Admission Decision Support System for Nigerian Universities

Hassan Bello
Department of Computer Sci
College of Education Hong
Hong
Adamawa State, Nigeria

Abdullahi M. Jingi
Department of Computer Sci.
Adamawa State University, Mubi
Adamawa State, Nigeria

ABSTRACT
Admission exercise has been a crucial activity that is performed almost every year by Universities. One of the challenges confronting these institutions during the admission exercise is the selection of the most qualified candidates who supposed to be given admissions in order to undergo studies with less difficulties. Some researchers have been able to develop admission support systems in order to assist to mitigate this challenge. In order to improve the standard of candidates to be admitted, this research work has developed a knapsack problem approach system titled, "Admission Decision Support System for Nigerian Universities." Which screens and ranks the qualified candidates and offered them admissions based on their aggregate points obtained from their UTME and O-level results. NetBeans7.2.1, Jboss4.2.2GA, My SQL and Macromedia Dreamweaver 8.0 were used in designing the system.

Keywords
Decision, Admission, Knapsack problem, System, Dynamic Programming

1. INTRODUCTION
Student selection for courses in Nigerian Universities is an activity that is performed by the Joint Admission and Matriculation Board (JAMB) and the University each year. In this process students are allocated courses of their choice according to their performance in Unified Tertiary Matriculation Examinations (UTME), College or Polytechnic results. Minimum requirements exist for each course and only students having the prescribed grades in specific subjects are eligible to be admitted into a particular course.

Selection examination results can be used in diverse ways from one country to another depending on their historical peculiarities, the purposes for which the results are intended and the issues being addressed.

One of the many reasons for this differentiation, apart from educational assessment, are other issues such as manpower, gender inequality, scarce resources, underdevelopment and the quest for advancement in science and technology [1].

It was against this backdrop and the need to use a fair method of selection for admission to ensure an equitable distribution of the available spaces in tertiary institutions for all the different parts of the country, which made the Federal Government of Nigeria to establish The Joint Admissions and Matriculation Board (JAMB) in 1978. JAMB came into being as a central testing and placement agency in response to the problems of the individual universities regarding multiple applications by candidates as well as multiple admissions. Hitherto, individual universities evolved their admissions processes, which relied essentially on their peculiar guidelines and standards, a situation that naturally led to multiple applications by candidates seeking admission into the various Universities. The decentralized system also led to lack of standard, lack of uniformity in the admissions process and multiple admissions, whereby the same candidates received offers of admission into two or more institutions. In the process, such candidates deprived other qualified candidates' places in those universities whose offers had been declined.

1.1 Statement of the Problem
According to [1], students seeking admission into tertiary institutions in Nigeria rose from around 30,000 in 1978 to over one million in 2017 while degree awarding institutions and universities in Nigeria has risen to 101.

Due to the high inflow of applicants seeking for admission into the university education system, the grading point strategy for selection and placement of applicants for studies in the university becomes necessary so that the most qualified applicants are enrolled. This is to enable candidates undergo their studies without engaging in examination malpractices, poor performance and probation, and some eventually ends up as dropout. The universities may also be overwhelmed by the number of students demanding access against limited university spaces. This process may lead to irregularities in the admission process leading to disadvantaging some students who are even more qualified.

1.2 Aim and Objectives
The aim of this research work is to develop a system model to assists in simplifying and optimizing the admission process. The system is strictly based on the JAMB general admission requirement and the grading point system of admission and it has the following objectives:

i. To study and understand the challenges confronting Nigerian universities during the admission process.

ii. To create a knapsack model that will optimize admission process as identified in one above.

iii. To construct a web based system using java scripts based on the model above.

1.3 Significance of the Study
The findings of this research work will help the Nigerian universities by simplifying and optimizing their admission process.

The Nigerian Universities will feel the impact of this research work as it will assign the most qualified students to courses of their interest. When this is eventually adopted, it reinstates the confidence of the people in the educational sector and eliminates or minimise the factors affecting the proper admission process in the entire system.

2. THE KNAPSACK PROBLEM

Knapsack is a well- known class of optimization problems, which seeks to maximize the benefit of objects in a knapsack without exceeding its capacity [2]. The *"knapsack problem"* appears in many forms in different areas of human endeavour such as economics, science, engineering etc.

It is a classic combinatorial optimization problem with numerous practical applications: several objects with given, known capacity needs (or weights) and given, known values must be packed into a *"knapsack"* of given capacity to maximize the total value of the included objects. The problem often arises in resource allocation where there are financial constraints and is studied in fields such as combinatorics, computer science, complexity theory, cryptography and applied mathematics [3]. The Knapsack model is a general resource allocation model in which a single resource is assigned to a number of alternatives with the objective of maximizing the total return. The model is one of the most important classes of applications of Dynamic programming [4]. The name *"knapsack problem"* came to be because our common experience of packing luggage (knapsack) expresses something akin to the problem: What should be chosen when space is limited?

The Knapsack problem in its basic form:

Maximize $\sum_{j=1}^{n} p_j x_j$

Subject to: $\sum_{j=1}^{n} w_j x_j \leq W$

$x_j \in \{0,1\} \forall j \in \{1, \ldots, n\}$[5]

3. METHODOLOGY

This section discussed admission requirements in Nigerian institutions and procedures followed in order to develop the system

3.1 Requirements for Admission

General guidelines for admission into the Nigerian tertiary institutions are contained in a brochure which provides detailed information on courses and entry requirements which include:

(i) Five 'O' level credit passes in relevant subjects including English and Mathematics particularly for science and social sciences while mathematics may be required at an ordinary pass level for Arts students.

(ii) Four credit 'O' level passes in relevant subjects for Monotechnics, Polytechnics and Colleges of Education.

(iii) The candidates must equally score the minimum cut-off marks for the desired course of study.

The cut-off marks for selection vary from one institution to another depending on the competitive nature of the desired course of study. The Federal Government guidelines for admissions into its institutions are based on 45% Merit, 35% Catchment/Locality and 20% Educationally Less Developed Sates [6].

3.1.1 Admission on Merit

Candidates with very high scores in each matriculation examination are given first consideration for their first choice of course and institution before other candidates.

3.1.2 Catchment Areas

To give equal opportunities to all applicants, the States of the Federation are grouped into catchment areas of each Tertiary Institution. Applicants seeking for admissions in institutions in their catchment areas has a better chance of being given admissions than applicants outside the catchment area.

3.1.3 Educationally Less Developed States

Certain states are considered educationally less developed. Candidates from these states are given special consideration for admission. The Tertiary Institutions assign lower cut-off marks to this category of candidates so that they can be given opportunity to forestall a lopsided development of education in the country.

3.1.4 Admission by Direct Entry

Direct entry admissions are for certain categories of candidates who need not go through the selection examination. They are candidates who possess higher entry qualifications such as Advanced Level Certificates, Nigeria Certificate in Education (NCE), National Diploma (ND), Higher National Diploma (HND), First Degree, etc.

In addition, these candidates must satisfy the normal general entry requirements as a pre-requisite for admission. Students in this category are admitted into the second year (200 level) in the universities [7].

3.2 Proposed JAMB Model for Screening of Recommended Candidates

A. Screening of candidates shall be for those offered Provisional Admissions by JAMB ONLY.

B. No written examination to be conducted.

C. Verification of Course Requirements (O'levels or A'levels).

D. Verification of valid JAMB results by checking:

i. Online Result Slip

ii. Printout

iii. Provisional Admission Letter

iv. Photo Album

v. Checklist

vi. Biometrics

5. Institutions are free to source from other Course(s) to compensate for SHORTFALL in any of the criteria.

Two samples of the admission screening models are taken from two institutions; Abubakar Tafawa Balewa University, Bauchi and Ibrahim Badamasi Babangida University, Lapai as model 1and 2 respectively.

3.3 The Summary of Screening Model 1

i. Screening of ONLY candidates recommended to JAMB and offered Provisional Admissions.

ii. No Examination conducted.

iii. Verification of Course Requirements (O'levels or A'levels) with maximum lifespan of five (5) years.

iv. Verification of valid JAMB results.

v. Fees charged for Screening**.**

3.4 Summary of Screening Model 2

i. Screening of candidates before recommendation and presentation to JAMB for Provisional Admissions.

ii. No examination conducted.

iii. Verification of Course Requirements (O'levels or A' levels) Grades and UTME scores are weighted.

iv. Verification of valid JAMB results.

v. Fees charged for Screening.

3.5 Multi-objective, Multiple Knapsack Problem (0-1 MMKP)

This proposed model is a beneficial combination of three different knapsack models thus:

A. The 0-1 Knapsack problem

B. The Multi-objective Knapsack problem

C. The Multiple Knapsack problem

The proposed model is defined as: "given a set of $n\ disjoint\ items$ and a set of *m Knapsacks* an item is either completely accepted or rejected in an attempt to maximize independent objectives subject to the constraint(s) that the total weights be less than or equal to the capacity of the knapsacks"[8].

$$\text{Maximize} z = \sum_{i=1}^{m}\sum_{j=1}^{n} p_j x_{ij} \quad (1)$$

Subject to:

$$\sum_{j=1}^{n} w_j x_{ij} \le c_i\ ,\ \ i \in M = \{1, \dots, m\} \quad (2)$$

$$\sum_{i=1}^{m} x_{ij} \le 1\ ,\ \ j \in N = \{1, \dots, n\} \quad (3)$$

Where

$x_{ij} = \begin{cases} 0 & \text{Otherwise} \\ 1 & \text{If item j is assigned to Knapsack i} \end{cases}$

And

$p = \sum_{h=1}^{y} b_h$ P varies for any instance of i [9].

3.5.1 MMKP in Optimal Admission Recommendation at the Departmental Level

$Maximize\ B_d$ (4)

$Subject\ to$:

$$W_d \le C_d \quad (5)$$

Where

W_d = Summation of weights of candidates for department d.

C_d = Carrying capacity of department d.

$B_d = \sum(E, F, G)$ and E,F,G are defined thus:

$$E = \sum_{i=1}^{m} X_i B_i \qquad ?=1,2,\dots,?$$

$$? =1,2,\dots,?$$

$$F = \sum_{j=1}^{n} X_j B_j$$

G = $\sum_{j=1}^{n} X_k B_k$

Where

$X_{i,j,k}$ = Candidates from JAMB, Direct Entry and Remedial respectively.

And

$X_{i,j,k} = \begin{cases} 1\ if\ it\ is\ selected \\ 0\ if\ otherwise \end{cases}$

$B_{i,j,k}$ = Value associated with the candidate

m, n & p are the number of students to be admitted by JAMB, Direct Entry and Remedial respectively. Weight is uniform for all candidates.

3.5.2 MMKP in Optimal Admission Recommendation at the University Level

Maximize

$$\sum_{x=1}^{n} V_x$$

Subject to

$$\sum_{x=1}^{n} W_x \le C_n$$

Where

V_x = sum of values for department x

i.e $V_x = \sum_{i,j,k=1}^{m,n,p}(X_i B_i, X_j B_j, X_k B_k)$

W_x = number of departments in the University

C_n = total number of departments' carrying capacity.

3.6 Admission Criteria

A. Conventional Institutions (Universities and Colleges of Education)

Admission of candidates into conventional institutions is 40:60, with sciences having 40% while Arts 60%.

$$Science = \left(\frac{40}{100}\right) X\ V_x$$

The total number of students to be admitted into Sciences is:

$$0.4V_x$$

$$Arts = \left(\frac{60}{100}\right) X\ V_x$$

The total number of students to be admitted into Arts is:

$$0.6V_x$$

B. Specialized Universities (Technology, Agriculture, e.t.c)

These institutions are strictly for admission for science students only.

$$Science = V_x$$

C. Polytechnics/Colleges of Technologies

In Polytechnics and Colleges of education, Science to Arts admission ratio is (70:30).

$$Science = \left(\frac{70}{100}\right) X\ V_x$$

The total number of students to be admitted into Sciences is:

$$0.7V_x$$

$$Arts = \left(\frac{30}{100}\right) X\ V_x$$

The total number of students to be admitted into Arts is:

$$0.3V_x$$

D. UTME/DE Ratio

The UTME/DE ratio for admission in Nigerian institutions is 90:10. This means 90% of applicants is admitted through UTME while 10% through DE.

$$UTME = \left(\frac{90}{100}\right) X\ V_x\ = 0.9\ V_x$$

While

$$DE = \left(\frac{10}{100}\right) X\ V_x\ = 0.1\ V_x$$

3.6.1 Admission Based on Merit

45% of total admitted students are admitted based on merit. That is, admission based on merit is:

$$M_t = 0.45V_x$$

3.6.2 Admission Based on Catchment Area

35% of total admitted students are admitted based on catchment area. That is, admission based on catchment area is:

$$C_A = 0.35V_x$$

3.6.3 Admission Based on Educationally Less Developed States

20% of total admitted students are admitted based educationally less developed states. That is:

$$E_{LDS} = 0.20V_x$$

3.7 Model Diagrams

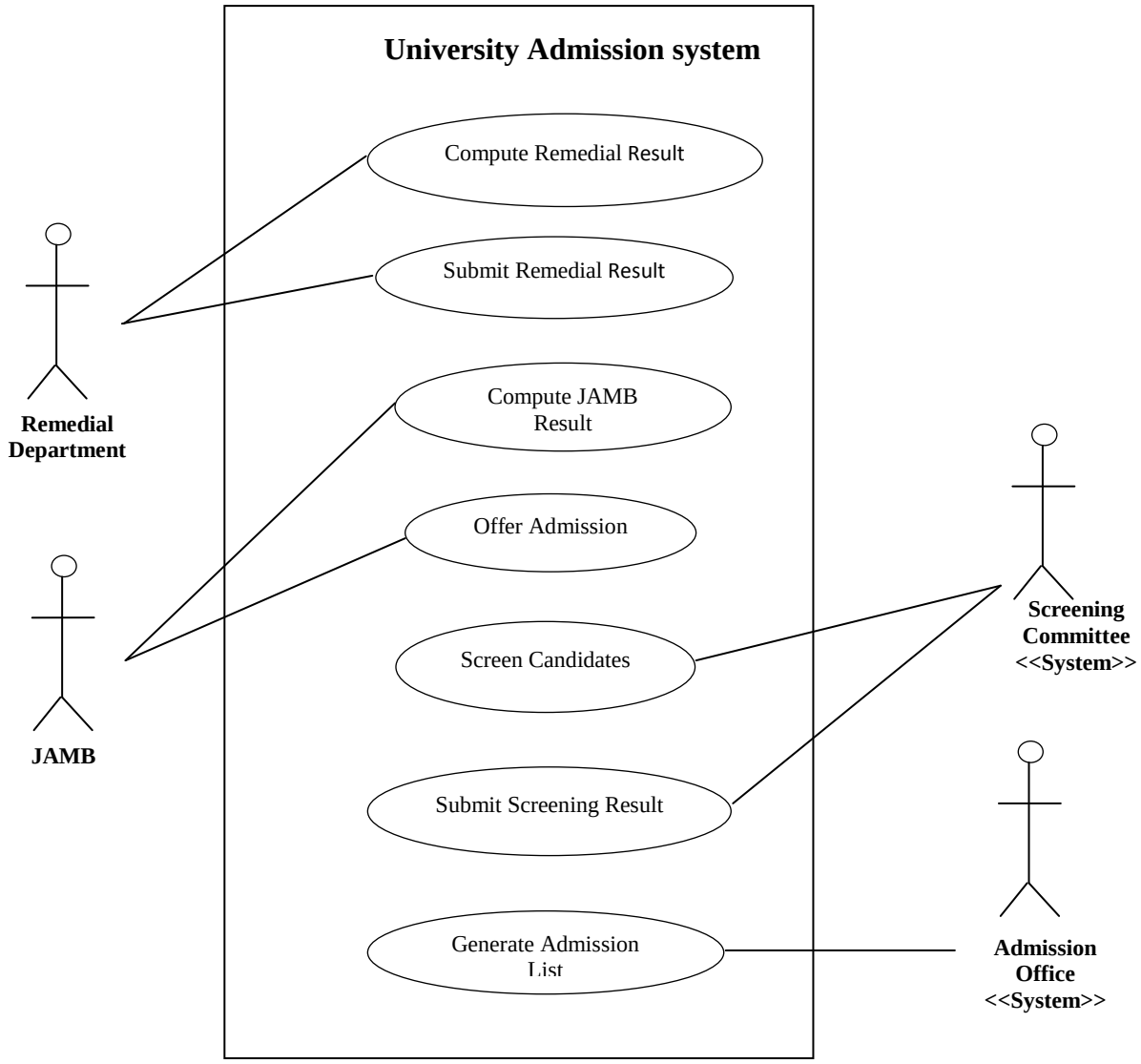

Fig 1: Use Case Diagram of an Admission System

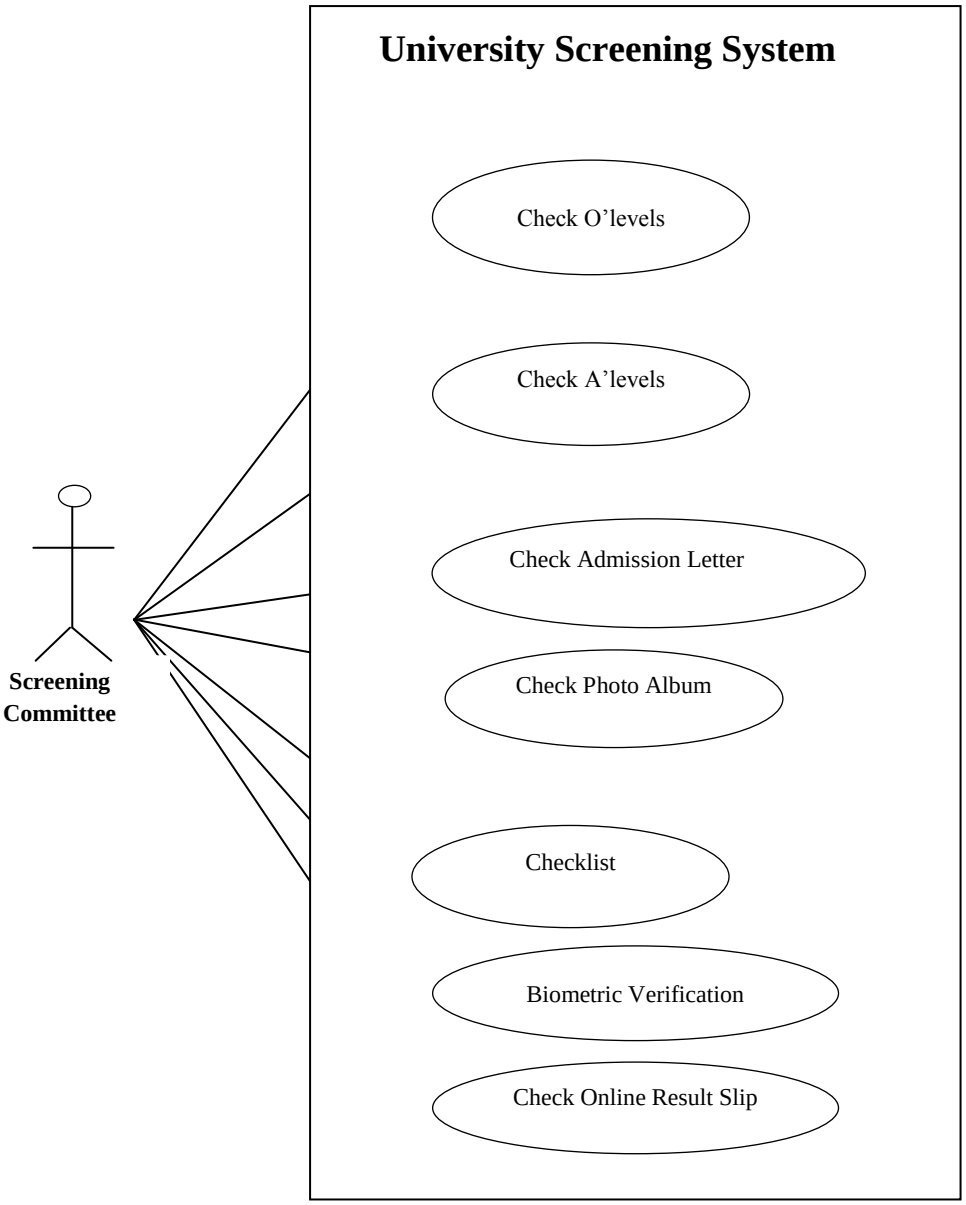

Fig 2: Use Case Diagram of a Screening System

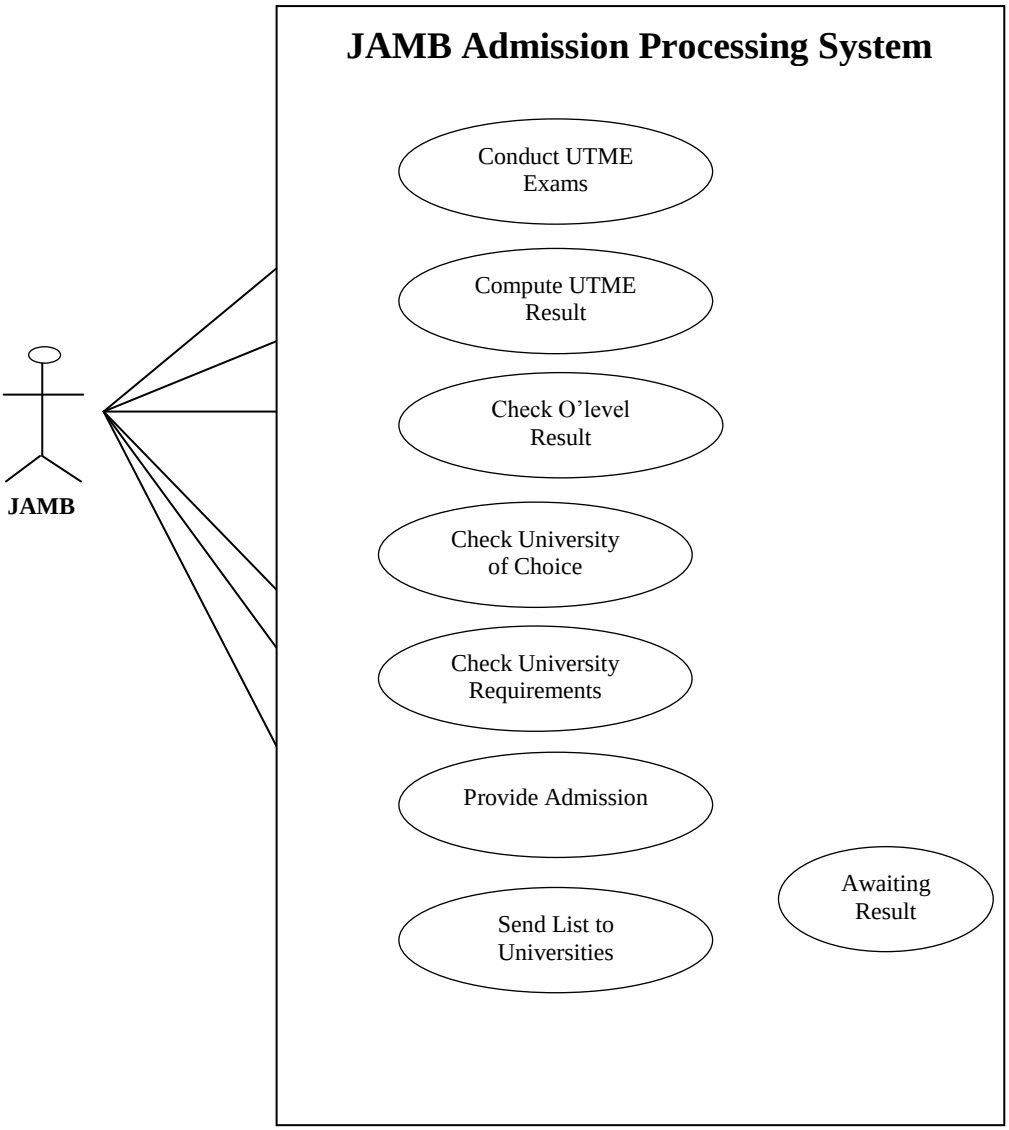

Fig 3: Use Case Diagram of JAMB Admission Processing System

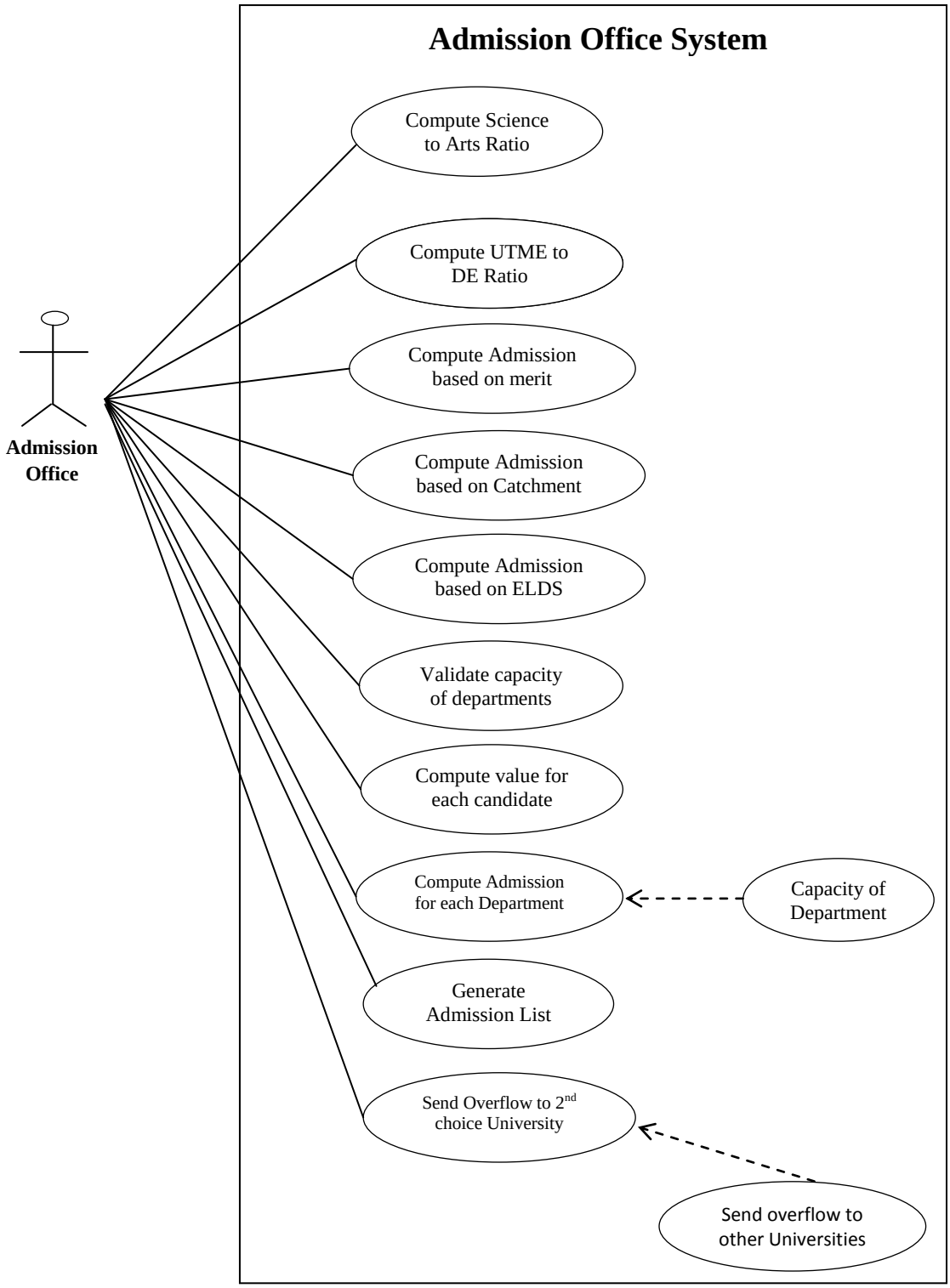

Fig 4: Use Case Diagram for Admission System

4. RESULT AND DISCUSSION

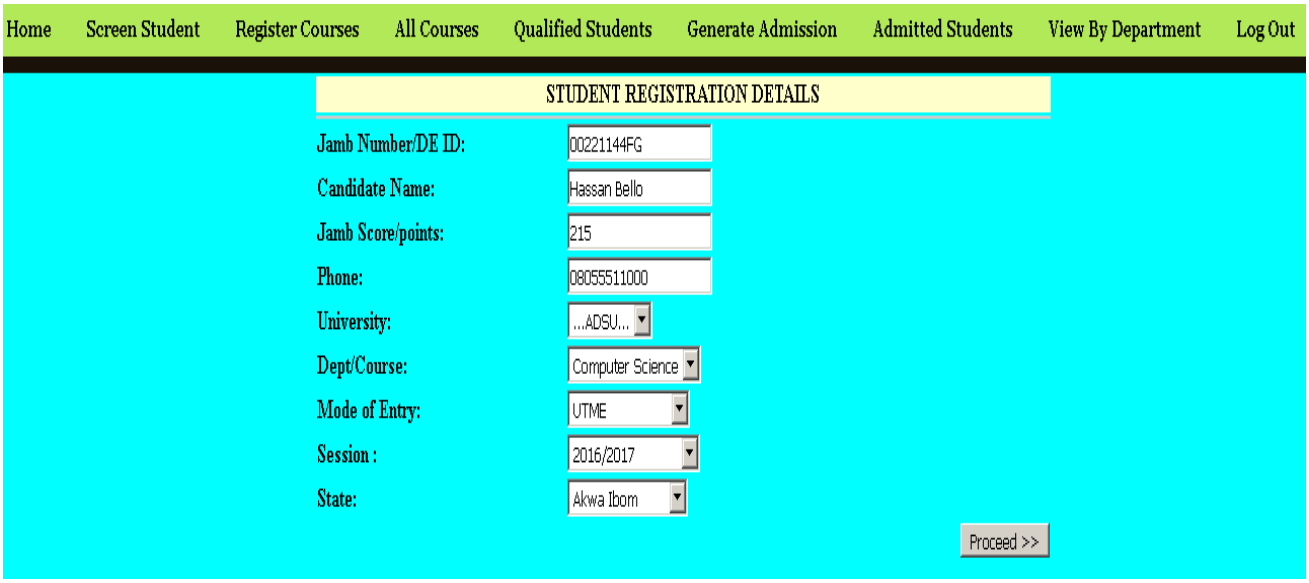

Fig 5: The Students Screening Page

Figure 5 above represents the screening page from where candidate's details are provided. Candidate's JAMB score, ND CGPA, NCE points or IJMB score is specified in the appropriate field along with other fields on this page. The system at this point evaluates candidate's score to determine if a candidate is qualified in the case of JAMB, or determine which level a candidate is qualified for, in the case of Direct Entry (DE) on clicking the proceed control button. If a candidate is successful, the admission process follows to determine if a candidate is qualified for the department applied for based on the O'level subjects passed, otherwise and optional department is suggested or the student is rejected for an admission.Furthermore, other criteria for admission such as catchment area and the less educated states are handled on figure 2. The state of origin of each candidate is selected, and our system assigns points to candidates within the university catchment area and educationally disadvantaged states. For the purpose of this research, five (5) points is assigned to the affected candidates since JAMB has not specified certain points. Thus, candidates from these states are added five points more to gain better chance of being admitted as opposed to candidates from other states.

LIST OF QUALIFIED CANDIDATES

S/N	JAMB/DE REG NO	CANDIDATE NAME/PHONE NO	UNIVERSITY/ SESSION	DEPARTMENT	LEVEL	POINTS	MODE OF ENTRY
1	00000001GN	Barak Obama-08050071000	ADSU-2016/2017	Physics	100	54	DE
2	00000002GN	Habila M. Sakawa-08069588787	ADSU-2016/2017	Computer science	100	104	UTME
3	00000010GN	Asad Alhassan-08050001000	ADSU-2016/2017	Mathematics	100	54	DE
4	00000021GN	Meshal Obama-08050071000	ADSU-2016/2017	Mathematics	100	57	DE
5	00010000GN	Kabiru Aliyu-08050011038	ADSU-2016/2017	Chemistry	100	77	UTME
6	00011100GN	Kulsi Adamu-08055511038	ADSU-2016/2017	Zoology	100	66	UTME
7	00050000GN	Zulai Aliyu-08050011038	ADSU-2016/2017	Chemistry	100	75	UTME
8	00110004ED	Bulus Abege-07082345678	ADSU-2016/2017	Computer science	200	47	DE
9	00123404ED	Mohammed Aliyu-08045632490	ADSU-2016/2017	Computer science	100	36	DE
10	01004900YG	Farnaa Gaius-07039233261	ADSU-2016/2017	Computer science	100	73	UTME
11	01094900YG	Hosea Gaius-07039233281	ADSU-2016/2017	Computer science	100	75	UTME
12	01094909YG	Wamanyi Gaius-07039233281	ADSU-2016/2017	Computer science	100	73	UTME
13	01114440YG	Falya Ezra-07039233281	ADSU-2016/2017	Computer science	100	93	UTME
14	01117611YG	Israel Judah-09039233281	ADSU-2016/2017	Computer science	100	43	DE
15	01994410YG	Hyellaidati Ezra-07039233281	ADSU-2016/2017	Computer science	100	90	UTME
16	01994440YG	Magdaleen Ezra-07039233281	ADSU-2016/2017	Computer science	100	88	UTME
17	05523800FG	Hassan Adamu-08039234501	ADSU-2016/2017	Computer science	100	43	DE
18	05523804FG	Hassan Bello-08039234501	ADSU-2016/2017	Computer science	100	55	DE
19	05577600FG	Benjamin Nathanyahu-08039234501	ADSU-2016/2017	Computer science	100	49	DE
20	05667611YG	Donald Trmph-09039233281	ADSU-2016/2017	Computer science	200	52	DE
21	100000O1GN	Yakubu Musa-08055771000	ADSU-2016/2017	Physics	200	56	DE
22	10011100GN	Aisha Adamu-08055511038	ADSU-2016/2017	Zoology	100	74	UTME

Fig 6: The List of All Qualified Candidates

Figure 6 above shows the list of students that applied for admission into the university and are qualified. The result shows the list of candidates with their JAMB or DE registration number, Name, University, department qualified for, level admitted into, points and finally mode of entry. The point accrued to each candidate is based on the recent JAMB criteria for admission; these include: the point scored in JAMB or DE results converted according to JAMB recent specification, catchment area, education disadvantaged state and O'level grades.

From the list of all qualified candidates as shown in Figure 6 above, candidates admission list for each department will be generated to a specific capacity of a department to which a specific number of admission will be generated is selected, the level and the required number of candidates as well. This process is performed for all the departments of the University, where number of candidates admitted into the department will be based on its size. Moreover, the candidates selected will be based on their cumulative points, where the bests (candidates with highest points) are selected. The remaining candidates whose points could not secure them admission are discarded by the system.

In addition. Figure 7 below shows the combined list of all admitted candidates of the University into various departments. From this list, each department can query the database to get the list of their potential candidates.

Home | Screen Candidates | Register Courses | All Courses | Qualified Candidates | Generate Admission | Admitted Candidates | View By Department | Log Out

LIST OF ADMITTED CANDIDATES

Serial No	Jamb/DE Number	Candidate Name	Phone No	Points	Level	Mode of Entry	Department
1	00000001GN	Barak Obama	08050071000	54	100	DE	Physics
2	00000002GN	Habila m. Sakawa	08069588787	104	100	UTME	Computer Science
3	00000010GN	Asad Alhassan	08050001000	54	100	DE	Mathematics
4	00000021GN	Meshal Obama	08050071000	57	100	DE	Mathematics
5	00010000GN	Kabiru Aliyu	08050011038	77	100	UTME	Chemistry
6	00050000GN	Zulai Aliyu	08050011038	75	100	UTME	Chemistry
7	01004900YG	Farnaa Gaius	07039233281	73	100	UTME	Computer Science
8	01094900YG	Hosea Gaius	07039233281	75	100	UTME	Computer Science
9	01094909YG	Wamanyi Gaius	07039233281	73	100	UTME	Computer Science
10	01114440YG	Falya Ezra	07039233281	93	100	UTME	Computer Science
11	01994410YG	Hyellaidati Ezra	07039233281	90	100	UTME	Computer Science
12	01994440YG	Magdaleen Ezra	07039233281	88	100	UTME	Computer Science
13	05523604FG	Hassan Bello	08049234501	55	100	DE	Computer Science
14	05577600FG	Benjamin Nathanyahu	08039234501	49	100	DE	Computer Science
15	10011100GN	Aisha Adamu	08055511038	74	100	UTME	Zoology
16	11004000YK	Jessy Japhet	07039233281	65	100	UTME	Computer Science
17	11011111YK	Chagya Alex	07039233281	78	100	UTME	Computer Science
18	11011122GN	Lucy Hassan	08055511000	67	100	UTME	Zoology
19	11014100YK	Nachafiya Alex	07039233281	74	100	UTME	Computer Science

Fig 7: List of All Admitted Candidates

Home | Screen Candidates | Register Courses | All Courses | Qualified Candidates | Generate Admission | Admitted Candidates | View By Department | Log Out

VIEW CANDIDATES ADMISSION BY DEPARTMENT

Select Department | View

Serial No	Jamb/DE Number	Candidate Name	Phone No	Points	Level	Mode of Entry	Department
1	00000002GN	Habila m. Sakawa	08069588787	104	100	UTME	Computer Science
2	01004900YG	Farnaa Gaius	07039233281	73	100	UTME	Computer Science
3	01094900YG	Hosea Gaius	07039233281	75	100	UTME	Computer Science
4	01094909YG	Wamanyi Gaius	07039233281	73	100	UTME	Computer Science
5	01114440YG	Falya Ezra	07039233281	93	100	UTME	Computer Science
6	01994410YG	Hyellaidati Ezra	07039233281	90	100	UTME	Computer Science
7	01994440YG	Magdaleen Ezra	07039233281	88	100	UTME	Computer Science
8	05523604FG	Hassan Bello	08049234501	55	100	DE	Computer Science
9	05577600FG	Benjamin Nathanyahu	08039234501	49	100	DE	Computer Science
10	11004000YK	Jessy Japhet	07039233281	65	100	UTME	Computer Science
11	11011111YK	Chagya Alex	07039233281	78	100	UTME	Computer Science
12	11014100YK	Nachafiya Alex	07039233281	74	100	UTME	Computer Science

Exit

Fig 8: List of 12 Admitted Candidates into Computer Science Department

There are 35 number of candidates that applied and qualified for the various courses with various points out of which 14 candidates from computer science were qualified. To demonstrate the Knapsack Problem, it is assumed that the department capacity cannot take all the 14 candidates but only 12 Candudates. Therefore, the model first selects the candidate with highest points in this case Habila M. Sakawa with 104 points, followed by second highest in this case Falya Ezra with 93 points, to the 12th candidate in this case Benjamin Nathanyahu with 49 points. Any other candidate with less than 49 points like Bulus Abege with 47 points and Mohammed Aliyu with 36 points will not be admitted into this department.This result is in conformity with Knapsack Problem which we use to demonstrate its applicability in admission system. The same thing is applied to other departments.From the above discussion, therefore the system is not only screening the qualified candidates but the most qualified ones among the qualified ones to be offered admission.

5. CONCLUSION

This study demonstrates the development of an admission decision support system in order to optimise admission exercise into Nigerian institutions. Admission requirements by Joint Admission and Matriculation Examination Board (JAMB) were taken into consideration. The system was developed based on the requirements using the principle of knapsack model. The system captured the candidates' UTME grade points-level grade points, A-level grade points and a constant for the educationally disadvantaged states and catchment areas as inputs to the system and output the list of most qualified candidates to be offered admission. The system was tested using a sample of 35 students who applied for admission to study in Adamawa state University, Mubi. The result shows that the system selects the most qualified applicants for admission into each Department, it also considers the capacity of each department and ensures that the number of admitted candidates do not exceed the capacity of each department.

6. REFERENCES

[1] Judith E.A and Yusuf L.A (2007) "Admissions into Tertiary institutions un Nigeria", paper presentation at the 33rd annual conference of the international Association for Educational Assessments (IAEA), Baku, Azerbaijan.

[2] Derya Turfan, Cagdan H.A and Ozgur Yeniay (2012)" A New Genetic Algorithm to Solve Knapsack Problem", journal of Social and Economic Statistics, Vol.1, No.2, pp 40-47

[3] Eliman A.A (1991) "A Decission Support System for University Admission Policies", European Journal of Operational Research, Vol.50, issue 2, pp 140-156

[4] Owoloko E.A and Sagoe E.T (2010) "Optimal Advert Placement Slot – Using the Knapsack Problem Model", American Journal of Scientific and Industrial Research, 2010, Vol. 1, issue 1, pp 51-55

[5] Hamdy A. Taha (2017) " Operations Research: An Introduction" 10th edition, Prentice Hall, 2017, ISBN -10: 0134444019.

[6] Guidelines for Admissions into Nigerian Universities 2007/2008.

[7] Mikailu Habila, Wajiga G.M and Zirra P.B (2014) "Students Admission Placement in Nigerian Universities Using Artificial Neural Network", International Journal of Engineering and Science (IJES),Vol.3, issue 4, 2014, pp 31-40.

[8] Viska D.F, Senot Sangadji and Sholihin As'ad (2017) "Integer 0/1 Knapsack Problem Dynamic Programming Approach in Building Maintenace Optimization", International Journal of Science and Applied Science: Conference series, Vol. 2, No.1, 2017.

[9] Ulrich Pferschy and Rosario Scattamacchia (2017) " Improved Dynamic Programming and Approximation Results for the Knapsack Problems with setups", Interntional Transactions in Operational Research, Vol.25, pp 667-680.