A Neutrosophic Similarity Approach to Selection of Department for Student Transiting from JSS3 to SSS1 Class in Nigerian Education System

Misturah Adunni Alaran[1], AbdulAkeem Adesina Agboola[2], Adio Taofik Akinwale[3] and Olusegun Folorunso[4]

[1]Department of Computer Science, Moshood Abiola Polytechnic, Abeokuta, Nigeria, E-mail: alaran.misturah@mapoly.edu.ng
[2]Department of Mathematics, Federal University of Agriculture, Abeokuta, Nigeria, E-mail: agboolaaaa@funaab.edu.ng
[3]Department of Computer Science, Federal University of Agriculture, Abeokuta, Nigeria, E-mail: akinwaleat@funaab.edu.ng
[4]Department of Computer Science, Federal University of Agriculture, Abeokuta, Nigeria, E-mail: folorunsoo@funaab.edu.ng

Abstract. Single-valued neutrosophic set has been of valued importance in multi-criteria decision making problems using similarity measure. Department selection for students moving from JSS to SSS class in Nigerian Education System is such an area where decision taking has been critical as the future career of a student depends of the choice of Department in SSS class. Neutrosophic similarity measure is proposed for this department selection.

Keywords: Similarity measure, BECE, Neutrosophy, UBE, Humanities, Grade legend.

1 Introduction

In 2006, Nigeria adopted the 9-3-4 system education, Universal Basic Education (UBE), which replaces the 6-3-3-4 system of education. This implies a first nine years of Basic and compulsory education i.e. from Primary (6 years) to Junior Secondary School (JSS) (3 years), three (3) years in Senior Secondary School (SSS) and four (7) years in tertiary institution. This new arrangement organized the over-crowded nature of subjects done at basic education level [21][10]. Moving from one class to another on the first 9-year is almost automatic but transiting to next stage requires an assessment to determine who and who qualifies for the next stage in the educational system. Basic Education Certificate Examination (BECE) is written by JSS3 students at the end of this section to determine what the student does next. There are two options; which are either the SSS class or Technical school where the next three (3) years in the education system will be spent. In most of the time, the school admits the academically good students to SSS class while the remaining are referred to Technical school where they school and learn a skill.

The SSS section has four Departments viz Sciences, Humanities, Business Studies and Technology. The basic requirement for any of these departments is majorly based on the students' performance in some key subjects of BECE though the interest of the student would be additional. This problem presents a multi-factor decision which must be handled by appropriate tool for a fair decision making process. Choice making is a delicate exercise that must be carefully managed as it could involve the processes of experimentation, trial and error, decision-making and finally the decision [18]. Single-valued neutrosophic decision making model has been experimented in the choice school for children as determined by their parents. This model is based on hybridization of grey system theory and single valued neutrosophic set considering a real life scenario of five criteria in the choice of school. This model has been proved to be helpful in solving a real life problem in taking correct and appropriate decision [13].

When decision making involves selecting among various contending attributes it is known as Multi-Attributes Decision Making (MADM) and in solving problems like this there is need to involve the processes of sorting and ranking [16]. Recently in research, multi-criteria decision making (MCDM) has been gaining attention especially when it is important to select the best alternatives from list of varying list of alternatives available in relation to some predefined attributes as presented for a particular problem at hand. Decision making becomes much more difficult when alternatives are not precisely stated. This may be due to the fact that information about the attributes/criteria are vague, uncertain or indeterminate. In his work, Smarandache introduced a new philosophy called 'neutrosophy'. This new concept is able to encompass all the past theories in expressing uncertainty [20]. Neutrosophic logic has been noted to be applied in several areas of human endeavours which include but not limited to Science, Engineering, Information Technology, game theory etc [4].

Neutrosophic logic is described as more suitable to be used in decision making as compared to fuzzy and intuitionistic fuzzy logic for the fact that vagueness and impreciseness information are always needed to be put into consideration in solving uncertainty problems. These are as identified in voting for election, football games, rule of penalty etc. The concept of Smarandache about neutrosophy is nearer to human reasoning as it has a better representation of the third component which is indeterminate (neither true nor false) for uncertainty element [6]. A multi-attribute decision method based on Sine, Cosine and Cotangent similarity measures under interval rough neutrosophic environment has been developed and these new methods have been proved to be useful with some appropriate examples in decision making considering interval rough neutrosophic environment [17].

A similarity measure based on single valued neutrosophic sets has been developed. This had been demonstrated to be applicable in single valued neutrosophic multi-criteria decision making. The results as compared to existing decision making methods were better-off. This could be attributed to the fact that this new approach could automatically take into account the indeterminate information provided by decision makers [7]. In the like manner, a tangent similarity measure based multi-attribute decision making of single valued neutrosophic set has been proposed and applied to solve problem in selection of educational stream and medical diagnosis. This concept has also been suggested to be useful in other multi-valued attribute decision making problems especially of neutrosophic nature [12]. Zou and Deng have also proposed a distance function to measure similarity between two single valued neutrosophic sets. In their work, an additional achievement was a new method developed to transform the single valued neutrosophic set into probability assignment. The efficiency of the new method has been proved by applying it to a multi-criteria decision making problem [24].

Some distance and similarity measures between two interval neutrosophic sets have been defined. The measures were applied to solve multi-criteria decision making problems (MCDM). The results of these compared to the results of the existing ones especially Ye's work was reported to be more precise and specific [23]. These proposed similarity measures are useful in real life applications of Science and Engineering such as medical diagnosis, pattern recognition, education etc [8]. The sugar selection device for diabetes patients has been analyzed using Neutrosophic TOPSIS on a MCDM problem where the method (TOPSIS) produced more realistic and reliable results than other existing MCDM techniques as evaluation was based on Spearmen's coefficient [1]. Two new algorithms for medical diagnosis have been developed using distance formulas and similarity measures. Examples have been evaluated numerically and the results thus compared with other existing methods based on normalized Hamming and normalized Euclidean distances [19]. A new framework has also been proposed with four phases for solving the problem of selection process in MCDM. This framework integrated two techniques of Analytical Network Process (ANP) and VIKOR (ViseKriterijumska Optimizacija I Kompromisno Resenje) in neutrosophic environment by using triangular neutrosophic number to present linguistic variable [2]. Neutrosophic TOPSIS method of the type 2 neutrosophic number has also been applied to the solving selection problems as the regards getting the best suppliers for importing cars [3]. Choosing the appropriate personnel for specific job is another area TOPSIS had been applied. This would go a long way in optimizing production cost and assist in meeting corporate goals [15]. While considering classical facts, Oddgram, sumSquare and set-based trigram similarity measures were proposed by Akinwale and Niewiadomski for evaluation of electronic text at subjective examination, retrieval of text matching from the medical database and word list. Their experiment revealed that the proposed methods as compared to existing classical methods of generalized n-gram, bi-gram and tri-gram assigned high values of similarity and performance to price with low running time. They concluded that their proposed methods are very useful in the application areas of the experiment [5].

In this paper, a new neutrosophic similarity measure is proposed in multi-criteria decision making and applied in educational sector where it concerns students' choice of department as they transit from Junior Secondary School (JSS) to Senior Secondary School (SSS) based on their performance in BECE and interests in the various Departments available.

The rest of this paper is arranged as follows, section 2 discusses preliminaries where neutrosophic set, single-valued neutrosophic set and axioms of neutrosophic similarity measures are presented. Section 3 presents the proposed neutrosophic similarity measure for multi-criteria decision making problems and the decision model. The proposed method of application to Department selection for transition from JSS3 to SSS1 is discussed in section 4 with the associated data set. Results, discussion and evaluation of the experiment are discussed in section 5 while the conclusion is finally presented in section 6.

2 Preliminaries

In this section, some definitions of Neutrosophic set, Single-Valued Neutrosophic set (SVNS) and axioms of Neutrosophic Similarity measure are presented.

Definition 1 : Neutrosophic Set

A neutrosophic set A on the universe of discourse X is defined as:

$A = \{< x: T_A(x), I_A(x), F_A(x)>, x \in X\}$ (1)

where the functions $T_A, I_A, F_A : X \rightarrow]^-0, 1^+[$ and

$^-0 \leq T_A(x) + I_A(x) + F_A(x) \leq 3^+$. (2)

From philosophical point of view, the neutrosophic set takes the value from real standard or non-standard subsets of $]^-0, 1^+[$. Therefore, instead of $]^-0, 1^+[$ the interval [0, 1] is taken for technical applications, because $]^-0, 1^+[$ will be difficult to apply in the real applications such as in scientific and engineering problems. For example, the fact that a person could win an election could be 0.7 true, 0.2 false and 0.1 indeterminate. This presents neutrosophy in voting election result.

Definition 2: Single-Valued Neutrosophic Set (SVNS)

A single valued neutrosophic set A is denoted by $A_{SVNS} = (T_A(x), I_A(x), F_A(x))$ for any x in X [11]. For two Single-Valued Neutrosophic sets A and B, let $A_{SVNS} = \{<x: T_A(x), I_A(x), F_A(x)> \mid x \in X\}$ and $B_{SVNS} = \{<x: T_B(x), I_B(x), F_B(x)> \mid x \in X\}$ then two relations are defined in [22] as follows:

i. $A_{SVNS} \subseteq B_{SVNS}$ if and only if $T_A(x) \leq T_B(x)$, $I_A(x) \geq I_B(x)$, $F_A(x) \geq F_B(x)$ (3)
ii. $A_{SVNS} = B_{SVNS}$ if and only if $T_A(x) = T_B(x)$, $I_A(x) = I_B(x)$, $F_A(x) = F_B(x)$ (4)

Other properties as presented in [11] are:

$$A_{SVNS} \cup B_{SVNS} = \left(\max(T_A(x), T_B(x)), \min(\mathrm{I}_A(x), \mathrm{I}_B(x)), \min(\mathrm{F}_A(x), \mathrm{F}_B(x)\right) \quad (5)$$ and

$$A_{SVNS} \cap B_{SVNS} = \left(\min(T_A(x), T_B(x)), \max(\mathrm{I}_A(x), \mathrm{I}_B(x)), \max(\mathrm{F}_A(x), \mathrm{F}_B(x)\right) \quad (6)$$

Definition 3: Axioms of Neutrosophic Similarity measure

A mapping $S(A, B)$: $NS(x) \times NS(x) \rightarrow [0,1]$, where $NS(x)$ denotes the set of all neutrosophic sets in $x = \{x_1, \ldots, x_n)$, is said to be the degree of similarity between A and B in [23][14][9] if it satisfies the following conditions:

1) $0 \leq S(A, B) \leq 1$ (7)

2) S(A, A) = 1 (Reflexive) (8)

2) $S(A, B) = 1$ if and only if $A = B$, $\forall A, B \in NS$ (Local-Reflexive) (9)

3) $S(A, B) = S(B, A)$ (Symmetric) (10)

4) $S(A, C) \leq S(A, B)$ and $S(A, C) \leq S(B, C)$ if $A \leq B \leq C$ for a SVNS C. (11)

where all x is in X. (Transitive)

3 Methodology: Neutrosophic Similarity Measure (N-Sim)

Let $A_{SVNS} = <x: T_A(x), I_A(x), F_A(x)>$ and $B_{SVNS} = <x, T_B(x), I_B(x), F_B(x)$ be two single valued neutrosophic numbers, presented here (eq. 12) is the proposed neutrosophic similarity measure which decides the measure of closeness between any two entities A and B be presented as follows:

$$N-Sim(A,B) = \frac{\sum_{i=1}^{n}\sum_{j=1}^{m} \min(\mathrm{T}_A(\mathrm{x}_i), T_B(\mathrm{x}_j)) + \min(I_A(\mathrm{x}_i), I_B(\mathrm{x}_j)) + \min(F_A(\mathrm{x}_i), F_B(\mathrm{x}_j))}{\sum_{i=1}^{n}\sum_{j=1}^{m} \max(\mathrm{T}_A(\mathrm{x}_i), T_B(\mathrm{x}_j)) + \max(I_A(\mathrm{x}_i), I_B(\mathrm{x}_j)) + \max(F_A(\mathrm{x}_i), F_B(\mathrm{x}_j))} \quad (12)$$

Proposition 1

Suppose the proposed neutrosophic similarity **N-Sim(A,B)** satisfies the similarity measure axioms as stated in eq.(12) then::

1. $0 \leq$ N-Sim(A,B) ≤ 1
2. N-Sim(A,B) = 1 iff A = B

3. N-Sim(A,B) = N-Sim(B, A)
4. If C is a SVNS in X and A⊂B⊂C then N-Sim(A,C) ≤ N-Sim(A,B) and N-Sim(A,C) ≤ N-Sim(B,C)

Proofs:

1. Since $T_A(x)$, $I_A(x)$, $F_A(x) \in [0, 1]$, then N-Sim(A,B) ≤ [0, 1]
2. For any two SNVS A and B if A = B, this implies that $T_A(x) = T_B(x)$, $I_A(x) = I_B(x)$, $F_A(x) = F_B(x)$, then

$$\sum_{i=1}^{n}\sum_{j=1}^{m} \min(\mathrm{T}_A(\mathrm{x}_i), T_B(\mathrm{x}_j)) + \min(I_A(\mathrm{x}_i), I_B(\mathrm{x}_j)) + \min(F_A(\mathrm{x}_i), F_B(\mathrm{x}_j)) = \sum_{i=1}^{n}\sum_{j=1}^{m} \max(\mathrm{T}_A(\mathrm{x}_i), T_B(\mathrm{x}_j)) + \max(I_A(\mathrm{x}_i), I_B(\mathrm{x}_j)) + \max(F_A(\mathrm{x}_i), F_B(\mathrm{x}_j)) \quad (13)$$

Thus N-Sim(A,B) =1, conversely N-Sim(B,A) =1

3. The proof is clear as stated in (2)
4. If A⊂B⊂C then $T_A(x) \le T_B(x) \le T_C(x)$, $I_A(x) \ge I_B(x) \ge I_C(x)$, $F_A(x) \ge F_B(x) \ge F_C(x)$, then the following inequalities hold:

$$\frac{\sum_{i=1}^{n}\sum_{j=1}^{m} \min(\mathrm{T}_A(\mathrm{x}_i), T_c(\mathrm{x}_j)) + \min(I_A(\mathrm{x}_i), I_c(\mathrm{x}_j)) + \min(F_A(\mathrm{x}_i), F_c(\mathrm{x}_j))}{\sum_{i=1}^{n}\sum_{j=1}^{m} \max(\mathrm{T}_A(\mathrm{x}_i), T_c(\mathrm{x}_j)) + \max(I_A(\mathrm{x}_i), I_c(\mathrm{x}_j)) + \max(F_A(\mathrm{x}_i), F_c(\mathrm{x}_j))} \le$$

i. $$\frac{\sum_{i=1}^{n}\sum_{j=1}^{m} \min(\mathrm{T}_A(\mathrm{x}_i), T_B(\mathrm{x}_j)) + \min(I_A(\mathrm{x}_i), I_B(\mathrm{x}_j)) + \min(F_A(\mathrm{x}_i), F_B(\mathrm{x}_j))}{\sum_{i=1}^{n}\sum_{j=1}^{m} \max(\mathrm{T}_A(\mathrm{x}_i), T_B(\mathrm{x}_j)) + \max(I_A(\mathrm{x}_i), I_B(\mathrm{x}_j)) + \max(F_A(\mathrm{x}_i), F_B(\mathrm{x}_j))} \quad (14)$$

Thus ; **N-Sim(A,C) ≤ N-Sim(A,B)**

Also,

$$\frac{\sum_{i=1}^{n}\sum_{j=1}^{m} \min(\mathrm{T}_A(\mathrm{x}_i), T_c(\mathrm{x}_j)) + \min(I_A(\mathrm{x}_i), I_c(\mathrm{x}_j)) + \min(F_A(\mathrm{x}_i), F_c(\mathrm{x}_j))}{\sum_{i=1}^{n}\sum_{j=1}^{m} \max(\mathrm{T}_A(\mathrm{x}_i), T_c(\mathrm{x}_j)) + \max(I_A(\mathrm{x}_i), I_c(\mathrm{x}_j)) + \max(F_A(\mathrm{x}_i), F_c(\mathrm{x}_j))} \le$$

ii. $$\frac{\sum_{i=1}^{n}\sum_{j=1}^{m} \min(\mathrm{T}_B(\mathrm{x}_i), T_C(\mathrm{x}_j)) + \min(I_B(\mathrm{x}_i), I_C(\mathrm{x}_j)) + \min(F_B(\mathrm{x}_i), F_C(\mathrm{x}_j))}{\sum_{i=1}^{n}\sum_{j=1}^{m} \max(\mathrm{T}_B(\mathrm{x}_i), T_C(\mathrm{x}_j)) + \max(I_B(\mathrm{x}_i), I_C(\mathrm{x}_j)) + \max(F_B(\mathrm{x}_i), F_C(\mathrm{x}_j))} \quad (15)$$

Thus; **N-Sim(A,C) ≤ N-Sim(B,C)**

3.1 Single-Valued Neutrosophic Multi-Criteria Decision Making (MCDM) model

Let S1, S2 , ..., Sm be a discrete set of students, C1, C2, ..., Cn be the set of selection factors (criteria) of each student and D1, D2, ..., Dk are the available departments (alternatives) for each student. The ranking alternatives would be deduced by the decision- maker as it affects each student's situation. The ranking thus presents the performances of student S(i = 1, 2,..., m) against the criteria Cj (j = 1, 2, ..., n) [12]. The different values associated with the alternatives for MCDM problem for this study are detailed out in section 4.

4 Experiment: Application of Neutrosophic Similarity Measure in Department Selection From JSS to SSS Class

BECE marks the end of compulsory basic education and the student's performance in this examination determines the actual department to put the student in the SSS section which is a basic foundation for the student's chosen career of higher institution [10]. A student's performance in BECE is graded; Distinction (A), Credit (C), Pass (P) or Fail (F). Out of maximum of ten (10) subjects offered by students in JSS, five (5) subjects are taken to be factors in consideration for the approved Departments in SSS section and the least grade expected for these subjects is Credit (C) for consideration into any desired Department. As a major factor is also the interest of concerned student in the chosen Department. The approved Departments are Science (D1), Humanities (D2), Business Studies (D3) and Technology (D4). The required JSS subject(s) to be passed at credit level of each Department is shown in Table 1.

S/NO	Department	Core Subject(s)
1	Science	(1)Mathematics and (2) Basic Science & Technology (BST)
2	Humanities	(1) English language and (2) Religion & Value Education (RVE)
3	Business Studies	(1) Business Studies (BUS)
4	Technology	(1)Mathematics and (2) Basic Science & Technology (BST)

Table 1: SSS Departments and JSS core subjects

For the purpose of this study, five (5) selection factors for any Department will be considered. These are performance in Maths and BST (C1), performance in English and RVE (C2), performance in BUS (C3), performance in English and Maths (C4) and student's interest in the Departments (C5). Figure 1 presents the proposed algorithm to determine the student's department in SSS considering these various factors in a neutrosophic environment.

Algorithm: Neutrosophic-Based Department Selection for student transiting From JSS to SSS class

Inputs: (1): The grade legends for BECE result in some selected subjects
(2): The neutrosophic values denoting interest of students in various departments
Output: Similarity values between the students and various departments

Procedure:
1. Determine of the relation between departments and selection factors
2. Evaluate the neutrosophic values of each student's grade in the subject
3. Evaluate the relation between the student and the selection factor
4. Determine of the similarity value between the student and the Departments using N-Sim(A, B)
5. Choose the best Department for the student as the highest value from 4
6. End

Figure 1: Algorithm on Neutrosophic-Based Department Selection from JSS to SSS

4.1 Neutrosophication of grades legends

S/NO	GRADE LEGEND	Interpretation	Neutrosophic values
1	A	Excellent	(1.0, 0, 0)
2	C	Credit	(0.6, 0.2, 0.1)
3	P	Pass	(0.4, 0.4, 0.4)
4	F	Fail	(0, 0, 1.0)

Table 2: Neutrosophic values of grade legends of BECE result

This could be determined using the extent of goodness of these grades as mostly desired, this is as presented in table 2. The neutrosophic values for the grades were deduced with the assistance of Senoir teachers in Secondary schools. These values were based on the desired expectation to achieve success in the education sector in accordance with the set goals and objectives of education as designed by Nigerian government.

For Departments where two (2) subjects are factors, the average neutrosophic value is determined (see illustration 1). Table 3 presents the proposed Neutrosophic relation between the Departments and the selection factors as determined by Senior Teachers in Secondary schools with the guidance of 9-3-4 Nigeria Basic Education curriculum.

	C1	C2	C3	C4	C5
D1	(0.8, 0.2, 0.2)	(0.6, 0.2, 0.4)	(0.2, 0.2, 0.7)	(0.7, 0.1,0.1)	(0.8, 0.1, 0.1)
D2	(0.4, 0.3, 0.4)	(0.8, 0.2, 0.1)	(0.4, 0.3, 0.6)	(0.7, 0.1, 0.1)	(0.7, 0.1, 0.2)
D3	(0.5, 0.3, 0.2)	(0.6, 0.3, 0.2)	(0.8, 0.2, 0.1)	(0.6, 0.2,0.2)	(0.6, 0.2, 0.4)
D4	(0.7, 0.2, 0.2)	(0.5, 0.3, 0.3)	(0.2, 0.2, 0.7)	(0.7, 0.1, 0.1)	(0.7, 0.2, 0.3)

Table 3: Relation between Departments and Selection factors

In evaluating a scenario, there is the need to get a relationship between student and the selection factors. Table 4 depicts a relation for student and selection factors based on required subject performances (i.e C1, C2, C3 and C4). Also, for the selection factor which is based on student's interest in the department (C5), there is another table, as the student's interest for each department varies, thus the need to get a relationship between each student's interest and the various departments available as depicted in Table 5.

	C1	C2	…..	Cn
S1	(T_{11}, I_{11}, F_{11})	(T_{12}, I_{12}, F_{12})	….	(T_{1n}, I_{1n}, F_{1n})

Table 4: Student and selection factors relation based on required subject performance

	D1	D2	D3	D4
C5	(T_{11}, I_{11}, F_{11})	(T_{12}, I_{12}, F_{12})	(T_{13}, I_{13}, F_{13})	(T_{14}, I_{14}, F_{14})

Table 5: Student's interest and Department relation

4.2 Illustration 1

Given the grades of a student as English (C), Maths (A), BST (C), RVE(C) and BUS (C). Also, the interests (C5) in various Departments as expressed by a particular student be given as; D1(0.7, 0.3, 0.2), D2(0.5, 0.2, 0.1), D3(0.2, 0.4, 0.2) and D4(0.1, 0.3, 0.6) as depicted in Table 5. Using Table 2, the neutrosophic representation of each required subject is thus computed based on the associated grades as; English(0.6, 0.2, 0.1), Maths(1, 0, 0), BST(0.6, 0.2, 0.1), RVE(0.4, 0.4, 0.4) and BUS(0, 0, 1). The relationship between student and selection factors would be as presented in Table 6a.

	C1	C2	C3	C4
S1	(0.8, 0.1, 0.05)	(0.6, 0.2, 0.1)	(0.6, 0.2, 0.1)	(0.8, 0.1, 0.05)

Table 6a: Student and selection factor for illustration 1

For selection factor C1, the required subjects are Maths and BST, this student's subject grade neutrosophic representation will be computed thus:

C1 = (average(1+0.6), average(0+0.2), average(0+0.1)) = (0.8, 0.1, 0.05).
C2 through C4 are also computed in the same way.

The neutrosophic values of student's interest in each Department, C5, are as expressed by each student when asked. Suppose Table 6b represents the interest of the student whose result is presented in this scenario.

	D1	D2	D3	D4
C5	(0.7, 0.3. 0.2)	(0.5, 0.2, 0.1)	(0.2, 0.4, 0.2)	(0.1, 0.3, 0.6)

Table 6b: Student and Department relation for Illustration 1

Using eq(12); thus we evaluate the similarity between this student's result with the interest and the available Departments;

$$N-Sim(S1,D1)=\frac{(0.8+0.1+0.05)+(0.6+0.2+0.1)+(0.2+0.2+0.1)+(0.7+0.1+0.05)+(0.7+0.1+0.1)}{(0.8+0.2+0.2)+(0.6+0.2+0.4)+(0.6+0.2+0.7)+(0.8+0.1+0.1)+(0.8+0.3+0.2)}$$

$$=\frac{4.1}{6.2}=0.6613$$

Similarly, N-Sim(S1, D2) = 0.5968, N-Sim(S1, D3) = 0.6333 and N-Sim(S1, D4) =0.5539

This illustration presents Science Dept (D1) as the best option as it has the highest similarity value, then Business Studies, Humanities and lastly Technology. These results use the combinations of student's BECE result grades and student's interest in the available Departments.

4.3 Data Set

The data set for this study comprises of 20 students' BECE results for consideration into SSS class. This data spanned some selected Secondary Schools in Abeokuta North Local Government of Ogun State, Nigeria. These schools comprised of both public and private schools. In order to deduce appropriate conclusion from this study, the result of this experiment showing the students' grade legends, the neutrosophic values of students' interests in all departments and the ranking of Department selection method (presented in this study) which shows the extent of recommendation were presented to 50 seasoned teachers not below the rank of Level 12 to rate on a Likert scale of five i.e. Strongly Agree, Agree, Indifferent, Disagree and Strongly Disagree. Then, percentage of each of the acceptance criteria is calculated to know the effectiveness of the proposed neutrosophic recommendation system as compared with experts' judgment. A sample of expert's judgment is shown in figure2.

5 Result, Discussion and Evaluation

BECE results and neutrosophic values of students' interest in each Department were taken as input to get the ranking of Department selection for such student using the proposed neutrosophic Similarity Measure.

S/No	Eng	Maths	Basic Sci & Tech	RVE	Bus Stud	Interest in Science (D1)	Interest in Humanities (D2)	Interest in Business Stud (D3)	Interest in Technology (D4)
1	C	A	C	C	C	0.7, 0.3, 0.2	0.5, 0.2. 0.1	0.8, 0.4, 0.2	0.1, 0.3, 0.6
2	C	A	C	C	C	0.7, 0.3, 0.2	0.5, 0.2, 0.1	0.2, 0.4, 0.2	0.1, 0.3, 0.6
3	A	P	F	A	C	0.7, 0.3,0.2	0.6, 0.2, 0.1	0.4, 0.4, 0.2	0.1, 0.3, 0.6

Table 7: Sample of Students' results and neutrosophic interest in each Department

The neutrosophic input for table 7 is presented in table 8 with the result which reveals the order of proposed Department from most preferred to the least recommended.

Students	C1	C2	C3	C4	C5				Rank of Department Selection
					Interest in Science (D1)	Interest in Humanities (D2)	Interest in Business Stud (D3)	Interest in Technology (D4)	
1	0.80, 0.10, 0.05	0.60, 0.20, 0.10	0.60, 0.20, 0.10	0.80, 0.10, 0.05	0.7, 0.3, 0.2	0.5, 0.2. 0.1	0.8, 0.4, 0.2	0.1, 0.3, 0.6	**D3, D1, D2, D4**
2	0.80, 0.10, 0.05	0.60, 0.20, 0.10	0.60, 0.20, 0.10	0.80, 0.10, 0.05	0.7, 0.3, 0.2	0.5, 0.2, 0.1	0.2, 0.4, 0.1	0.1, 0.3, 0.6	**D1, D3, D2, D4**
3	0.20, 0.20, 0.70	1.00, 0.00, 0.00	0.60, 0.20, 0.10	0.70, 0.20, 0.20	0.7, 0.3,0.2	0.6, 0.2, 0.1	0.4, 0.4, 0.2	0.8, 0.3, 0.2	**D2, D3, D1, D4**

Table 8: Sample of Neutrosophic inputs and the Department rank selection output

- Evaluation

A sample of evaluation sheet is thus presented in figure 2 for this experiment.

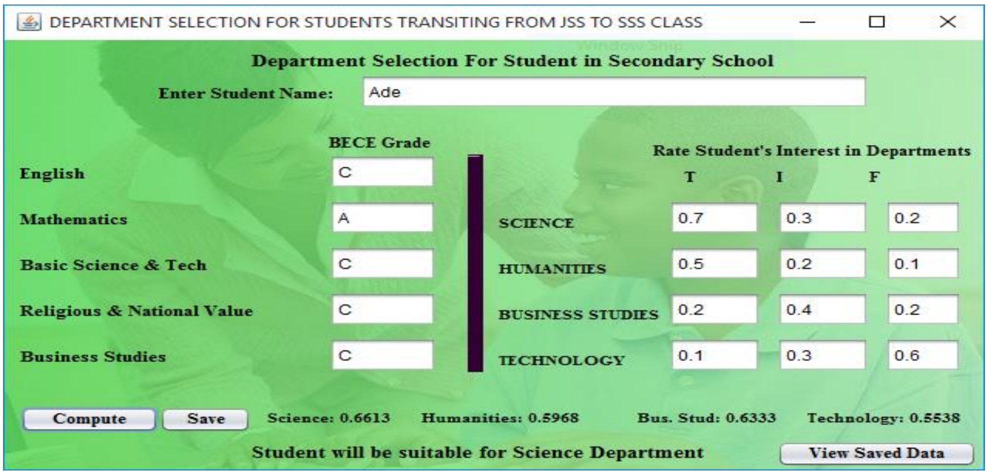
S/No	Eng	maths	Basic Sci & Tech	RVE	Bus Stud	Interest in Science (D1)	Interest in Humanities (D2)	Interest in Business (D3)	Interest in Techno-logy (D4)	Order of dept decision rank	Strongly agree	Agree	Indifferent	Disagree	Strongly disagree
1	C	A	C	C	C	0.7, 0.3, 0.2	0.5, 0.2. 0.1	0.8, 0.4, 0.2	0.1, 0.3, 0.6	D3, D1, D2, D4	✓				
2	C	A	C	C	C	0.7, 0.3, 0.2	0.5, 0.2, 0.1	0.2, 0.4, 0.1	0.1, 0.3, 0.6	D1, D3, D2, D4		✓			
3	A	D	F	A	C	0.7, 0.3,0.2	0.6, 0.2, 0.1	0.4, 0.4, 0.2	0.1, 0.3, 0.6	D2, D3, D1, D4	✓				
4	A	D	F	A	C	0.7, 0.3,0.2	0.6, 0.2, 0.1	0.4, 0.4, 0.2	0.8, 0.3, 0.2	D2, D3, D1, D4	✓				
5	C	A	C	C	F	0.7, 0.3, 0.2	0.5, 0.2, 0.1	0.8, 0.4,0.2	0.1, 0.3, 0.6	D1, D3, D2, D4		✓			
6	C	A	C	C	F	0.4, 0.3, 0.2	0.5, 0.2, 0.1	0.8, 0.2,0.2	0.1, 0.3, 0.6	D3, D1, D2, D4				✓	
7	F	A	F	C	C	0.5, 0.3, 0.2	0.8, 0.2, 0.1	0.6, 0.2, 0.2	0.6, 0.3, 0.5	D3, D4, D2, D1	✓				
8	F	A	F	C	C	0.5, 0.3, 0.2	0.8, 0.2, 0.1	0.4, 0.2, 0.2	0.4, 0.3, 0.6	D3, D2, D4, D1	✓				
9	C	A	A	C	P	0.7, 0.2, 0.2	0.2, 0.2, 0.1	0.3, 0.2, 0.2	0.8, 0.1, 0.1	D1, D4, D2, D3	✓				
10	P	A	F	P	C	0.5, 0.3, 0.2	0.8, 0.2, 0.1	0.6, 0.2, 0.2	0.6, 0.3,B0.5	D3, D4, D2, D1		✓			

The total number and percentage of responses is presented in Table 9 from 992 responses. Considering the desirable results i.e. Strongly Agree and Agree responses a total percentage of 82.86 is obtained which presents that the proposed method is highly rated by experts to be used as a selection tool in deciding the student's Department of choice for SSS class.

S/No	Choice of response	Number or reponses	%
1	Strongly Agree	385	38.81
2.	Agree	437	44.05
3.	Indifferent	73	7.36
4.	Disagree	76	7.66
5.	Strongly Disagree	21	2.12
	Total	**992**	

Table 9: Number and percentage of responses

The new neutrosophic similarity method has been implemented using JAVA programming language embedded in NetBean IDE 8.0.1. This was analyzed on HP laptop with an Intel Pentium 2.20GHz dual core CPU and 2.00GB memory running a 64-bit Windows 10 operating system. An application was developed where grades of students in the required subjects and their interest rating were taken as inputs and the output produces the similarity value for each student with the available departments as shown in figure 3. The application also selects the best option for the Department based on analysis made and it could also save in a specified file for future reference.



Fgure 3: Sample of Automated Department Selection Process

Conclusion

In this paper, a neutrosophic similarity measure has been proposed to assist in taking decision with multi-criteria with single valued neutrosophic value set. An application on selection of Departments for students transiting from Junior Secondary school to Senior Secondary Class has been done with a high percentage of acceptance of 82.86 for the proposed method from teachers who are mostly involved in this kind of exercise. An application also developed to enhance the usage of the new method.

References

[1] M. Abdel-Basset, G. Manogaran, A. Gama,l F, Smarandache. A group decision making framework based on Nesosphic-TOPSIS approach for Smart medical device selection, Journal of Medical Systems, (2019) 43-38. https://doi.org/10.1007/s10916-019-1156-1.

[2] M. Abdel-Baset, V. Chang, A. Gamal, F. Smarandache, An integrated neutrosophic ANP and VIKOR method for achieving sustainable supplier selection: A case study in importing field, Computers in Industry, 106 (2019) 94–110.

[3] M. Abdel-Basset, M. Saleh, A. Gamal, F. Smarandache, An approach of TOPSIS technique for developing supplier selection with group decision making under type-2 neutrosophic number, Applied Soft Computing Journal, (2019) https://doi.org/10.1016/j.asoc.2019.01.035.

[4] S. A. Akinleye, E. O. Adeleke, A. A. A. Agboola, Introduction to Neutrosophic nearrings, Annals of Fuzzy Mathematics and Informatics, 12 (3) (2016) 397-410.

[5] A. Akinwale, A. Niewiadomski, Efficient Similarity measures for texts matching, Journal of Applied Computer Science, 23(1) (2015) 7-28.

[6] S. Alias, D. Mohamad, A Review on Neutrosophic Set and Its Development, Menemui Matematik (Discovering Mathematics), 39(2) (2017) 61-69.

[7] A. Aydoğdu, On Similarity and Entropy of Single Valued Neutrosophic Sets, Gen. Math. Notes, 29(1) (2015) 67-74.

[8] S. Bhattacharyya, B. K. Roy, P. Majumdar, On Distances and Similarity Measures between two interval neutrosophic sets, Journal of New Theory, 20 (2018) 27-47.

[9] S. Broumi, F. Smarandache, Cosine similarity measure of interval valued neutrosophic sets, Neutrosophic Sets and Systems, 5 (2014) 15–20.

[10] E. Efosa, Education System in Nigeria: Primary, Secondary and Tertiary, (2018) https://infoguidenigeria.com/education-system-nigeria/.

[11] K. Mondal, K. Basu, Improved similarity measure in neutrosophic environment and its application in finding minimum spanning tree, Journal of Intelligent & Fuzzy Systems, 31 (2016) 1721–1730. DOI:10.3233/JIFS-152082. IOS Press.

[12] K. Mondal ,S. Pramanik, Neutrosophic Tangent Similarity measure and its application to multiple attribute decision makin, Neutrosophic Sets and Systems, 9 (2015) 80-87.

[13] K. Mondal, S. Pramanik, Neutrosophic Decision Making Model of School Choice, Neutrosophic Sets and Systems, 7 (2015) 62-68. doi.org/10.5281/zenodo.571507.

[14] A. Mukherjee, S. Sarkar, Several similarity measures of neutrosophic soft sets and its application in real life problems, Annals of Pure and Applied Mathematics, 7 (2014) 1–6.

[15] N. A. Nabeeh, F. Smarandache, M. Abdel-Basset, H. A. El-Ghareeb, A. Aboelfetouh. An Integrated Neutrosophic-TOPSIS Approach and Its Application to Personnel Selection: A New Trend in Brain Processing and Analysis, IEEE Access, 7, (2019). 29734-29744.

[16] S. Pramanik, R. Mallick, A. Dasgupt, Contributions of Selected Indian Researchers to Multi-Attribute Decision Making in Neutrosophic Environment: An Overview, Neutrosophic Sets and Systems, 20, (2018) 109-130. http://doi.org/10.5281/zenodo.1284870.

[17] S. Pramanik, R. Roy, T. Kumar Roy, F. Smarandache, Multi-Attribute Decision Making Based on Several Trigonometric Hamming Similarity Measures under Interval Rough Neutrosophic Environment, Neutrosophic Sets and Systems, 19 (2018) 110-118. http://doi.org/10.5281/zenodo.1235207.

[18] O. Salami, O. Salami, The factors Determining the choice of Career among secondary school students, The international Journal of Engineering and Science, 2(6) (2013), 33-44.

[19] G. Shahzadi, M. Akram, A. B. Saeid, An Application of Single-Valued Neutrosophic Sets in Medical Diagnosis, Neutrosophic Sets and Systems,18, 2017, 80-88. http://doi.org/10.5281/zenodo.1175158.

[20] F. Smarandache. A Unifying Field in Logics. Neutrosophy:Neutrosophic Probability, Set and Logic. Rehoboth: American Research Press. (1995).

[21] V. O. Uwaifo, P. S. O. Uddin, Transition from 6-3-3-4 to the 9-3-4 system of Education in Nigeria: An assessment of its implementation on Technology subjects, Stud Home Comm Science. 3(2) (2009) 81-86.

[22] H. Wang, F. Smarandache, Y. Q. Zhang and R. Sunderrama,. Single valued neutrosophic sets, in Multispace and Multistructure 4 (2010), 410–413.

[23] J. Ye, Vector Similarity Measures of Simplified Neutrosophic Sets and Their Application in Multi-criteria Decision Making, International Journal of Fuzzy Systems, 16(2) (2014), 204-211.

[24] J. Zou, Y. Deng, Y. Hu, G. Lin, Measure distance between neutrosophic sets: An evidential approach, (2016).

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