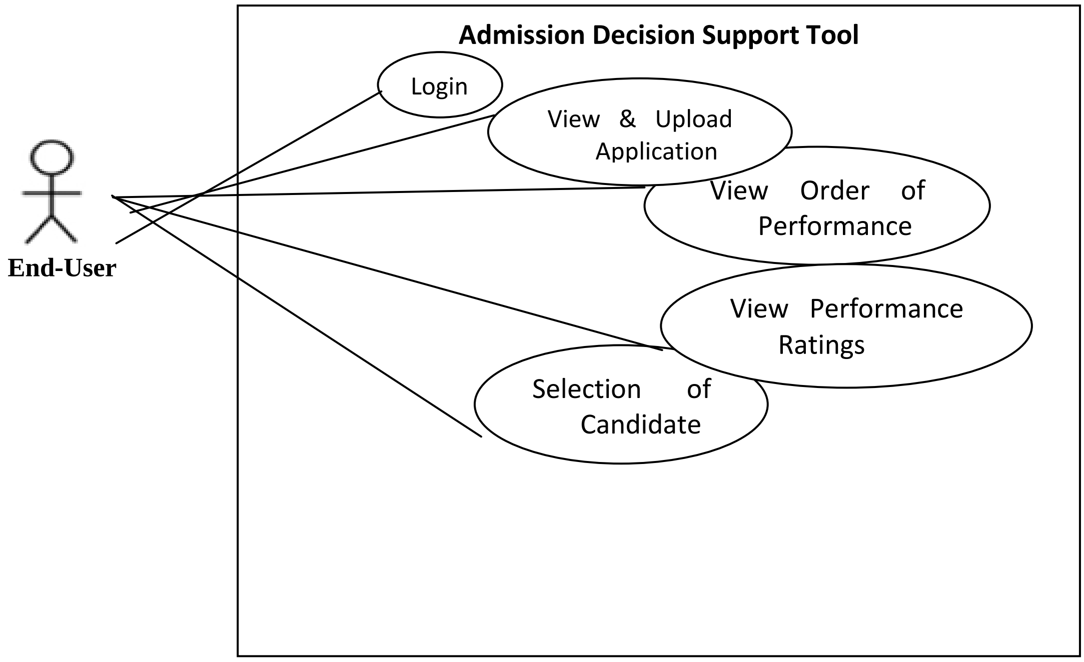
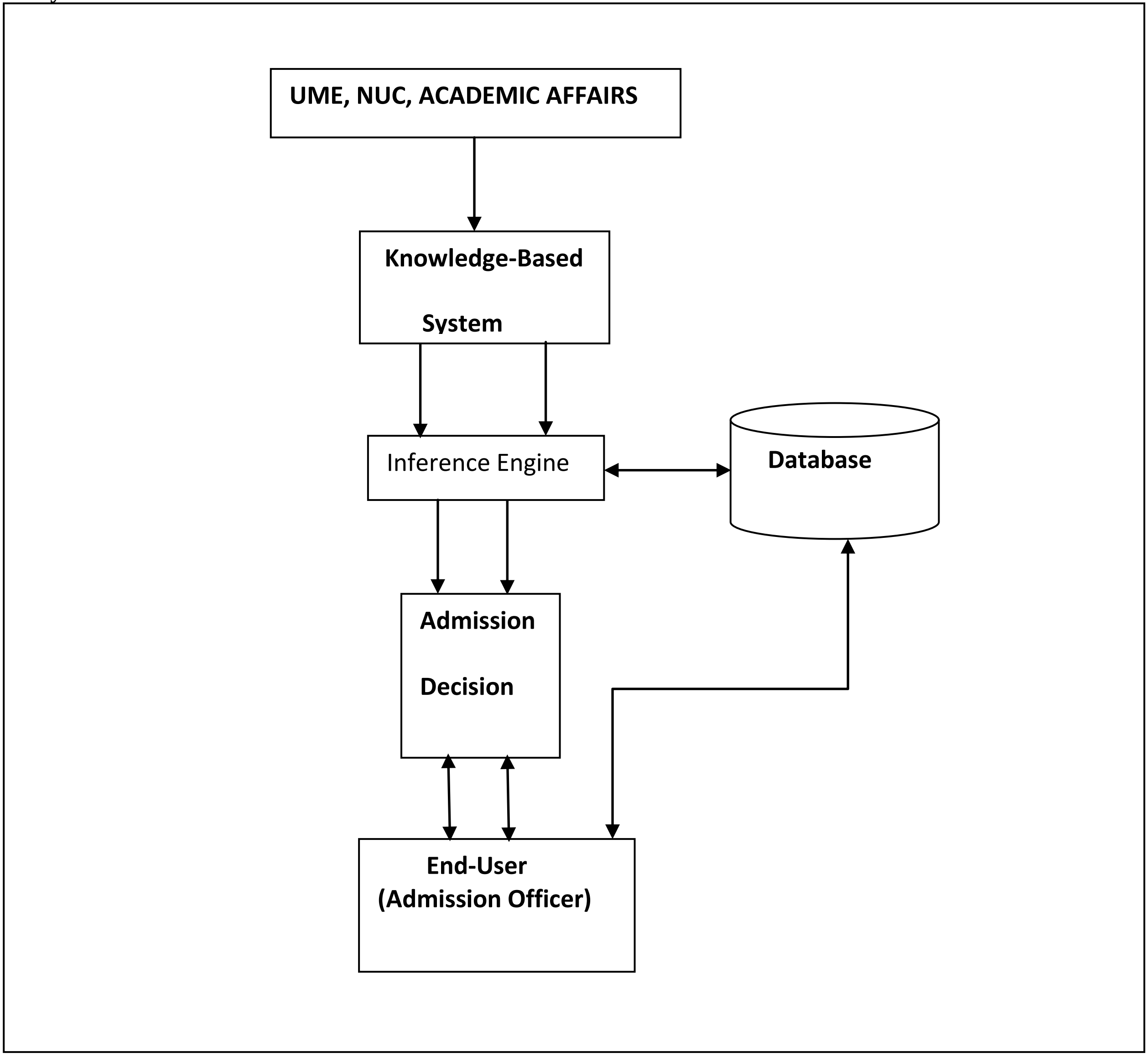


Figure 3: Admission Decision Support Tool use case diagram.
Source: Author

System Flow



Program Logic

The logic of the program is based on the concepts of rule-based systems. When the user logs on, the system will first and foremost, validate the user's authenticity. However, if the information provided is found to be valid, the system simply takes the user to the menu page. The menu provides the user with four core admission-related functions, most importantly, candidates' selection.

To select candidates, the user just need to select faculty, department, and input admission quota. After this has been done, the system will determine the cut-off mark, and select candidates that satisfies admission requirements and within cut-off mark range.

Algorithm/Rules for Selecting Candidates

--from end-user--
Select faculty and department
Input admission quota
--system---
Generate admission requirements of the selected departments
merit1=0.3*quota; merit2=0.1*quota
catchment1=0.4*quota; catchment2=0.2*quota
counter=0

-merit list-

```
Repeat Until (counter<=merit1) {
Select candidates that satisfies admission requirements, chose
AAUA as 1st choice     institution and are within merit score range
Update counter
}
Repeat Until (counter<=merit2) {
Select candidates that satisfies admission requirements, chose AAUA as 2nd choice institution and are within merit score range
Update counter
}
```

-catchment list-

```
Repeat Until (counter<=catchment1) {
Select candidates that satisfies admission requirements and state-of-origin condition, chose AAUA as 1st choice institution and are within catchment score range
Update counter
}
Repeat Until (counter<=catchment2) {
Select candidates that satisfies admission requirements and state-of-origin condition, chose AAUA as 2nd choice institution and are within catchment score range
Update counter
}
```

Database

Database tables

The following database tables were created using MySQL database management system.

Table 4.1: **Personal_data table**

This table has attributes of applicants in the system.

S/N	NAME	TYPE	DESCRIPTION
1	Id	Tinyint(4)	Primary key for identification
2	Reg_no	Varchar(10)	Holding candidates' JAMB registration ID
3	Surname	Varchar(20)	Holding candidates' surname
4	Last_name	Varchar(20)	Holding candidates' last name
5	Mid_name	Varchar(20)	Holding candidates' middle name
6	Sex	Varchar(6)	Holding candidates' gender
7	Dob	Varchar(10)	Holding candidates' date-of-birth
8	state_of_origin	Varchar(15)	Holding candidates' state-of-origin
9	Lga	Varchar(20)	Holding candidates' state's local govt. area

Table 4.2: **Login_detail table**

This table has the attributes of the admission officer login data

S/N	NAME	TYPE	DESCRIPTION
1	Username	Varchar(12)	Holding user's secret username
2	Password	Varchar(12)	Holding user's password

Table 4.3: **Utme_de_info table**

This table shows all the required attributes of UME information of applicants.

S/N	NAME	TYPE	DESCRIPTION
1	Id	Tinyint(4)	Primary key for identification
2	Reg_no	Varchar(10)	Holding candidates' JAMB registration ID
3	Entry_mode	Varchar(3)	Holding candidates mode of entry
4	Subject1	Varchar(12)	Holding first subject
5	Subject1_score	Varchar(2)	Holding first subject's score
6	Subject2	Varchar(12)	Holding second subject
7	Subject2_score	Varchar(2)	Holding second subject's score
8	Subject3	Varchar(12)	Holding third subject
9	Subject3_score	Varchar(2)	Holding third subject's score
10	Subject4	Varchar(12)	Holding fourth subject
11	Subject4_score	Varchar(2)	Holding fourth subject's score
12	Total_score	Varchar(3)	Holding aggregate scores
13	Putme_score	Varchar(2)	Holding post-UME score
14	First_choice_sch	Varchar(6)	Holding 1st choice institution
15	Faculty1	Varchar(12)	Holding 1st choice faculty
16	Course1	Varchar(15)	Holding 1st choice course
17	second_choice_sch	Varchar(6)	Holding 2nd choice institution
18	Faculty2	Varchar(12)	Holding 2nd choice faculty
19	Course2	Varchar(15)	Holding 2nd choice course

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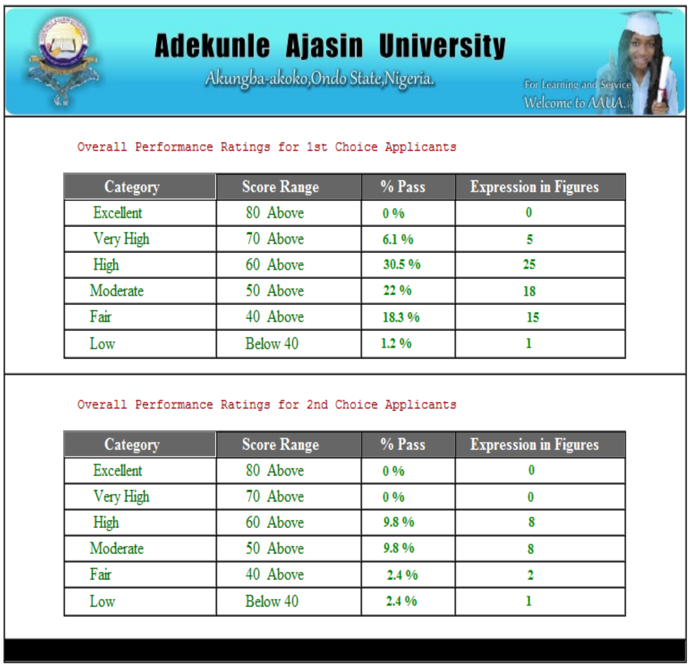
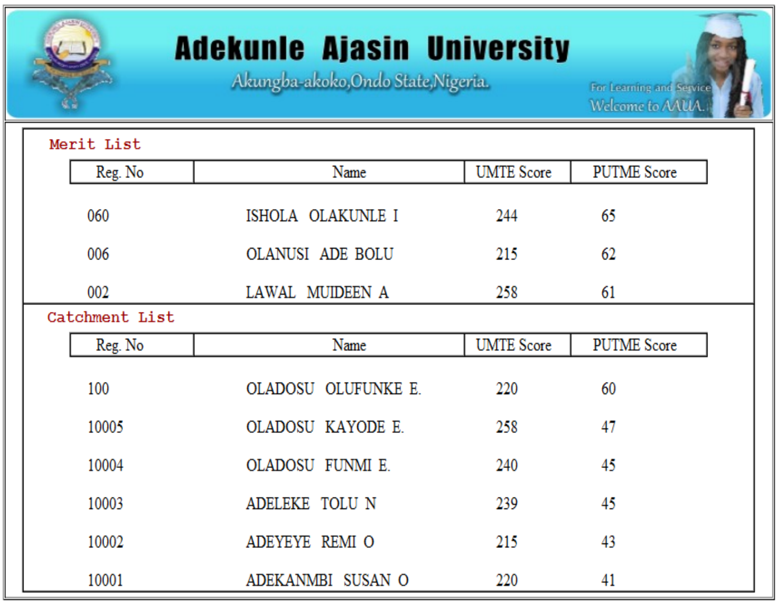
Design Outputs





Conclusion and Recommendation

Conclusion

In many educational institutions, the management of admissions related information has been poorly handled. The admissions officer has therefore been confronted with the problem of generation of accurate and up-to-date information during each of the stages inherent in admission process.

The development of a knowledge-driven ADSS seems to be the needed shift away from the awkward manual way of admitting students into higher institution of learning; a system which clearly permits for corruption and man-know-man in admission process. The ADSS is a standard way of admission management. It allows easy processing of admission related data into meaningful information. If well administered, the ADSS will reduce admissions rigours to a manageable range.

Recommendation

This ADST was developed with the intention of using it in the admissions process management in higher education institutes. The researcher recommends that this ADST be put to its intended use and provide an avenue for proper, efficient and effective admissions process management. This ADST is also recommended for use by admissions officers to enable them to carry out proper admission management. In future, the use of Fuzzy Control System shall be considered.

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