Assessment of English Teaching Systems Using a Single-Valued Neutrosophic MACROS Method

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Abstract: Multi-Criteria Decision Making (MCDM) approaches are an effective tool for dealing with decision-making in various areas. It is a very complex and challenging task for computing an admittable solution with different and conflicting criteria. This work developed a new Measurement of Alternatives and Ranking according to the Compromise Solution (MARCOS) approach for English Teaching System (ETS). The main advantage of using this method is using a cost and profit solution for starting the formulation matrix, calculating the utility degree in both solutions, new way for calculation a function of utility and combination method, employed a large set of criteria and alternatives while keeping stability. ETS is very important for organizations, countries, and governments. It is a very critical task for assessing ETS. This paper proposed an example for using the MARCOS method for Assessment ETS. This example contains five main criteria, twenty-two sub-criteria and six alternatives for assessment ETS. The MARCOS method is employed under Single Valued Neutrosophic Sets (SVNSs) because the assessment ETS contains incomplete and uncertain information. So, SVNSs are an effective tool for overcoming this uncertainty. Scale from 1-5 used for evaluated criteria and alternatives by three experts and decision-makers who have an expert in this field. This paper help organization and countries which want to build an ETS.

Keywords: MARCOS, English Teaching System, SVNSs, Uncertainty.

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1. Introduction

Higher education plays a vital role in the assessment English Teaching System (ETS) by improving the quality of training senor talent[1], [2]. Many countries that do not have an English mother tongue are trying to improve the education process in science and the English language by training students. So this goal is very important to evaluate and enhance the quality of English teaching with the ability of English outstanding[3], [4]. Assessment ETS is a very complex task due to contains many various criteria and alternatives like teaching system, management system, research of scientific, teachers, students, innovation, system integrations and mechanism of teaching, course material, employment, resource utilization, self-study communications skills, various methods and technical skills. So many researchers move toward innovation to assess the ETS by using various methods and functions.

The process of evaluation ETS contains incomplete and vague information. So, we propose a Single Valued Neutrosophic Sets (SVNSs) to overcome this problem through introduce three values truth, indeterminacy and falsity membership degrees. SVNSs used to handle with the incomplete, inconsistent and uncertainty information. It used is this paper to deal with vague information in process assessment ETS. SVNS used in scientific and engineering fields. Due to this problem contains multiple and conflict criteria, the multi-criteria decision making (MCDM) methods were used for this evaluation. We select an MCDM method MARCOS for evaluation ETS. MARCOS method is used for calculation weight of criteria and rank alternatives. It is the best method for dealing with conflict and complex criteria and alternatives. It builds a relationship between criteria and alternatives through cost and benefit ideal solutions. Also, MARCOS is used for calculation the utility degree between cost and benefit ideal solutions. The main benefit of the utility function is to compute the position of alternatives regard cost and benefit ideal solutions. It used to present the anti-ideal and ideal solution and determine utility degree for two solution. It deal effectively with large dimension criteria and alternatives. The best alternative determined by nearest to benefit solution and farness of cost solution.

Stević et al.[5] used the MARCOS method for supplier selection in healthcare industries. They used twenty-one criteria and eight alternatives for their problem. They used fuzzy systems and scales from 1 to 5 to evaluate criteria and alternatives. The main limitations in their paper not considering the indeterminacy value in their calculations. They used only truth, and falsity membership degrees.

Puška et al. [6] used a MARCOS method for the selection of sustainable suppliers. They used fuzzy systems in their calculations. They were not consider the indeterminacy value in their calculations.

The main contributions in this paper, we proposed a hybrid model from SVNSs and the MARCOS method for overcoming the uncertainty in evaluating ETS. We use six alternatives with five main criteria and twenty-two criteria. The indeterminacy value considers in calculations to overcome incomplete information. This paper help decision makers and government to make a best decisions in process of English teaching. This paper aids many countries to develop process of English teaching by providing many criteria that impact in this process.

The rest of this paper presented section two for hybrid model and section three presented an example and results. Section 4 presented conclusions of this paper.

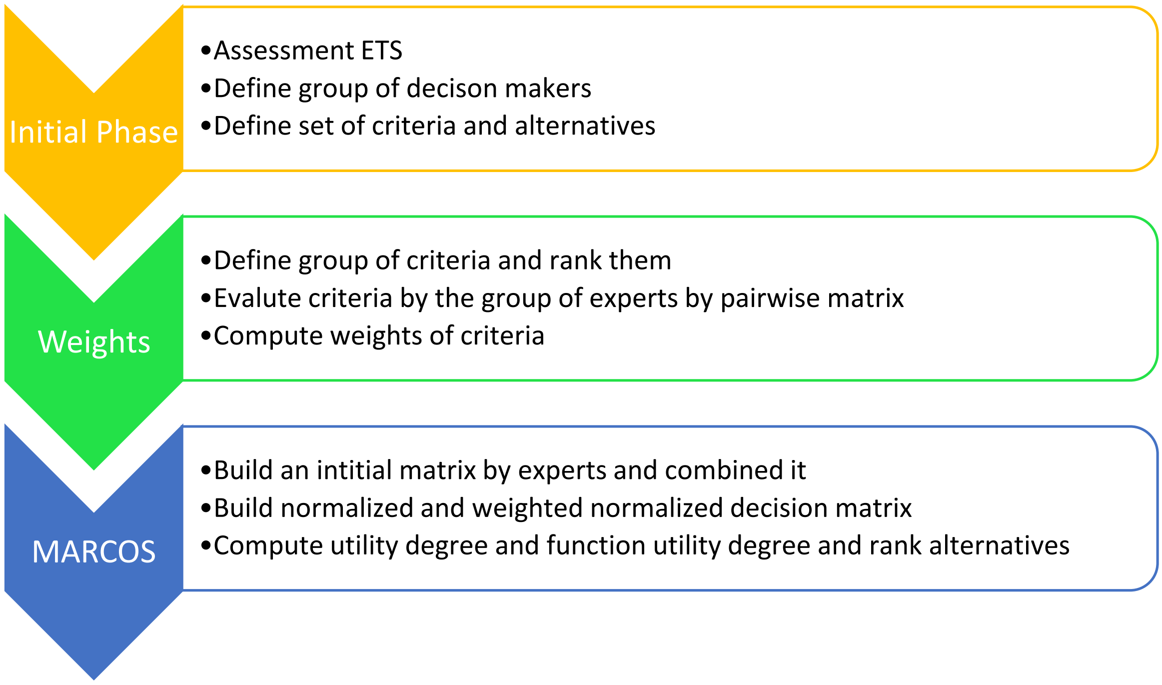

Fig 1. The methodology of this paper

2. Framework of this paper

This section consists form two-part. The first part is calculating the weights of criteria, and the second part rank alternatives and introduce neutrosophic equations. The neutrosophic sets created by Smarandache[7]–[14] . Fig 1. presented the methodology of this paper.

The following definitions with SVNNs.

Definition 1: let $K_1 = (T_1, I_1, F_1)$ $K_2 = (T_2, I_2, F_2)$two single-value neutrosophic numbers (T_1, I_1, F_1) present the Truth, Indeterminacy and Falsity and their operations presented as follow:

Complement $K_1^C = (F_1, 1 - I_1, T_1)$ (1)

Equality $K_1 = K_2$ *if and only if* $K_1 \subseteq K_2$ *and* $K_2 \subseteq K_1$ (2)

Union $K_1 \cup K_2 = (T_1 \vee T_2, I_1 \wedge I_2, F_1 \wedge F_2)$

(3)

Intersection$K_1 \cap K_2 = (T_1 \wedge T_2, I_1 \vee I_2, F_1 \vee F_2)$

(4)

Definition 2: The following addition and multiplication the two SVNSs:

$K_1 \oplus K_2 = (T_1 + T_2 - T_1T_2, I_1 I_2, F_1F_2)$ (5)

$K_1 \otimes K_2 = (T_1T_2, I_1 + I_2 - I_1 I_2, F_1 + F_2 - F_1F_2)$ (6)

Definition 3: The following subtraction and division

$K_1 \ominus K_2 = \left(\frac{T_1 - T_2}{1 - T_2} + \frac{I_1}{I_2}, \frac{F_1}{F_2}\right) k_1 > k_2, T_2 \neq 0, I_2 \neq 0, F_2 \neq 0,$ (7)

$K_1 \oslash K_2 = (\frac{T_1}{T_2} + \frac{I_1 - I_2}{1 - I_2}, \frac{F_1 - F_2}{1 - F_2}) k_2 > k_1, T_2 \neq 0, I_2 \neq 0, F_2 \neq 0,$ (8)

The steps of the MARCOS method are organized as follow:

Step 1: Build an initial decision matrix between criteria and alternatives. So, define the number of criteria, alternatives and experts who evaluate the decision matrix—then combined the initial matrix that includes opinions of various experts into one decision matrix. Then apply score function to obtain the single value instead of three values.

S(A) = $\frac{2+a-b-c}{3}$ (9) where a,b,c refers to Truth, Indeterminacy and Falsity value

Step 2: Define the cost (B) and benefit (A) ideal solution in the initial matrix. This matrix called the extended matrix. The ideal benefit solution computed by the maximum of criteria value considers the best characteristics. But ideal cost solution is the opposite benefit ideal solution. Cost ideal solution computed by the minimum value of each criterion.

Step 3: Build an extended normalized matrix.

$norm_{xy} = \frac{S_x}{A_x}$ for benefit criteria (10)

$norm_{xy} = \frac{A_x}{S_x}$ for cost criteria (11)

Where S_x presented value of decision matrix and A_x present value of benefit ideal solution. x refers to the number of criteria and y refers to number of alternatives

Step 4: Build a weighted normalized decision matrix by multiplying values of the extended normalized matrix by the value of criteria.

$Q_{xy} = norm_{xy} * E_y$ (12)

Where, value of E_y presented weights of criteria.

Step 5: Compute the utility degree of alternatives for benefit and cost ideal solution.

$H_x^+ = \frac{L_x}{L_{A_x}}$ for benefit criteria. (13)

$H_x^- = \frac{L_x}{L_{B_x}}$ for cost criteria. (14)

$L_x = \sum_{x=1}^{n} Q_{xy}$ where L_x summation values of weighted normalized decision matrix (15)

Step 6: Compute the utility function of alternative which show relationship between best and cost ideal solution.

$$f(H_x) = \frac{H_x^+ + H_x^-}{1+\frac{1-f(H_x^+)}{f(H_x^+)}+\frac{1-H_x^-}{H_x^-}} \quad (16)$$

Step 6.1 The utility function for cost and benefit ideal solution can compute as:

$f(H)_x^+ = \frac{H_x^-}{H_x^+ + H_x^-}$ for benefit criteria (17)

$f(H)_x^- = \frac{H_x^+}{H_x^+ + H_x^-}$ for cost criteria (18)

Step 7: Rank alternatives according to the highest value of utility function.

Table 1. The five main and twenty-two sub criteria.

Main Criteria	Sub Criteria
Student's Learning (SL)	Interest of ET ($SL_{.1}$)
	Learning initiative ($SL_{.2}$)
	Self-study ($SL_{.3}$)
	Ability find and solve problems ($SL_{.4}$)
Innovation (I)	Intelligent educational technology ($I_{.1}$)
	Excellent course (I_2)
	Learning base (I_3)
System Integration (SI)	Political Success ($SI_{.1}$)
	Professional Compaction (SI_2)

	Practices and exercises (SI.3)
	Transformation Rate (SI.4)
	Physical achievement (SI.5)
Management (M)	Ability ET Management (M.1)
	Reward and punishment (M2)
	Resource utilization (M.3)
Professional Teachers (PT)	Cognitive comprehension (PT.1)
	Technical skills (PT.2)
	Course materials (PT.3)
	Scientific research (PT.4)
	Communications skills (PT.5)
	Skilled Teachers (PT.6)
	Teaching effect (PT.7)

3. An Example and Results

In this section, we provide an example for a MARCOS method and introduce its results. First, the five main criteria, twenty-two sub-criteria and six alternatives, are used for an example. Table 1 presents five main criteria and twenty-two sub-criteria. The criteria proposed in this work collected for literature review [4], [15]. Fig 2. Present the alternatives proposed in this work.

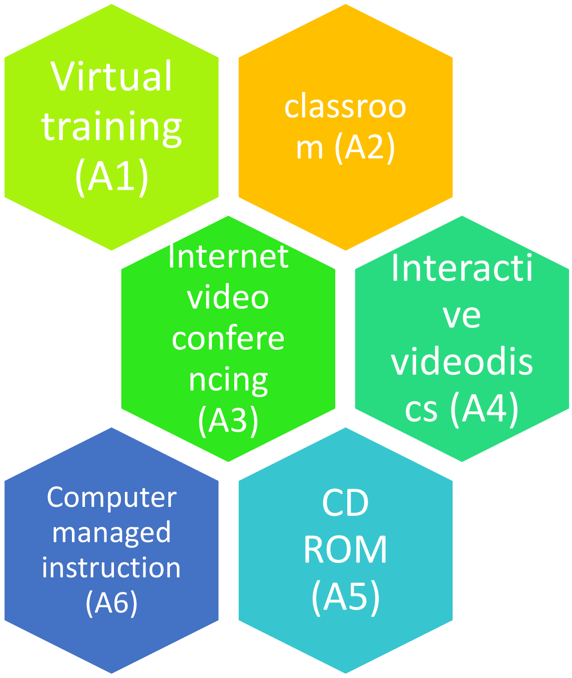

Fig 2. Six alternatives.

Table 2. SVNNS

Linguistics terms	SVNNS
Very Bad (VP)	<0.30,0.75,0.70>
Bad (P)	<0.40,0.65,0.60>
Medium (M)	<0.50,0.50,0.50>
Good (G)	<0.80,0.15,0.20>
Very Good (VG)	<0.90,0.10,0.10>

Three decision-makers and experts evaluated criteria and alternatives by Single-Valued Neutrosophic Numbers in Table 2. Where Very Bad presents the lowest rank and Very Moral presents the highest rank. First, experts evaluated criteria for calculating the weights of criteria. Table 3 presented the opinions of experts for evaluation criteria. The weights of criteria computed by the mean value of criteria for three criteria. Fig 3. presented the weights of five main criteria from Fig 3. Professional teachers are the highest weight of criteria, and system integration is the lowest weight of criteria.

Values in Table 3. Obtained from applying score function of SVNSs using Eq (10).

Table 3. Pairwise matrix for five main criteria

	SL	I	SI	M	PT	Sum
DM1	0.8167	0.383	0.283	0.9	0.8167	3.1994
DM2	0.383	0.9	0.383	0.283	0.8167	2.7657
DM3	0.9	0.9	0.8167	0.383	0.9	3.8997
DM1	0.255267	0.11971	0.088454	0.281303	0.255267	
DM2	0.138482	0.325415	0.138482	0.102325	0.295296	
DM3	0.230787	0.230787	0.209426	0.098213	0.230787	
Mean	0.208179	0.225304	0.145454	0.160613	0.26045	

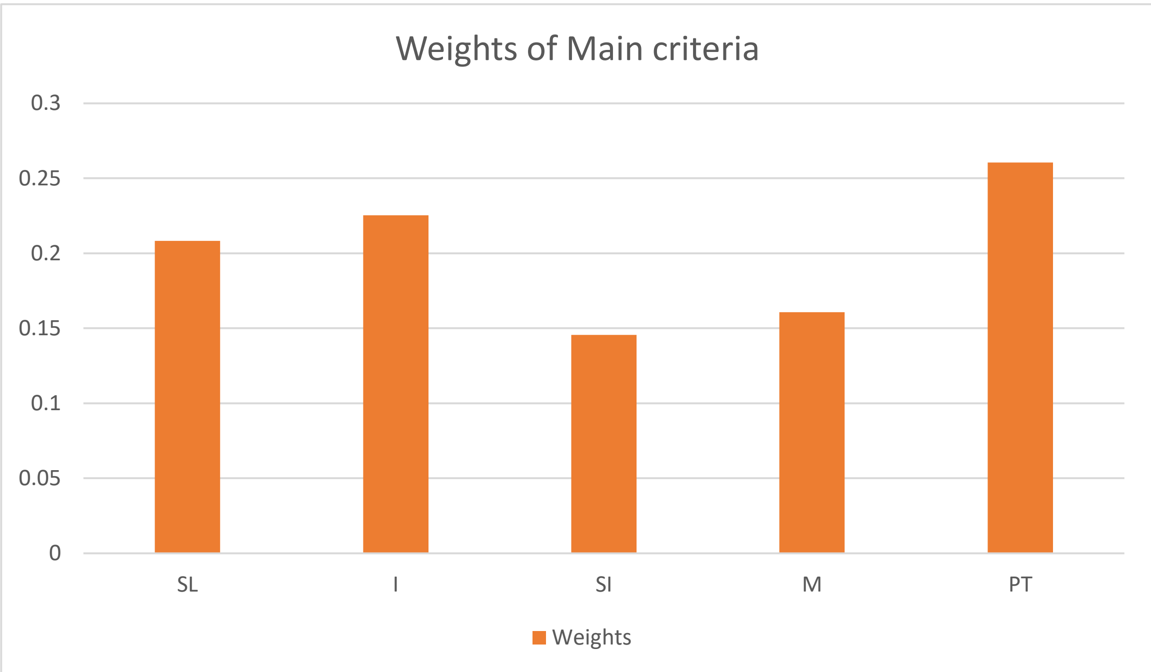

Fig 3. Weights of main criteria

Then evaluate sub-criteria by experts. Table 4-8 present the opinions of experts in twenty-two sub-criteria and weights of sub-criteria. Fig 4-8 present the weights of sub-criteria for five main criteria. Value in Table 4-8 obtained from score function is in Eq. (10).

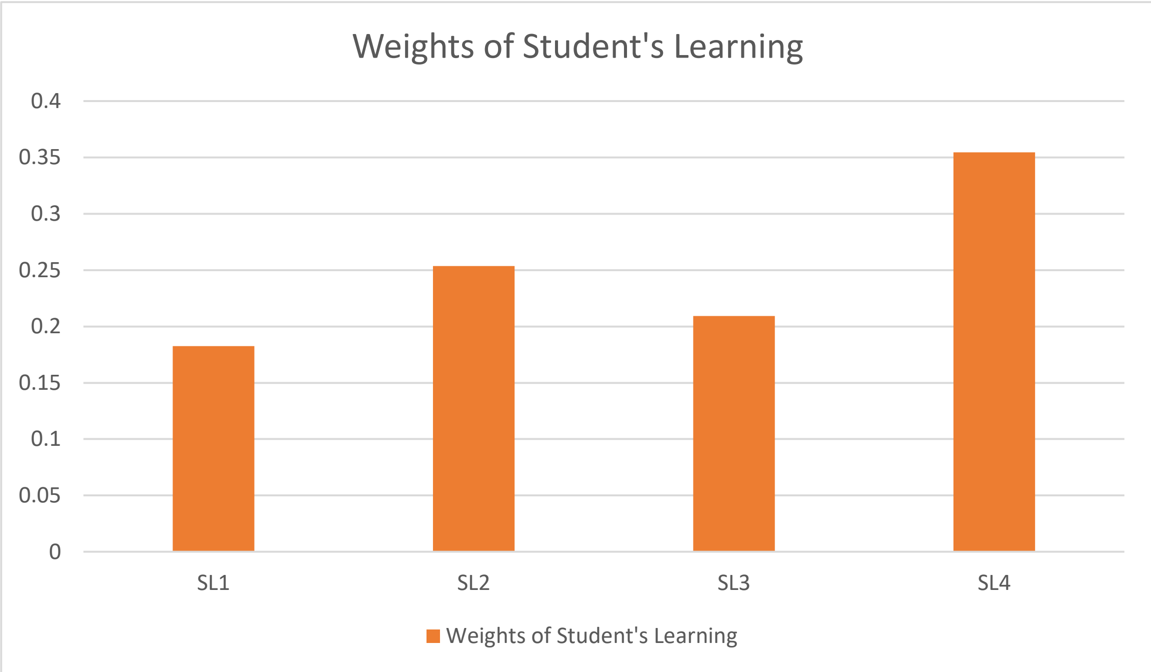

Fig 4. Weights of Student's Learning

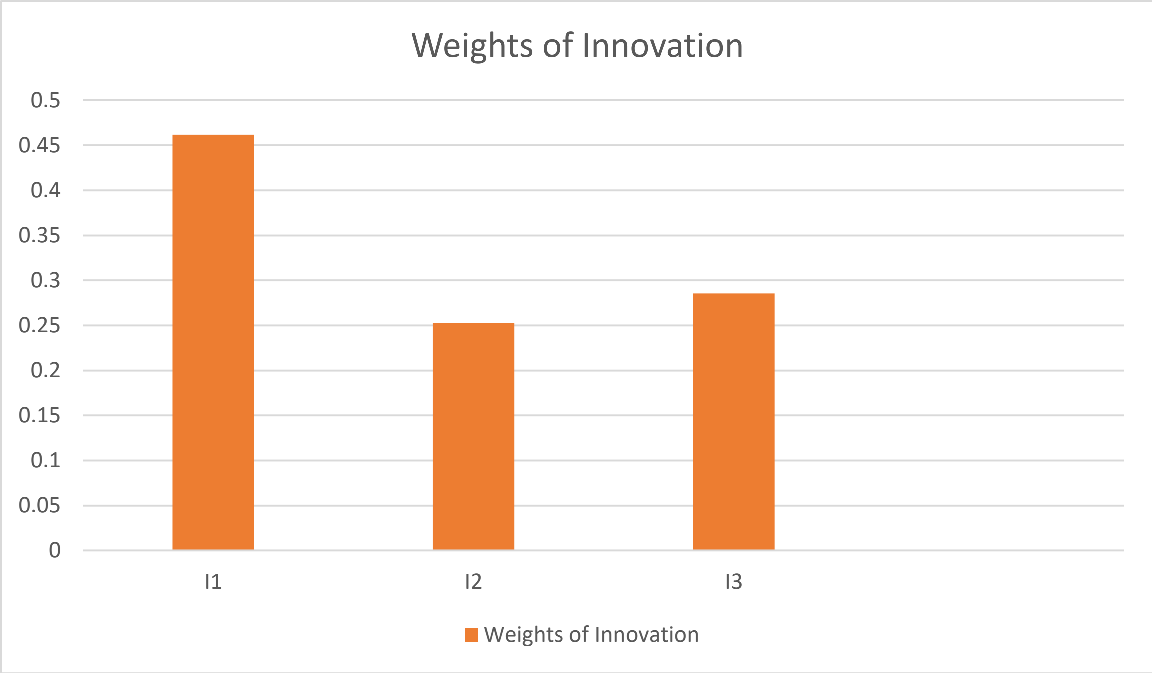

Fig 5. Weights of Innovation.

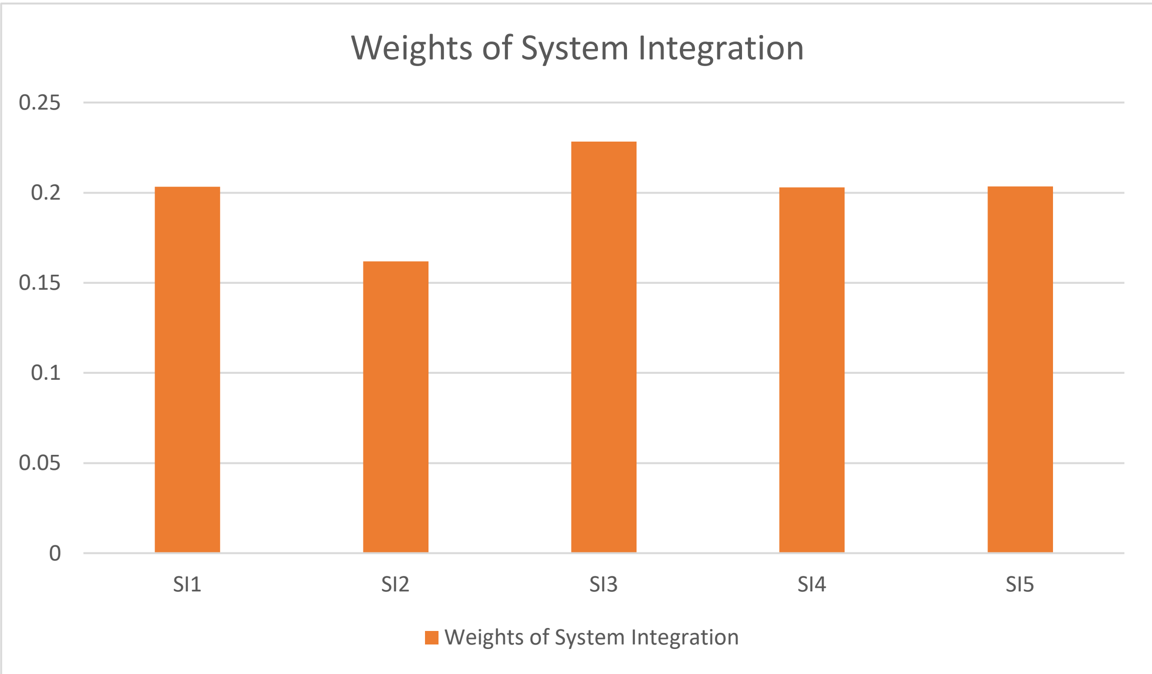

Fig 6. Weights of System Integration.

Fig 7. Weights of Management.

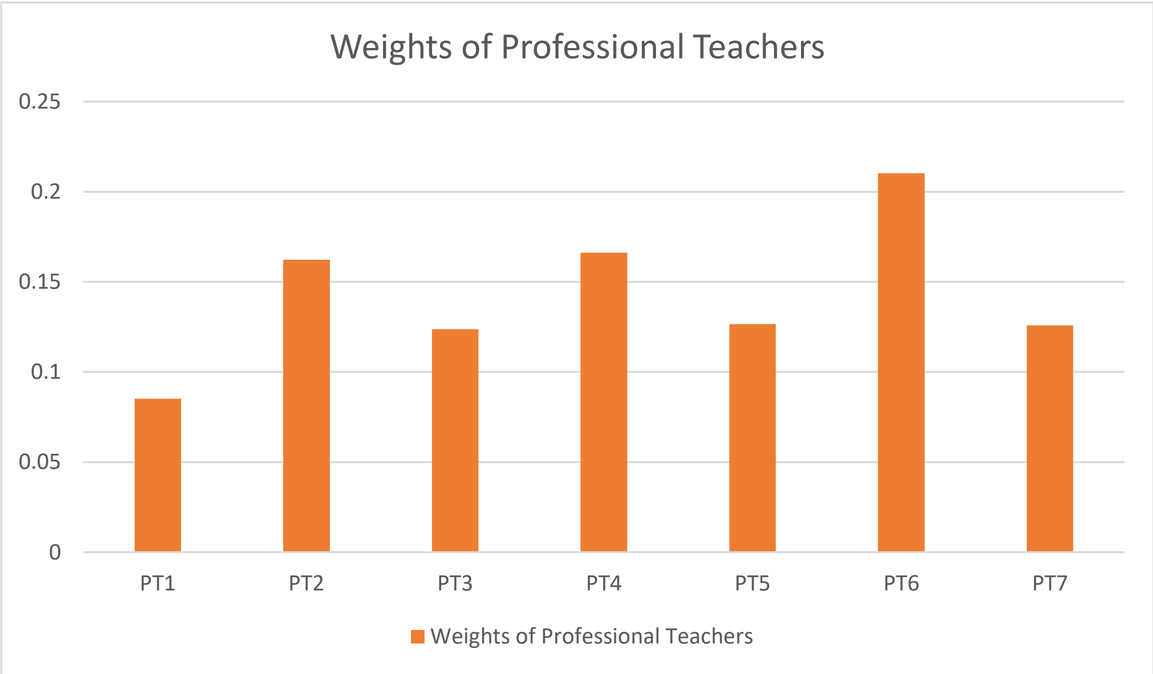

Fig 8. Weights of professional Teachers.

Table 4. Pairwise matrix for Student's Learning

	SL_1	SL_2	SL_3	SL_4	Sum
DM1	0.283	0.9	0.9	0.8167	2.8997
DM2	0.283	0.283	0.383	0.8167	1.7657
DM3	0.8167	0.8167	0.283	0.9	2.8164
DM1	0.097596	0.310377	0.310377	0.28165	
DM2	0.160276	0.160276	0.216911	0.462536	
DM3	0.28998	0.28998	0.100483	0.319557	
Mean	0.182618	0.253544	0.209257	0.354581	

Table 5. Pairwise matrix for Innovation

	I_1	I_2	I_3	Sum
DM1	0.8167	0.383	0.9	2.0997
DM2	0.8167	0.8167	0.5	2.1334
DM3	0.9	0.283	0.283	1.466
DM1	0.38896	0.182407	0.428633	
DM2	0.382816	0.382816	0.234368	
DM3	0.613915	0.193042	0.193042	
Mean	0.461897	0.252755	0.285348	

Table 6. Pairwise matrix for System Integration

	SI_1	SI_2	SI_3	SI_4	SI_5	Sum
DM1	0.9	0.283	0.5	0.9	0.8167	3.3997

DM2	0.8167	0.9	0.9	0.283	0.283	3.1827
DM3	0.283	0.383	0.8167	0.8167	0.9	3.1994
DM1	0.264729	0.083243	0.147072	0.264729	0.240227	
DM2	0.256606	0.282779	0.282779	0.088918	0.088918	
DM3	0.088454	0.11971	0.255267	0.255267	0.281303	
Mean	0.203263	0.16191	0.228372	0.202971	0.203483	

Table 7. Pairwise matrix for Management

	M_1	**M_2**	**M_3**	**Sum**
DM1	0.9	0.283	0.383	1.566
DM2	0.8167	0.5	0.8167	2.1334
DM3	0.283	0.283	0.9	1.466
DM1	0.574713	0.180715	0.244572	
DM2	0.382816	0.234368	0.382816	
DM3	0.193042	0.193042	0.613915	
Mean	0.383524	0.202708	0.413768	

Table 8. Pairwise matrix for Professional Teachers

	PT_1	**PT_2**	**PT_3**	**PT_4**	**PT_5**	**PT_6**	**PT_7**	**Sum**
DM1	0.383	0.8167	0.383	0.8167	0.9	0.8167	0.283	4.3991
DM2	0.283	0.8167	0.283	0.383	0.383	0.9	0.383	3.4317
DM3	0.383	0.283	0.9	0.9	0.283	0.8167	0.9	4.4657

DM1	0.087063	0.185652	0.087063	0.185652	0.204587	0.185652	0.064331	
DM2	0.082466	0.237987	0.082466	0.111606	0.111606	0.262261	0.111606	
DM3	0.085765	0.063372	0.201536	0.201536	0.063372	0.182883	0.201536	
Mean	0.085098	0.162337	0.123689	0.166265	0.126522	0.210265	0.125825	

Then compute the weights of global criteria by multiplying weights of main criteria by weights of sub-criteria. Table 9 presented the values of weights sub-criteria.

Table 9. Global weights for sub criteria.

	Weights
SL.1	0.038017
SL.2	0.052783
SL.3	0.043563
SL.4	0.073816
I.1	0.104067
I.2	0.056947
I.3	0.06429
SI.1	0.029565
SI.2	0.023551
SI.3	0.033218
SI.4	0.029523
SI.5	0.029597
M.1	0.061599
M.2	0.032558
M.3	0.066457
PT.1	0.022164

PT_2	0.042281
PT_3	0.032215
PT_4	0.043304
PT_5	0.032953
PT_6	0.054764
PT_7	0.032771

Then rank six alternatives according to values of the MARCOS method. First, build the three initial matrices that contain the opinions of three matrices with the first row presents the cost ideal solution, and the last row presents the ideal benefit solution. Table 10-12 presented the opinions of three experts. Then combined three decision matrices into one matrix in Table 13. Then normalize the decision matrix in Table 14. Then compute the weighted normalized decision matrix in Table 15. Then compute the utility degree and function utility in Table 16. Then rank alternatives according to the highest value in function utility in Table 16. Fig 9 presented rank of alternatives. The classroom is the highest rank, and CD-ROM is the lowest rank. Values in Table 10-12 obtained through Eq. (10). Column A and B refers to the cost and ideal solution as mentioned in step 2. And all criteria are benefit.

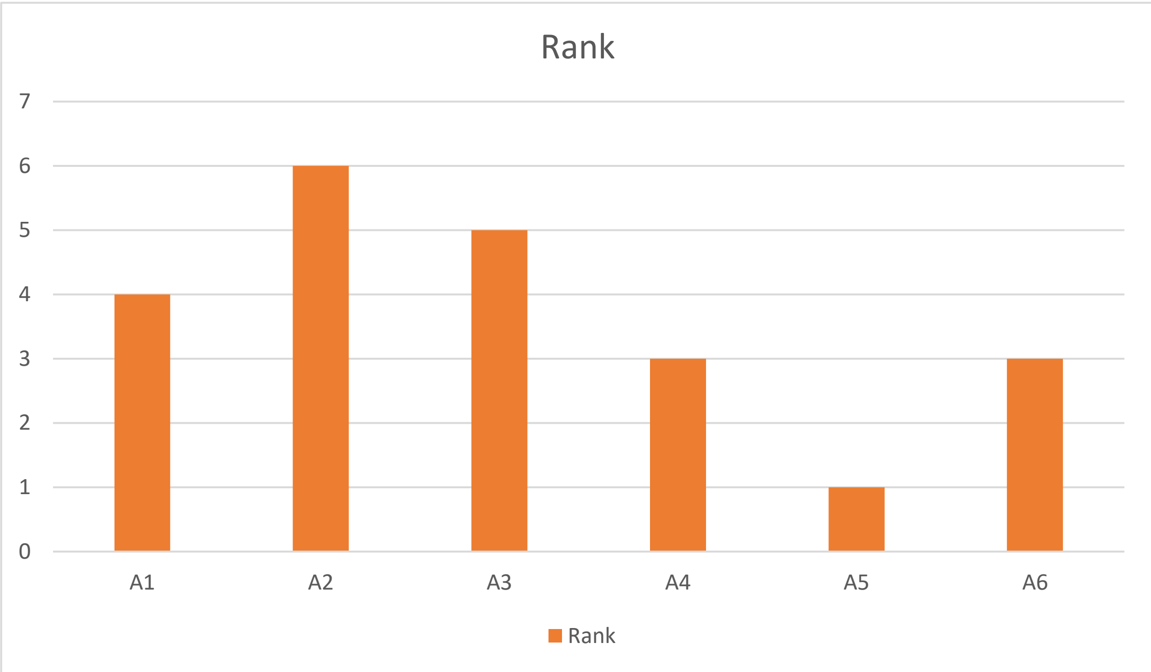

Fig 9. Rank alternatives

Table 10. The initial decision matrix by first expert

DM1	$SL_{.1}$	$SL_{.2}$	$SL_{.3}$	$SL_{.4}$	I_1	I_2	I_3	SI_1	SI_2	SI_3	SI_4	SI_5	M_1	M_2	M_3	$PT_{.1}$	PT_2	PT_3	PT_4	PT_5	PT_6	PT_7
A	0.283	0.383	0.283	0.283	0.283	0.283	0.283	0.283	0.283	0.283	0.283	0.283	0.5	0.283	0.283	0.283	0.283	0.283	0.283	0.283	0.283	0.283
A1	0.283	0.383	0.5	0.8167	0.8167	0.9	0.9	0.8167	0.283	0.383	0.8167	0.5	0.9	0.283	0.9	0.383	0.5	0.9	0.383	0.5	0.8167	0.8167
A2	0.5	0.9	0.9	0.283	0.9	0.8167	0.8167	0.9	0.9	0.9	0.9	0.5	0.5	0.383	0.9	0.283	0.8167	0.8167	0.283	0.8167	0.5	0.5
A3	0.8167	0.5	0.8167	0.383	0.9	0.8167	0.8167	0.5	0.8167	0.383	0.9	0.9	0.5	0.283	0.8167	0.8167	0.283	0.9	0.9	0.9	0.8167	0.5
A4	0.8167	0.9	0.8167	0.9	0.283	0.9	0.283	0.5	0.8167	0.283	0.5	0.283	0.8167	0.383	0.283	0.8167	0.383	0.5	0.5	0.8167	0.9	0.9
A5	0.383	0.5	0.283	0.5	0.5	0.9	0.283	0.283	0.383	0.5	0.8167	0.383	0.8167	0.5	0.5	0.9	0.5	0.8167	0.8167	0.283	0.283	0.9

A6	B
0.283	0.8167
0.383	0.9
0.383	0.9
0.5	0.9
0.9	0.9
0.283	0.9
0.383	0.9
0.383	0.9
0.283	0.9
0.383	0.9
0.283	0.9
0.5	0.9
0.8167	0.9
0.5	0.5
0.283	0.9
0.5	0.9
0.9	0.9
0.283	0.9
0.283	0.9
0.5	0.9
0.383	0.9
0.283	0.9

Table 11. The initial decision matrix by second expert

DM2	A	A1	A2	A3	A4	A5	A6	B
$SL_{.1}$	0.283	0.9	0.5	0.9	0.5	0.283	0.283	0.9
$SL_{.2}$	0.5	0.8167	0.8167	0.5	0.5	0.5	0.8167	0.8167
$SL_{.3}$	0.283	0.8167	0.8167	0.5	0.8167	0.283	0.9	0.9
$SL_{.4}$	0.283	0.5	0.283	0.5	0.9	0.5	0.9	0.9
I_1	0.283	0.283	0.9	0.5	0.283	0.5	0.8167	0.9
I_2	0.283	0.5	0.8167	0.283	0.9	0.9	0.5	0.9
I_3	0.283	0.383	0.8167	0.8167	0.283	0.283	0.9	0.9
SI_1	0.283	0.5	0.9	0.5	0.283	0.283	0.9	0.9
SI_2	0.383	0.8167	0.9	0.8167	0.8167	0.383	0.9	0.9
SI_3	0.283	0.8167	0.9	0.5	0.283	0.5	0.283	0.9
SI_4	0.5	0.9	0.9	0.8167	0.5	0.8167	0.5	0.9
SI_5	0.283	0.8167	0.5	0.9	0.283	0.383	0.8167	0.9
$M_{.1}$	0.283	0.5	0.5	0.8167	0.5	0.8167	0.283	0.8167
$M_{.2}$	0.283	0.5	0.383	0.283	0.383	0.5	0.9	0.9
$M_{.3}$	0.283	0.8167	0.5	0.8167	0.283	0.5	0.383	0.8167
$PT_{.1}$	0.283	0.8167	0.283	0.9	0.8167	0.9	0.383	0.9
PT_2	0.283	0.9	0.8167	0.283	0.383	0.5	0.8167	0.9
PT_3	0.5	0.8167	0.5	0.9	0.5	0.8167	0.5	0.9
PT_4	0.283	0.5	0.283	0.9	0.5	0.5	0.283	0.9
PT_5	0.283	0.5	0.8167	0.9	0.8167	0.283	0.5	0.9
PT_6	0.383	0.5	0.5	0.8167	0.9	0.5	0.383	0.9
PT_7	0.5	0.5	0.9	0.5	0.9	0.9	0.5	0.9

Table 12. The initial decision matrix by third expert

DM3	A	A1	A2	A3	A4	A5	A6	B
$SL_{.1}$	0.283	0.8167	0.283	0.9	0.5	0.283	0.383	0.9
$SL_{.2}$	0.283	0.283	0.8167	0.5	0.5	0.5	0.383	0.8167
$SL_{.3}$	0.283	0.5	0.8167	0.9	0.8167	0.283	0.283	0.9
$SL_{.4}$	0.283	0.9	0.283	0.9	0.9	0.5	0.383	0.9
I_1	0.283	0.383	0.9	0.8167	0.283	0.5	0.283	0.9
I_2	0.283	0.9	0.8167	0.283	0.8167	0.9	0.383	0.9
I_3	0.283	0.283	0.8167	0.5	0.283	0.283	0.5	0.8167
SI_1	0.283	0.8167	0.9	0.5	0.283	0.283	0.5	0.9
SI_2	0.383	0.5	0.9	0.8167	0.8167	0.383	0.5	0.9
SI_3	0.283	0.8167	0.9	0.5	0.283	0.5	0.5	0.9
SI_4	0.5	0.8167	0.9	0.9	0.5	0.8167	0.5	0.9
SI_5	0.283	0.9	0.5	0.9	0.283	0.383	0.9	0.9
$M_{.1}$	0.283	0.283	0.5	0.383	0.5	0.8167	0.283	0.8167
$M_{.2}$	0.283	0.8167	0.383	0.283	0.383	0.5	0.383	0.8167
$M_{.3}$	0.283	0.9	0.5	0.8167	0.5	0.5	0.283	0.9
$PT_{.1}$	0.283	0.9	0.283	0.9	0.8167	0.9	0.283	0.9
PT_2	0.283	0.8167	0.5	0.283	0.383	0.5	0.5	0.8167
PT_3	0.5	0.9	0.5	0.9	0.5	0.8167	0.8167	0.9
PT_4	0.283	0.9	0.283	0.283	0.5	0.5	0.383	0.9
PT_5	0.283	0.383	0.8167	0.283	0.8167	0.283	0.8167	0.8167
PT_6	0.5	0.8167	0.5	0.9	0.9	0.5	0.8167	0.9
PT_7	0.283	0.8167	0.9	0.5	0.283	0.9	0.383	0.9

Table 13. The Combined decision matrix.

	A	A1	A2	A3	A4	A5	A6	B
SL.$_{1}$	0.283	0.666567	0.427667	0.872233	0.605567	0.316333	0.316333	0.872233
SL.$_{2}$	0.388667	0.494233	0.844467	0.5	0.633333	0.5	0.527567	0.844467
SL.$_{3}$	0.283	0.605567	0.844467	0.7389	0.8167	0.283	0.522	0.9
SL.$_{4}$	0.283	0.7389	0.283	0.594333	0.9	0.5	0.594333	0.9
I$_{1}$	0.283	0.494233	0.9	0.7389	0.283	0.5	0.666567	0.9
I$_{2}$	0.283	0.766667	0.8167	0.4609	0.872233	0.9	0.388667	0.9
I$_{3}$	0.283	0.522	0.8167	0.711133	0.283	0.283	0.594333	0.872233
SI$_{1}$	0.283	0.711133	0.9	0.5	0.355333	0.283	0.594333	0.9
SI$_{2}$	0.349667	0.533233	0.9	0.8167	0.8167	0.383	0.561	0.9
SI$_{3}$	0.283	0.672133	0.9	0.461	0.283	0.5	0.388667	0.9
SI$_{4}$	0.427667	0.844467	0.9	0.872233	0.5	0.8167	0.427667	0.9
SI$_{5}$	0.283	0.7389	0.5	0.9	0.283	0.383	0.7389	0.9
M$_{1}$	0.355333	0.561	0.5	0.566567	0.605567	0.8167	0.4609	0.844467
M$_{2}$	0.283	0.533233	0.383	0.283	0.383	0.5	0.594333	0.7389
M$_{3}$	0.283	0.872233	0.633333	0.8167	0.355333	0.5	0.316333	0.872233
PT$_{1}$	0.283	0.6999	0.283	0.872233	0.8167	0.9	0.388667	0.9
PT$_{2}$	0.283	0.7389	0.711133	0.283	0.383	0.5	0.7389	0.872233
PT$_{3}$	0.427667	0.872233	0.605567	0.9	0.5	0.8167	0.533233	0.9
PT$_{4}$	0.283	0.594333	0.283	0.694333	0.5	0.605567	0.316333	0.9
PT$_{5}$	0.283	0.461	0.8167	0.694333	0.8167	0.283	0.605567	0.872233
PT$_{6}$	0.388667	0.711133	0.5	0.844467	0.9	0.427667	0.527567	0.9
PT$_{7}$	0.355333	0.711133	0.766667	0.5	0.694333	0.9	0.388667	0.9

Table 14. The Normalized decision matrix.

	SL.$_{1}$	SL.$_{2}$	SL.$_{3}$	SL.$_{4}$	I$_{1}$	I$_{2}$	I$_{3}$	SI$_{1}$	SI$_{2}$	SI$_{3}$	SI$_{4}$	SI$_{5}$	M$_{1}$	M$_{2}$	M$_{3}$	PT$_{1}$	PT$_{2}$	PT$_{3}$	PT$_{4}$	PT$_{5}$	PT$_{6}$	PT$_{7}$

B	A6	A5	A4	A3	A2	A1	A
1	0.362671	0.362671	0.694271	1	0.490312	0.764207	0.324454
1	0.624734	0.59209	0.74998	0.59209	1	0.585261	0.460251
1	0.58	0.314444	0.907444	0.821	0.938296	0.672852	0.314444
1	0.66037	0.555556	1	0.66037	0.314444	0.821	0.314444
1	0.74063	0.555556	0.314444	0.821	1	0.549148	0.314444
1	0.431852	1	0.969148	0.512111	0.907444	0.851852	0.314444
1	0.681393	0.324454	0.324454	0.815302	0.936332	0.598464	0.324454
1	0.66037	0.314444	0.394815	0.555556	1	0.790148	0.314444
1	0.623333	0.425556	0.907444	0.907444	1	0.592481	0.388519
1	0.431852	0.555556	0.314444	0.512222	1	0.746815	0.314444
1	0.475185	0.907444	0.555556	0.969148	1	0.938296	0.475185
1	0.821	0.425556	0.314444	1	0.555556	0.821	0.314444
1	0.545788	0.967119	0.7171	0.670917	0.59209	0.664325	0.420778
1	0.804349	0.676682	0.518338	0.383002	0.518338	0.721658	0.383002
1	0.362671	0.573241	0.407383	0.936332	0.726105	1	0.324454
1	0.431852	1	0.907444	0.969148	0.314444	0.777667	0.314444
1	0.847136	0.573241	0.439103	0.324454	0.815302	0.847136	0.324454
1	0.592481	0.907444	0.555556	1	0.672852	0.969148	0.475185
1	0.351481	0.672852	0.555556	0.771481	0.314444	0.66037	0.314444
1	0.694271	0.324454	0.936332	0.796041	0.936332	0.528528	0.324454
1	0.586185	0.475185	1	0.938296	0.555556	0.790148	0.431852
1	0.431852	1	0.771481	0.555556	0.851852	0.790148	0.394815

Table 15. The weighted normalized decision matrix.

	A
$SL_{.1}$	0.012335
$SL_{.2}$	0.024293
$SL_{.3}$	0.013698
$SL_{.4}$	0.023211
I_1	0.032723
I_2	0.017907
I_3	0.020859
$SI_{.1}$	0.009297
$SI_{.2}$	0.00915
$SI_{.3}$	0.010445
SI_4	0.014029
$SI_{.5}$	0.009307
$M_{.1}$	0.02592
$M_{.2}$	0.01247
$M_{.3}$	0.021562
$PT_{.1}$	0.006969
PT_2	0.013718
PT_3	0.015308
PT_4	0.013617
PT_5	0.010692
PT_6	0.02365
PT_7	0.012938

A1	A2	A3	A4	A5	A6	B
0.029053	0.01864	0.038017	0.026394	0.013788	0.013788	0.038017
0.030892	0.052783	0.031252	0.039586	0.031252	0.032975	0.052783
0.029311	0.040875	0.035765	0.039531	0.013698	0.025266	0.043563
0.060603	0.023211	0.048746	0.073816	0.041009	0.048746	0.073816
0.057148	0.104067	0.085439	0.032723	0.057815	0.077075	0.104067
0.04851	0.051676	0.029163	0.05519	0.056947	0.024593	0.056947
0.038475	0.060197	0.052416	0.020859	0.020859	0.043807	0.06429
0.023361	0.029565	0.016425	0.011673	0.009297	0.019524	0.029565
0.013953	0.023551	0.021371	0.021371	0.010022	0.01468	0.023551
0.024807	0.033218	0.017015	0.010445	0.018454	0.014345	0.033218
0.027701	0.029523	0.028612	0.016402	0.026791	0.014029	0.029523
0.024299	0.016443	0.029597	0.009307	0.012595	0.024299	0.029597
0.040922	0.036472	0.041328	0.044173	0.059574	0.03362	0.061599
0.023496	0.016876	0.01247	0.016876	0.022031	0.026188	0.032558
0.066457	0.048255	0.062226	0.027073	0.038096	0.024102	0.066457
0.017236	0.006969	0.02148	0.020112	0.022164	0.009571	0.022164
0.035817	0.034471	0.013718	0.018566	0.024237	0.035817	0.042281
0.031221	0.021676	0.032215	0.017897	0.029233	0.019087	0.032215
0.028596	0.013617	0.033408	0.024058	0.029137	0.01522	0.043304
0.017416	0.030855	0.026232	0.030855	0.010692	0.022878	0.032953
0.043271	0.030424	0.051384	0.054764	0.026023	0.032102	0.054764
0.025894	0.027916	0.018206	0.025282	0.032771	0.014152	0.032771

Table 16. Utility, function utility and rank alternatives.

	L_x	H_x^+	H_x^-	f(H_x^+)	f(H_x^-)	$(f(H_x)$	Rank
A	0.354097						
A1	0.738442	0.738442	2.085423	0.7385	0.2615	0.675859	3
A2	0.751279	0.751279	2.121677	0.7385	0.2615	0.687609	1
A3	0.746485	0.746485	2.108137	0.7385	0.2615	0.683221	2
A4	0.636951	0.636951	1.798806	0.7385	0.2615	0.58297	4

A5	0.606483	0.606483	0.354097	0.368628	0.631372	0.291384	6
A6	0.585865	0.585865	1.654533	0.7385	0.2615	0.536213	5
B	1						

4. Conclusions

This paper introduces assessment ETS through an MCDM method. A new method is an extension of SVNSs called MARCOS. The main idea of this method proposed a relationship between alternatives and cost, benefit ideal solutions. Also, MARCOS is used for computing utility degree and function utility degree for cost and benefit ideal solution. Then rank alternatives through the highest value of function utility degree. ETS was proposed through the MARCOS method with six alternatives, five main criteria and twenty-two sub-criteria. Three experts and decision-makers who have experience in this area evaluated criteria and alternatives. In this paper, the weights of criteria and rank of alternatives were determined.

From the outcome, professional teachers are the highest, and system integration is the lowest. While in alternatives, the CD-ROM is the lowest in alternatives, and the classroom is the highest in alternatives. MARCOS method is an effective tool for dealing with uncertain information.

References

[1] A. P. Ayala and H. G. V. Berumen, "Evaluation of the influence that higher education boosts on students' entrepreneurial proclivity: Evidence from Mexico and Spain: Article 100404," *Int. J. Manag. Educ.*, vol. 18, no. 3, pp. 1–21, 2020.

[2] R. Matsuoka, "Concerted cultivation developed in a standardized education system," *Soc. Sci. Res.*, vol. 77, pp. 161–178, 2019.

[3] K.-D. Vattøy and K. Smith, "Students' perceptions of teachers' feedback practice in teaching English as a foreign language," *Teach. Teach. Educ.*, vol. 85, pp. 260–268, 2019.

[4] N. Li, "A Fuzzy Evaluation Model of College English Teaching Quality Based on Analytic Hierarchy Process," *Int. J. Emerg. Technol. Learn.*, vol. 16, no. 2, pp. 17–30, 2021.

[5] Ž. Stević, D. Pamučar, A. Puška, and P. Chatterjee, "Sustainable supplier selection in healthcare industries using a new MCDM method: Measurement of alternatives and ranking according to COmpromise solution (MARCOS)," *Comput. Ind. Eng.*, vol. 140, p. 106231, 2020.

[6] A. Puška, Ž. Stević, and I. Stojanović, "Selection of Sustainable Suppliers Using the Fuzzy MARCOS Method," *Curr. Chinese Sci.*, vol. 1, no. 2, pp. 218–229, 2021.

[7] F. Smarandache, "Neutrosophic set-a generalization of the intuitionistic fuzzy set," *Int. J. pure Appl. Math.*, vol. 24, no. 3, p. 287, 2005.

[8] F. Smarandache, "Neutrosophic set–a generalization of the intuitionistic fuzzy set," *J. Def. Resour. Manag.*, vol. 1, no. 1, pp. 107–116, 2010.

[9] F. Smarandache, "Neutrosophic set is a generalization of intuitionistic fuzzy set, inconsistent intuitionistic fuzzy set (picture fuzzy set, ternary fuzzy set), pythagorean fuzzy set, spherical fuzzy set, and q-rung orthopair fuzzy set, while neutrosophication is a generalization of regret theory, grey system theory, and three-ways decision (revisited)," *J. New Theory*, no. 29, pp. 1–31, 2019.

[10] F. Smarandache, "Neutrosophy, neutrosophic probability, set and logic, American Res," *Press. Rehoboth, USA*, 1998.

[11] F. Smarandache, "Linguistic paradoxes and tautologies," *Collect. Pap. Vol. III*, vol. 3, p. 122, 2000.

[12] F. Smarandache, "A unifying field in Logics: Neutrosophic Logic.," in *Philosophy*,

American Research Press, 1999, pp. 1–141.

[13] S. Pramanik, R. Roy, T. K. Roy, and F. Smarandache, “Multi-attribute decision making based on several trigonometric hamming similarity measures under interval rough neutrosophic environment,” *Neutrosophic Sets Syst.*, vol. 19, pp. 110–118, 2018.

[14] S. Broumi and F. Smarandache, “Interval neutrosophic rough set,” *Neutrosophic Sets Syst.*, vol. 7, pp. 23–31, 2015.

[15] H. Li, “Improved fuzzy-assisted hierarchical neural network system for design of computer-aided English teaching system,” *Comput. Intell.*, 2020.

Received: May 9, 2021. Accepted: October 1, 2021