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Intelligent Approach for School Teacher Recruitment: Distributing IT Subjects Based on Multiple Attributes

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Abstract: Choosing suitable IT courses for potential applicants or graduates based on their academic performance (GPA) and soft skills is a multicriteria decision-making (MCDM) problem due to three factors: multiple evaluation criteria, uncertain importance levels of these criteria and data variability. In this study, data from 80 Bachelor of Education (Information Technology) honour graduates (AT20) at Sultan Idris Education University's School of Art, Computing and Creative Industry in 2017 was analysed. A decision matrix was constructed for each applicant based on the analysed data. The analytic hierarchy process (AHP) and VIseKriterijumska Optimizacija I Kompromisno Resenje (VIKOR) methods were used to determine the criteria weights and rank the IT subjects for each applicant, respectively. Results indicated the following: (i) AHP effectively allocated weights to the evaluation criteria, with GPA receiving the highest weight of 0.708 and soft skills obtaining a weight of 0.292. (ii) The integration of AHP and VIKOR (intelligent approach) efficiently ranked each IT subject for each applicant and assigned the highest-ranked subject to the applicants. A systematic ranking was conducted to validate the proposed results. Selecting IT subjects for graduates based on GPA and soft skills can considerably affect the quality of education, the success of schools and the professional development of individual educators. By incorporating these factors into the hiring process, educational institutions can foster more diverse, adaptable and high-performing teaching staff applicants.

Keywords: AHP; Multicriteria decision-making; School teacher recruitment; VIKOR.

1. INTRODUCTION

Education plays a crucial role in fostering creativity and innovation and equipping individuals with the skills and knowledge necessary for national growth. Social and economic well-being considerably depend on the development of education [1]. Higher education institutions are striving to enhance their student assessment systems by paying close attention to student accomplishments. This approach encourages a competitive spirit and pushes students to meet global standards in terms of quality. One way to improve student skills involves refining exam scoring techniques, which typically involve systematically gathering and discussing information for recording student learning outcomes and degree attainment [2].

The evaluation of student learning processes and acquired competencies (abilities, knowledge, independence, skills, and responsibility towards learning) is determined through established tools, procedures and methods [2]. Over the past two decades, remarkable shifts have occurred in higher education student evaluation. Current trends favour continuous assessment, which some researchers view as uncontroversial [3] due to its connection to active, student-centred learning [4]. Various assessment tools suggest that group and peer learning processes should be heavily emphasised, as they are perceived as effective and authentic in assessing factors closely related to employment. As such, research on university-level assessment focuses primarily on students' learning benefits from different assessment methods. Consequently, new assessment tools that can efficiently implement learning assessment principles are needed. One issue with many new techniques is that they emphasise student 'performativity', which pertains to the regular public evaluation of visible student behaviour rather than private assessment [5].

This study can serve as a valuable guide for many school administrations in choosing the best IT courses for each applicant. Monitoring and evaluating student performance throughout their learning and analysing the relationship between this aspect and other variables in education is essential for identifying relevant factors related to performance. This analysis also helps classify students, thereby enhancing their learning effectiveness [6]. Therefore, this study explores the optimal method for selecting the most appropriate IT courses, which is important because it assists schools in selecting the best IT courses for each applicant. This approach enables schools to hire teachers using a fair and systematic method.

Securing skilled teachers in schools is a formidable challenge. Current evidence indicates a concerning decline in the intellectual quality of individuals choosing to enter the teaching profession [7]. If the quality of teachers decreases, then the education they deliver is likely to suffer. Teaching has often been regarded as an 'easy in' career [8], with conditions that encourage low professional commitment. High-quality teachers cannot emerge from those who are less committed, as they must cater to the diverse needs of younger generations. Mastery of the subject matter is not the sole prerequisite; good teachers should also possess amiable personalities, build effective connections with students and use engaging teaching methods. Teachers' behaviour serves as a model for students [9]; thus, they should demonstrate excellent personal, professional and social qualities.

In Malaysia, teacher quality has been a long-standing issue. Fewer strong candidates apply for teaching positions due to low wages, status and facilities [10, 11]. Qualifications and criteria for becoming a teacher are influenced by factors, such as soft skills and university performance grades. Though this information is readily available, it has not been used as the primary measure for selecting the best IT course for each applicant who fits a specific teaching direction [12]. Lately, the emphasis has been on selecting the most suitable candidates for initial teacher education (ITE), with the aim of choosing individuals who demonstrate exceptional cognitive skills (intelligence, teaching practice awareness, literacy and numeracy skills, subject knowledge) and well-developed noncognitive attributes (self-regulation, reflection, commitment to the profession, emotional resilience and interpersonal skills) [13]. Relying solely on academic performance may not always yield the best professional candidates [14]. In choosing IT courses for teachers, noncognitive attribute assessment is often conducted informally through personal statement evaluations and behavioural observations during interviews. The current selection process is resource intensive, time consuming and dependent on the intuition and expertise of the interviewers.

Recently, noncognitive traits have gained prominence in the selection of teacher candidates. The grades and soft skills attained by candidates may influence their areas of expertise. Additionally, students who have excelled in related courses at the school level may contribute to teaching quality [14, 15]. For instance, students with high GPAs and strong soft skills are more capable of teaching in schools and are highly sought after by employers. These students help improve the quality of education and the students they teach. However, factors, such as GPA and soft skills, which are considered large-scale data, have not been adequately utilised in determining suitable IT courses for applicants. The era of large-scale data collection for university graduates in education offers new opportunities for schools to attain high relevance and impact amidst ongoing changes and transformations in teacher management. Large-scale data, such as grades and soft skills for each course taken by students, can be used to identify appropriate teaching subjects, potentially enhancing teaching quality in the future. As the selection process considers multiple criteria from graduates, the issue of multiple criteria arises [16, 17]. Consequently, a multicriteria decision-making (MCDM) technique and solution is required [18, 19].

A method for choosing the appropriate IT courses for potential applicants can be devised. This study aims to address the issue of assessing data variation. The criteria considered in this study include soft skills and academic achievement (GPA). As a result, ranking applicants necessitates evaluating multiple criteria (GPA and soft skills) and assigning the correct weight to these criteria to identify the most suitable IT subjects [20, 21]. This study aligns with one of the 11 transformations outlined in the Malaysian Educational Blueprint 2013–2025, which strives to revamp the education system to cultivate well-prepared nation-builders for the future [22, 23]. The contributions of this study can be summarised as follows:

- This study constructs and formulates a decision matrix of IT subjects for school-teacher recruitment.
- This study adopts the AHP method to determine the weight value of the applicants' evaluation criteria.
- This study proposes an intelligent approach for distributing IT subjects to the determined applicants for school recruitment based on MCDM methods (analytic hierarchy process [AHP]-VIseKriterijumska Optimizacija I Kompromisno Resenje [VIKOR]).

The subsequent sections of this article are organised as follows: Section 2 provides a comprehensive analysis of the existing literature. Section 3 outlines the methodology used in the selection of suitable applicants for IT subjects. Section 4 presents the results and discussion of the study. The proposed approach's validation is assessed through a systematic ranking conducted in Section 5. Section 6 presents the implications of the study. Section 7 provides an outline of the conclusion, limitations and future directions of the study.

2. RELATED WORK

The process of evaluating and selecting students is intricate and time consuming. Consequently, researchers have sought to discover more efficient methods for assessing and choosing students. One such method is MCDM, which involves making decisions amongst various alternatives characterised by multiple, often conflicting, criteria [24-26]. MCDM's primary goal is to aid decision-makers in identifying the most appropriate alternative from a set of alternatives by evaluating and ranking them based on their performance [27-29]. The assessment and selection process involves the concurrent evaluation of multiple criteria, leading to the ranking of potential choices and the selection of the most preferable one [30, 31]. Therefore, choosing the appropriate IT courses for potential applicants or graduates can be categorised as an MCDM problem.

MCDM is recognised as an important approach for aiding decision-making and is a subdomain of operations research that deals with decision-related issues concerning decision criteria [32, 33]. Its emphasis lies in developing and organising decision-making approaches that can resolve problems by considering multiple attributes [34, 35]. MCDM focuses on the development of decision and planning issues involving multiple criteria, with the goal of supporting decision-makers in tackling these challenges [36, 37]. MCDM has gained prominence recently due to its ability to improve decision-making quality by streamlining the decision-making process, rendering it more efficient, rational, transparent and explicit in comparison with conventional methods [38, 39].

The ranking of alternatives in MCDM relies on the definition of crucial terms, such as the decision matrix and its attributes [24, 40]. The MCDM has become increasingly popular in various fields and applications, such as education [41], transportation [42], healthcare domain [43, 44], agriculture [45] and geographical information systems [35, 46].

Amongst the numerous MCDM methods, eight algorithms are particularly prominent. These sophisticated problem-solving approaches encompass AHP, simple additive weighting (SAW), multiattribute evaluation weight (MEW), weighted product model (WPM), weighted sum model (WSM), hybrid additive weighting (HAW), VIKOR and TOPSIS algorithms. In accordance with prior scholarly research [47], the strengths and weaknesses of these MCDM methods are detailed.

Furthermore, none of the aforementioned methods have been used to select the most suitable IT courses for each applicant within an educational context. Nevertheless, TOPSIS and VIKOR are deemed appropriate for situations encompassing an extensive array of alternatives and criteria. These techniques are particularly adept at handling cases that involve quantitative or objective data. TOPSIS identifies the solution that exhibits the minimal distance to the ideal solution whilst simultaneously maintaining the maximal distance from the negative ideal solution. However, it does not account for the relative significance of these distances [48]. Conversely, VIKOR is frequently utilised for addressing discrete-alternative problems and is considered one of the most practical strategies for addressing real-world challenges. The foremost merit of VIKOR lies in its ability to discern the optimal solution rapidly. As a result, VIKOR is well-suited to scenarios involving numerous alternatives and attributes [48]. The VIKOR method excels at ascertaining the most favourable alternatives and establishing the ranking preference amidst conflicting criteria derived from a collection of alternatives.

3. METHODOLOGY

The proposed methodology is constructed by integrating two fundamental MCDM methods, with the aim of weighting the criteria, as well as ranking and selecting the most favourable alternatives. In Section 3.1, the decision matrix of IT subjects to select the most favourable IT subject for each applicant is presented. In Section 3.2, the AHP method is adopted to determine the weight of each criterion. In Section 3.3, the VIKOR method is adopted to rank and select the IT subject for each applicant. The description of the proposed methodology is presented in Figure 1.

3.1 Decision Matrix of IT Subject Formulation

The decision matrix of the IT subjects is constructed in this section. The data requested were namely, the performance and soft skills results of 80 graduates who have taken the exams in 2017 at the Academic Development Centre in the Education University of Sultan Idris. On the basis of these data, the matrix is constructed as follows:

Step 1: In accordance with the interview conducted with two lecturers at Sultan Idris Education University from the Faculty of Art, Computing Creative Industry, the data are collected. The interview with the lecturer aims to discuss IT subject alternatives, as shown in Table 1.

Step 2: In accordance with the analysis of the related works (Section 2), two main criteria are identified, i.e. soft skills at university and GPA. Soft skills at university includes seven subcriteria, i.e. communication skills, continuous learning and information management, entrepreneurial, critical thinking and problem solving, professional ethics and moral, teamwork and leadership, as given in Table 2.

Step 3: The decision matrix is formulated on the basis of the crossover in between identified alternatives (step 1) and criteria (step 2), as given in Table 3.

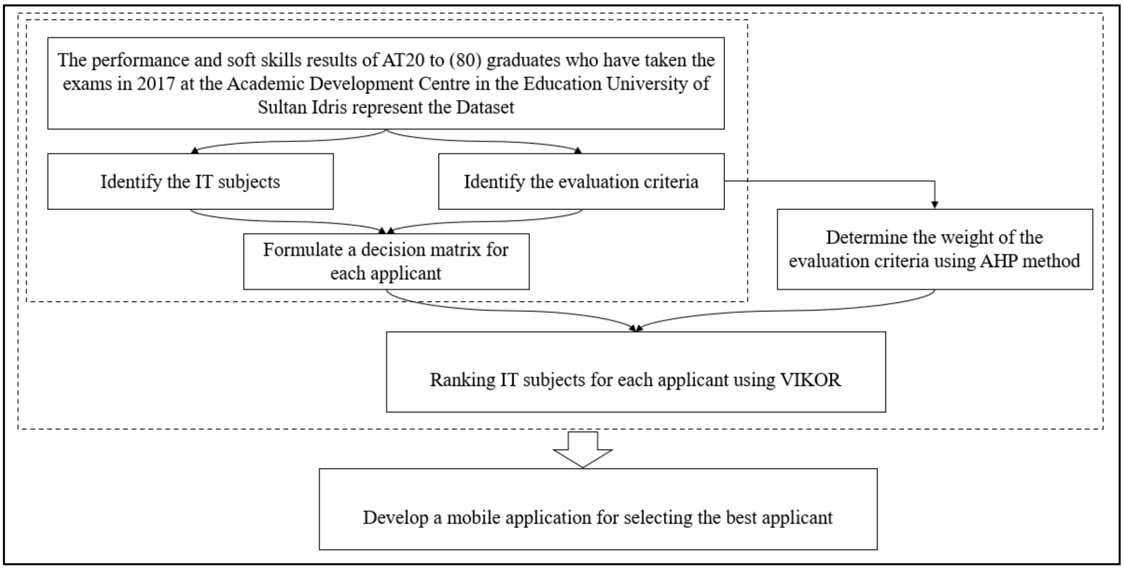

Figure 1. Proposed Methodology

Table 1. IT subject alternatives

Basic Computer Science (BCS)	Computer Science (CS)	Information & Communications Technology (ICT)
MTK3013 (Discrete Structures)	MTK3013 (Discrete Structures)	MTK3013 (Discrete Structures)
MTS3063 (Principles of Programming)	MTS3063 (Principles of Programming)	MTS3063 (Principles of Programming)
MTD3063 (Database-driven Web)	MTD3063 (Database-driven Web)	MTD3063 (Database-driven Web)
MTD3033 (Database System)	MTD3033 (Database System)	MTD3033 (Database System)
MTN3013 (Computer Architecture)	MTN3013 (Computer Architecture)	MTN3013 (Computer Architecture)
MTN3023 (Computer Network)	MTN3023 (Computer Network)	MTN3023 (Computer Network)
MTS3023 (Data Structures)	MTS3023 (Data Structures)	MTS3023 (Data Structures)
MTS3033 (Object Oriented)	MTS3033 (Object Oriented)	MTS3033 (Object Oriented)
	MTN3033 (System Administration)	MMP3013 (Multimedia in Education)
	MMG3033 (Human Computer Interaction)	MTD3043 (System Analysis and Design)

Table 2. Criteria and subcriteria

Criteria	Subcriteria
C1 (Soft Skills)	C1.1 (Communication)
	C1.2 (Critical Thinking and Problem Solving)
	C1.3 (Continuous Learning and Information Management)
	C1.4 (Teamwork)
	C1.5 (Entrepreneurial)
	C1.6 (Leadership)
	C1.7 (Professional Ethics and Moral)
C2 (GPA)	

Table 3. Decision matrix of IT subject formulation

Alternatives / Criteria	GPA	Soft Skills
Basic Computer Science (BCS)	data	data
Computer Science (CS)	data	data
Information & Communications Technology (ICT)	data	data

3.2 Adoption of the AHP Method

In this section, the AHP method is used to determine the importance level and assign a weight value of each criterion with the assistance of four experts. It can be implemented in four steps [49]:

Step 1: Building the structuring hierarchy by decomposing the problem into a hierarchical structure with three layers. The top level consists of the overarching objective, whereas the next level consists of the decision factors. The lowest level is dedicated to alternative solutions.

Step 2: Generating diagonal pairwise comparison matrix via Saaty's 1–9 scale

$$X = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix}, \tag{1}$$

where x_{ij} is the relative importance value of each criterion. i and $j = 1, \ldots, n$.

Step 3: Normalise each element of the pairwise comparison matrix using (2) and (3).

$$a_{ij} = \frac{x_{ij}}{\sum_{i=1}^{n} x_{ij}} \tag{2}$$

$$A = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ a_{m1} & a_{m2} & \cdots & a_{mn} \end{bmatrix} \tag{3}$$

Step 4: Calculate the weight value of each criterion using (4).

$$W_i = \frac{\sum_{j=1}^{n} a_{ij}}{n}, \tag{4}$$

where $\sum_{j=1}^{n} w_i = 1$, and n is the is the number of the compared elements.

3.3 Adoption of the VIKOR Method

In this section, the VIKOR method is used to rank the selected IT subjects for each applicant. The decision matrix and the calculated weight of the criteria are fed to VIKOR for this purpose. The compromise ranking algorithm VIKOR has the following steps [50]:

Step 1: Determine the best f_i^* and the worst f_i^- values of all criterion functions, $i = 1,2, \ldots \ldots n$. If the ith function represents a benefit, then $f_i^* = max_j f_{ij}$, and $f_i^- = min_j f_{ij}$,
where f_{ij} represents the value of the i^{th} criterion function corresponding to alternative x_i, and the optimal solution aims to maximise the benefit criteria and minimise the nonbenefit criteria. Conversely, the negative ideal solution seeks to maximise the nonbenefit criteria whilst minimising the benefit criteria.

Step 2: Compute the values S_j and R_j , $j = 1,2, \ldots \ldots , J$ by the relations,

$$S_j = \sum_{i-1}^{n} w_i \left(f_i^* - f_{ij}\right)/(f_i^* - f_i^-), \quad (5)$$

$$R_j = max_i\left[w_i\left(f_i^* - f_{ij}\right)/(f_i^* - f_i^-)\right], \quad (6)$$

where S_j and R_j represent the utility and regret measures for alternative f_i , respectively, and w_i is the weight of criterion, expressing its relative importance.

Step 3: Compute the values $Q_j, j = 1,2, \ldots \ldots , J$ by the relation:

$$Q_j = V\left(S_j - S_j^*\right)/\left(S_j^- - S_j^*\right) + (1 - \nu)\left(R_j - R_j^*\right)\left(R_j^- - R_j^*\right) \quad (7)$$

where

$$S^* = min_j S_j, S^- = max_j S_J , \quad (8)$$

$$R^* = min_j R_j , R^- = max_j R_j. \quad (9)$$

The S^* solution represents the optimal outcome with the highest group utility, whereas the R^* solution is calculated to minimise the individual regret of the opponent. The weight assigned to the strategy based on majority of the criteria is denoted by the symbol υ.

Step 4: The alternative ranking can be conducted by sorting the values of S , R , Q in decreasing order. The results are three ranking lists.

Step 5: If two specific conditions are met, then the suggested compromise solution would be to select the alternative (a'), which has the highest ranking according to the measure (Q) with the lowest value:

1. Acceptable advantage: $Q(a") - Q(a') \geq 1 / (1/(J - 1))$, where $a"$ is the alternative with the second position in the ranking list by Q ,J is the number of alternatives.
2. Acceptable stability in decision-making: alternative a' must also be the best ranked by S and/or R.

A set of compromise solutions is presented if one of the conditions is not satisfied, consisting of the following:

- alternatives $a'$and $a"$if only condition (2) is not satisfied.
- alternatives $a'$and $a"$and a^m if condition (1) is not satisfied, and a^m is determined by the relation $Q(a^m) - Q(a') < 1(J - 1)$ for maximum M (these alternatives positions are ‘in closeness’). The alternative that has the lowest value for the measure Q considered the best value. The primary ranking outcome is the compromise ranking list of alternatives, which is utilised to identify the compromise solution using the ‘advantage rate’.

4. RESULTS AND DISCUSSION

The overall results of this study are presented in this section. In Section 4.1, the data and the decision matrix of IT subjects are reported. The weight values of the criteria determined using AHP are given in Section 4.2. In Section 4.3, the results of selecting the IT subject for each applicant based on their GPA and soft skills are reported.

4.1 IT Subject Decision Matrix Result

A total of 80 students who had qualified from Sultan Idris Education University in 2016 from the faculty of computing were involved in this study. The dataset was adopted from the Academic Development Centre of UPSI. It included IT subjects, soft skills and GPA for each applicant. Table 4 reports a sample of the acquired data, whereas the overall data are reported in Table A.1 in the appendix.

Table 4. Sample of the acquired dataset

APPLICANT 1			APPLICANT 2		
Subject	*GPA*	*Soft Skills*	*Subject*	*GPA*	*Soft Skills*
MTK3013	2.9	2.54	MTK3013	3.2	2.74
MTS3063	3.4	3.7	MTS3063	3	2.5
MTD3063	3	3.18	MTD3063	3	3.2
MTD3033	3	3.188	MTD3033	3.3	3.5
MTN3013	3.2	3.25	MTN3013	3.1	3.25
MTN3023	3	3.35	MTN3023	3.4	3.15
MTS3023	4	3.871	MTS3023	3.3	3.321
MTS3033	3	3.063	MTS3033	3	3.25
MTN3033	3.5	3.68	MTN3033	3.4	3.6
MMG3033	3.3	3.5	MMG3033	4	4
MMP3013	3.5	3.75	MMP3013	4	4
MTD3043	4	4	MTD3043	3.7	3.7

Table 5. Sample of the decision matrix of IT subject for first and second applicants

SEQ	SUBJECTS	GPA	Soft Skills
APPLICANT 1	BCS	3.188	3.268
	CS	3.23	3.332
	ICT	3.3	3.389
APPLICANT 2	BCS	3.163	3.114
	CS	3.27	3.251
	ICT	3.3	3.261

Each applicant has three columns in Table 4 and Table A.1 in the Appendix. The first column comprises the number of university courses taught. The second column comprises the students' GPA for each subject. Finally, the third column includes soft skills for each university course. To formulate the decision matrix of the IT subject for each applicant, the mean values are calculated for BCS, CS and ICT of each applicant, as reported in Table A.2 in the Appendix. A sample of the decision matrix of the first and second applicants is reported in Table 5. This matrix is fed to VIKOR to rank the IT subjects for each applicant. In the following section, the importance level of each criterion resulting from using the AHP method is reported.

4.2 Weight Results of Evaluation Criteria Using AHP

This section reports the weight results of evaluation criteria using AHP. To conduct a pairwise comparison, four experts are recruited. In line with the AHP method outlined in Section 3.2, a three-layer hierarchical structure was constructed to determine the importance level of each criterion. This structure consists of criteria weighting, criteria and alternatives, as elaborated in Step 1. Then, a pairwise comparison matrix was built for each expert, as mentioned in Step 2. Thereafter, each element of the pairwise comparison matrix was normalised using (2) and (3), as detailed in Step 3. Finally, the weight value of each criterion was calculated using (4), as explained in Step 4. Table 6 reports pairwise comparison matrix, normalised matrix, aggregation and weights of each expert.

A consolidated set of weights was derived from the input of the four experts, as shown in Table 6 and Figure 2. For the first expert, the highest weight (0.75) was given to the GPA criterion, with the lowest weight for soft skills at 0.25. The second expert's maximum weight for GPA reached 0.83, whereas the minimum weight for soft skills was 0.17. The third expert's top weight for the GPA criterion was 0.75, with the soft skills' minimum weight at 0.25. Lastly, the fourth expert gave a weight of 0.50 for GPA and soft skills. As demonstrated in Table 6 and Figure 2, a difference was found amongst expert views. To address this issue, the experts' weights must be unified to find the final weight value of each criterion. Therefore, arithmetic mean was used, and the final weight of the criteria was reported in Table 7.

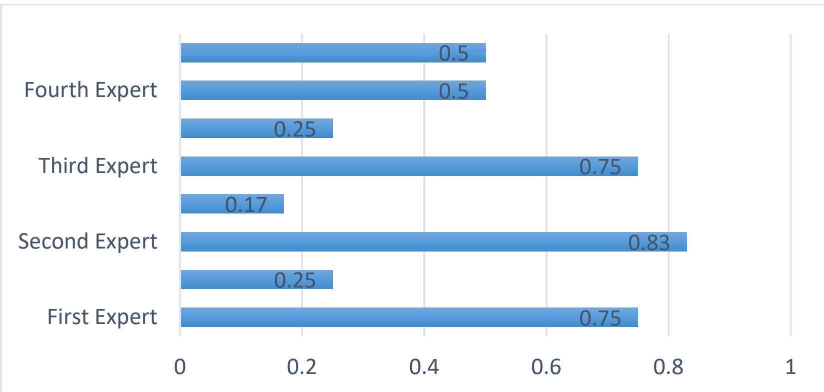

Figure 2. Final AHP weights for all experts

Table 6. Pairwise comparison matrix, normalised matrix, aggregation, and weights of each expert

		Pairwise Comparison Matrix		Normalised Matrix		Aggregation	Weights
First Expert	***Criteria***	*GPA*	*Soft Skills*	*GPA*	*Soft Skills*		
	GPA	1.00	3.00	0.75	0.75	1.50	0.75
	Soft Skills	0.33	1.00	0.25	0.25	0.50	0.25
	Sum	1.33	4.00				1.00
		Pairwise Comparison Matrix		**Normalised Matrix**		**Aggregation**	**Weights**
Second Expert	***Criteria***	*GPA*	*Soft Skills*	*GPA*	*Soft Skills*		
	GPA	1.00	5.00	0.83	0.83	1.67	0.83
	Soft Skills	0.20	1.00	0.17	0.17	0.33	0.17
	Sum	1.20	6.00				1.00
		Pairwise Comparison Matrix		**Normalised Matrix**		**Aggregation**	**Weights**
Third Expert	***Criteria***	*GPA*	*Soft Skills*	*GPA*	*Soft Skills*		
	GPA	1.00	3.00	0.75	0.75	1.50	0.75
	Soft Skills	0.33	1.00	0.25	0.25	0.50	0.25
	Sum	1.33	4.00				1.00
		Pairwise Comparison Matrix		**Normalised Matrix**		**Aggregation**	**Weights**
Fourth Expert	**Criteria**	*GPA*	*Soft Skills*	*GPA*	*Soft Skills*		
	GPA	1.00	1.00	0.50	0.50	1.00	0.50
	Soft Skills	1.00	1.00	0.50	0.50	1.00	0.50
	Sum	2.00	2.00				1.00

Table 7. Final weight value of the criteria

Criteria	GPA	Soft Skills	Sum
Average weights	0.708	0.292	1.000

Table 8. Ranking results of APPLICANT 1.

SUBJECTS	Weighted Matrix		S_j	R_j	Q_j
	GPA	*Soft Skills*			
BCS	0.708	0.292	1	0.708	0
CS	0.4425	0.137554	0.580054	0.4425	0.397473
ICT	0	0	0	0	1
		$\boldsymbol{S^*}, \boldsymbol{R^*}$	1	0.708	
		$\boldsymbol{S^-}, \boldsymbol{R^-}$	0	0	

4.3 Ranking Results of IT Subjects for Each Applicant Using VIKOR

This section reports the ranking of the IT subject alternatives (i.e. BCS, CS and ICT) for each applicant using the VIKOR method. According to the steps of this method (Section 3.3), the best f_i^* and the worst f_i^- values of each criterion were determined in Step 1. Both criteria (i.e. GPA and soft skills) are benefit criteria. Then, the weighted matrix of each applicant was calculated on the basis of the weight values of the criteria calculated in the previous section and the best f_i^* and the worst f_i^- values. In Step 2, the values S_j and R_j were calculated. The values Q_j were computed on the basis of the values of S^* and R^* in Step 3. In Step 4, the Q_j values of the IT subjects of each applicant were sorted in decreasing order. The alternative with the highest Q_j value was the fevered IT subject for each applicant. Table 8 reports the ranking results of the APPLICANT 1.

Similar calculations were conducted for each applicant (80 applicants). The overall results revealed that the ICT earned the first rank in 49 applicants, representing 61.3%. By contrast, the BCS earned the first rank in 17 applicants, which represented 21.3%, whereas the CS earned the first rank in 14 applicants which represented 17.5%. Table 9 reports the first-ranked IT subject for each applicant.

Upon examining the data, which includes GPA and soft skills, of each applicant utilising the AHP and VIKOR method, the following outcomes were ascertained: 17 applicants are suited to teach BCS, 14 are suitable for teaching CS, and 49 are well-suited to teach ICT. In the context of the 17 individuals recommended for teaching basic computer science, they exhibited exceptional GPA and soft skills throughout their relevant bachelor's degree coursework. Similarly, the 14 applicants suggested for teaching computer science demonstrated high GPA and soft skills in their pertinent undergraduate studies. As for the 49 applicants endorsed for ICT teaching, they too displayed strong GPA and soft skills in their corresponding bachelor's degree courses. This study introduces a selection approach that assists users in identifying the most fitting applicant for a specific subject in an educational setting.

Table 9. First-ranked IT subject results for each applicant

Applicants	Suitable Subject	Applicants	Suitable Subject	Applicants	Suitable Subject	Applicants	Suitable Subject
1	ICT	21	ICT	41	ICT	61	ICT
2	ICT	22	BCS	42	ICT	62	ICT
3	ICT	23	BCS	43	ICT	63	ICT
4	ICT	24	CS	44	BCS	64	BCS
5	ICT	25	CS	45	BCS	65	BCS
6	CS	26	ICT	46	BCS	66	BCS
7	ICT	27	ICT	47	ICT	67	BCS
8	BCS	28	BCS	48	ICT	68	ICT
9	CS	29	ICT	49	ICT	69	ICT
10	ICT	30	CS	50	BCS	70	ICT
11	ICT	31	CS	51	ICT	71	ICT
12	ICT	32	BCS	52	ICT	72	BCS
13	ICT	33	ICT	53	BCS	73	BCS
14	ICT	34	ICT	54	CS	74	ICT
15	ICT	35	ICT	55	ICT	75	ICT
16	CS	36	ICT	56	ICT	76	ICT
17	ICT	37	CS	57	CS	77	ICT
18	ICT	38	CS	58	BCS	78	CS
19	ICT	39	ICT	59	ICT	79	CS
20	ICT	40	ICT	60	ICT	80	CS

Table 10. Validation results of the systematic ranking

Groups	Applicants	IT subjects	Mean
First group	8, 22, 23, 28, 32, 44, 45, 46, 50, 53, 58, 64, 65, 66, 67, 72, 73	**BCS**	**3.362911765**
		CS	3.284794118
		ICT	3.307617647
Second group	6, 9, 16, 24, 25, 30, 31, 37, 38, 54, 57, 78, 79, 80	BCS	3.195357
		CS	**3.258429**
		ICT	3.116393
Third group	1, 2, 3, 4, 5, 7, 10, 11, 12, 13, 14, 15, 17, 18, 19, 20, 21, 26, 27, 29, 33, 34, 35, 36, 39, 40, 41, 42, 43, 47, 48, 49, 51, 52, 55, 56, 59, 60, 61, 62, 63, 68, 69, 70, 71, 74, 75, 76, 77	BCS	3.151693878
		CS	3.188265306
		ICT	**3.253479592**

5. VALIDATION

The aim of this section is to explore the systematic ranking assessment of the ranking outcomes for IT subjects corresponding to each applicant, as determined by the AHP-VIKOR method. Such an approach has been previously used in multiple MCDM studies [21,35]. The quantity of alternatives within each group does not influence the assessment procedure [22,34]. The following steps are undertaken for the systematic ranking of the obtained findings: (1) The applicants are divided into three groups, with the first comprising 17 applicants, the second containing 14 applicants, and the third encompassing 49 applicants. (2) The decision matrix data (see Table 5 and Table A.2 in the Appendix) are used to ascertain the mean values for each IT subject across the groups. (3) The mean values of the IT subjects within each group are compared. The results gained from this examination must correspond with the ranking outcomes for the IT subjects related to the applicants to be considered accurate and valid. Table 10 reports the validation results of the systematic ranking.

According to Table 10, the BCS had the highest mean value of 3.362911765 in the first group, followed by ICT and CS with mean values of 3.307617647 and 3.284794118, respectively. These results prove that the rankings of the IT subjects were conducted systematically as the 17 applicants (8, 22, 23, 28, 32, 44, 45, 46, 50, 53, 58, 64, 65, 66, 67, 72, 73) were recommended to teach BCS (see Table 12). Similarly, CS had the highest mean value of 3.258429 in the second group, followed by BCS and ICT with mean values of 3.195357 and 3.116393, respectively. These results prove that the rankings of the IT subjects were conducted systematically as the 14 applicants (6, 9, 16, 24, 25, 30, 31, 37, 38, 54, 57, 78, 79, 80) were recommended to teach CS. Finally, ICT had the highest mean value of 3.253479592in the second group, followed by CS and BCS with mean values of 3.188265306 and 3.151693878, respectively. These results prove that the rankings of the IT subjects were conducted systematically as the 49 applicants (1, 2, 3, 4, 5, 7, 10, 11, 12, 13, 14, 15, 17, 18, 19, 20, 21, 26, 27, 29, 33, 34, 35, 36, 39, 40, 41, 42, 43, 47, 48, 49, 51, 52, 55, 56, 59, 60, 61, 62, 63, 68, 69, 70, 71, 74, 75, 76, 77) were recommended to teach ICT.

6. CONCLUSION

This study accurately achieved the ranking of IT subjects for 80 applicants based on the MCDM methods, AHP and VIKOR. The proposed methodology consists of three sections. The first section involved the formulation of the IT subject decision matrix. The second section included the steps in determining the importance level of each criterion (GPA and soft skills) and finding their weight values with the assistance of four experts using the AHP method. These weight values and the formulated decision matrix were fed into the third section of the methodology, and the VIKOR method was used to rank the IT subjects for each applicant. The validation of the results was applied statistically using the systematic ranking test.

Despite the advantage of this study, it has some limitations: (i) The evaluation and selection of the best IT subject for teachers based on MCDM using VIKOR and AHP were only conducted with IT graduates (AT20) in UPSI. Other types of subjects could not be determined because the approach only made evaluation and selection based on a certain criterion. (ii) The only theories of MCDM that were used are VIKOR and AHP, and other techniques, such as HAW, SAW, WSM, PSI, ELECTRE and MEW, were not compared in this study.

Recommendations for future directions are as follows: (i) The study's methodology could be used to determine the optimal teachers for alternative disciplines (including physics, chemistry and mathematics) upon establishing the relevant criteria for each respective subject. (ii) Other methods, such as HAW, SAW, WSM, PSI, ELECTRE and MEW, can be used to select the most suitable IT subject for each teacher. (iii) Fuzzy numbers can be used to extend AHP and VIKOR in dealing with the hesitation and the uncertainty of the experts and provide more accurate results.

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The authors declare no potential conflicts of interest with respect to the research and publication of this article.

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APPENDIX

The appendix can be found in: https://docs.google.com/document/d/1nXcSrjkn-Tq0B6jZrK5trPUVoaeUG5LC/edit?usp=sharing&ouid=112118789112429012281&rtpof=true&sd=true