A Hybrid Methodology for Ranking Cadets Based on Multi-Criteria Decision-Making Techniques A Comparative Study

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Abstract

The issue of guaranteeing the process of preparing qualified cadets, which is primarily focused on the professional and personal development of future officers, is currently receiving more and more attention in the Ministry of Defense's higher military school system. The purpose of this study is to help decision-makers rank the proficiency of computer science and information systems students by presenting a decision matrix based on multi-criteria analysis. An experiment was carried out in this study using several stages. To evaluate cadets according to multi-measuring criteria (Grade and soft skills), a decision matrix was first created. The cadets were then sorted according to the decision matrix that was created, with the alternatives being ranked using the Technique for Order Performance by Similarity to the Ideal Solution (TOPSIS) and the multi-measurement criterion being weighted by the AHP. The data included the soft skills and grades of 59 students enrolled in a web services course at Military University. The study's findings demonstrated that ranking cadets according to their performance and soft skills using AHP and TOPSIS was successful. The study's finding implies that the university will profit from identifying cadets' strengths and shortcomings so they can offer stronger oversight.

Keywords : hybrid Multi-criteria decision making(MCDM); Military; cadets ; evaluation

منهجية هجينة لتصنيف الطلاب العسكريين استنادًا
إلى تقنيات اتخاذ القرار متعدد المعايير
دراسة مقارنة

الملخص

تعتبر وزارة الدفاع واحدة من الركائز الأساسية في أي دولة تطمح الى التقدم حيث تشمل القوات المسلحة. إن من أبرز التحديات التي تواجه القوات لمسلحة هي اعداد ضباط مؤهلين أكاديميا وعسكريا وقادة في مجالاتهم. حيث إن مدارس وكليات وجامعات وزارة الدفاع يعملون على التطوير المهني والشخصي لضباط المستقبل. الغرض من هذه الدراسة هو مساعدة صناع القرار على تصنيف كفاءة طلاب علوم الحاسوب ونظم المعلومات الحاسوبية من خلال تقديم مصفوفة قرار تعتمد على تحليل مبني على عدة المعايير. تم إجراء تجربة في هذه الدراسة باستخدام عدة مراحل لتقييم الطلاب في مقرر خدمات الويب وفقًا لمعايير قياس متعددة (الدرجة النهائية والمهارات الشخصية)، تم إنشاء مصفوفة القرار لأول مرة. تم بعد ذلك تم تصنيف الطلاب وفقًا لمصفوفة القرار التي تم إنشاؤها. تم استخدام خوارزمية AHP لتقيم المعايير و توزيع أهميتها بناء على خبراء وبعد ذلك استخدام TOPSIS لترتيب الطلاب حسب افضليتهم. بلغ عدد الطلاب في هذه الدراسة 59 طالب. أظهرت نتائج الدراسة أن تصنيف الطلاب وفقًا لأدائهم ومهاراتهم الشخصية باستخدام AHP وTOPSIS كان ناجحًا. تشير نتائج الدراسة إلى أن أي كلية عسكرية تدرس مقرر خدمات الويب ستستفيد من تحديد نقاط القوة والعيوب لدى الطلاب العسكريين حتى يتمكنوا من تقديم إشراف أقوى ومعالجة نقاط الضعف لدى الطلاب، كما انه من الممكن تعميم هذه المصفوفة على كل المقررات.

الكلمات المفتاحية: اتخاذ القرارات الهجينة متعددة المعايير (MCDM)، الجيش، الطلاب، التقييم.

1. Introduction

People enrolling in military or police training programs are known as cadets. Usually, they are young people who have decided to become police enforcement or military personnel. A "cadet" is a student who attends a military school and undergoes intense training and study to become an officer in the future. As an alternative, anyone enrolled in a police academy or other comparable training program might alternatively be referred to as cadets [1]. These cadets get both intellectual and physical training to equip them with the abilities and knowledge needed to defend and serve their communities. Since cadets are expected to exhibit the greatest levels of expertise and commitment in their chosen disciplines, the term provides a feeling of discipline and dignity. The goal of their training is to get students ready for the duties and difficulties that come with starting a career in the military or police enforcement [2].

Today's cadets are tomorrow's commanders, and the traditional schooling method of the developing hard core continues to shape the profile of future leadership. [3] It should be mentioned that both basic and applied psychology rank the issue with the prospective officer's personality as one of the most important. The reason for this is that to complete the responsibilities required by military schools to prepare highly qualified officer cadres, it is first necessary to develop the human aspect. Second, to foster the cadets' creative abilities, a clear shift must be made from a mass, general approach to their education and upbringing to an individual one. [4]

The term "militarization" typically refers to a process or collection of related processes that enable the integration of military institutions, operations, and organizational structures into a variety of social contexts [5]. Being a leader in the military is a difficult job [6]. Military leaders occasionally experience high stress and are required to lead in challenging circumstances. [7]. This type of leadership is also known as “in extremis leadership”, and these types of situations are also known as “the unforeseen” [8] Compared to ordinary colleges, academics at military academies and institutions—also referred to as cadets—work in a different setting. Because of the unique educational goals these kinds of organizations have [9]

Furthermore, military education can help students acquire values and soft skills like critical and systemic thinking, resource management, and communication [10]. Therefore, military academies and other higher education establishments stand to gain from combining academic curricula with military training to develop technical and leadership competencies [11]. Therefore, they must learn and use a wide range of safety skills in line with best practices, technical requirements, and scientific principles as military students. This guarantees that they possess a strong basis in safety knowledge and can comply with the strictest safety regulations as mandated by military directives [12].

The current system for evaluating and ranking the cadet in university (X) depends on two major criteria plus sub-criteria. The cadet evaluation is based on their CGPA and Military scores. In education, assessing and evaluating students can be difficult. [13]. A crucial element in the field of education is determining an appropriate technique for student evaluation. [14]. To describe the specific problems in terms of issues for ranking and selecting the Cadet, three issues are described as specific problems. A multi-criteria decision-making is the method of ranking cadets with several attributes (soft skills and grade) according to the appropriate importance allocated for every criterion .; this is the first issue [15]. However, the problem appears when cadets are evaluated using multiple criteria (grade and soft skills). Every cadet is evaluated based on several criteria, and the weights assigned to these criteria vary depending on the decision maker.; this is the second issue [16]. The data varies depending on the cadet; for instance, cadet (A) might score highly on the grade but poorly on the soft skills. The third problem is that, in contrast, cadets (B) can have a low grade but great in soft skills. This situation is regarded as a data variation. [17].

This research is focused on proposing a new framework to rank a computer information system and computer science students (cadets) in a “web service” course by evaluating them based on multiple criteria (grade and soft skills). Each cadet serves as a potential choice for the decision maker in this multi-criteria/multi-attribute decision-making (MCDM/MADM) problem of cadet ranking. The MCDM/MADM problem refers to making the first choice or decision amongst the presented alternatives that are characterized by multiple data [18].

2. Literature Review

Keeney and Raiffa [19] characterized MCDM as an expansion of decision theory that encompasses decisions involving multiple objectives. Furthermore, Belton and Stewart [20] formulated MCDM as a comprehensive concept referring to a variety of formal methods that aim to consider multiple criteria explicitly when assisting individuals or groups in navigating significant decisions.

MCDM is the preeminent decision-making approach within the realm of operations research, specifically focusing on resolving decision challenges related to decision attributes (criteria).[21, 22]. To assist decision-makers in resolving these kinds of issues, multiple criteria (MCDM) are used in organizing, scheduling, and replying to decision problems [22], to help decision-makers solve such problems [23]. MCDM explicitly and concurrently considers a multitude of choices through a combination of qualitative and quantitative methodologies [24, 25]. Because MCDM can enhance decision value by adding balance to the decision-making process., well-organized, and transparent than that of traditional methods, its application is expanding swiftly [26]

Among a range of viable options, MCDM seeks to: (1) assist data miners in choosing the greatest option; (2) rank the alternatives in decreasing order; and (3) classify the viable alternatives. [27, 28]. Consequently, the appropriate alternative(s) are assessed as a result.

Important issues in any MCDM ranking should be well specified; these topics include criteria, alternatives, and decision or evaluation matrix (EM). [29]. EM is made up of m choices and n criteria. The relationship between every option and the criteria as $\mathrm{x_{ij}}$, in the matrix $(\mathrm{x_{ij}})_{\mathrm{m*n}}$ that is obtained as follows:

$$DM/EM = \begin{array}{c c} & \begin{array}{cccc} C_1 & C_2 & \dots & C_n \end{array} \\ \begin{array}{c} A_1 \\ A_2 \\ \vdots \\ A_m \end{array} & \begin{bmatrix} x_{11} & x_{12} & \dots & x_{1n} \\ x_{21} & x_{22} & \dots & x_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ x_{m1} & x_{m2} & \dots & x_{mn} \end{bmatrix} \end{array} \dots\dots\dots\dots\dots\dots\dots (2.1)$$

$A_1, A_2, \dots, A_m$: Alternatives scored by DMs; and

$C_1, C_2, \dots, C_n$: Criteria to rank alternatives.

The rating of an A_i option concerning criterion C_j is expressed as x_{ij} i, where W_j is the weighted relevance of the criterion C_j. To rank the alternatives according to the approach, several procedures, including normalization, weighting, and others, must be finished.

Authors in [30-34] discovered numerous MCDM theories. Several widely used MCDM techniques include the multiplicative exponential weighting (MEW), weighted product method (WPM), weighted sum model (WSM), simple additive weighting (SAW), analytic network process (ANP), hierarchical adaptive weighting (HAW), analytic hierarchy process (AHP), and technique for order performance by similarity to ideal solution (TOPSIS). [18]. Integrating two or more MCDM strategies to offset the shortcomings of a single technique is the newest trend in MCDM applications. [35-37].

The integration of AHP and TOPSIS into a combined MCDM approach is widely recognized and accepted due to its ability to deliver comprehensive ranking outcomes, and handle nonlinear relationships to ease trade-offs, This method is readily adaptable for programming and can be integrated with stochastic analysis. It also uses weights and objective data to obtain relative distances. [36, 38]. The literature addresses alternative ranking problems using several integrated methodologies. Beikkhakhian, Javanmardi [39] Ren and Sovacool [40]

3. Methodology

The research methodology for developing a Multiperspective Framework for ranking computer information systems and computer science cadets Based on AHP and TOPSIS Techniques is presented in this section and divided into three phases. Firstly, the Preliminary Study Phase presents the investigation for evaluation criteria. The second phase is the Identification Phase, three steps are implemented, namely, dataset handling, classifying the criteria, and proposing the pre-DM. Development Phase is the third stage. AHP is used for assigning weights, and TOPSIS is used for ranking. Figure 1 presents the research methodology phases.

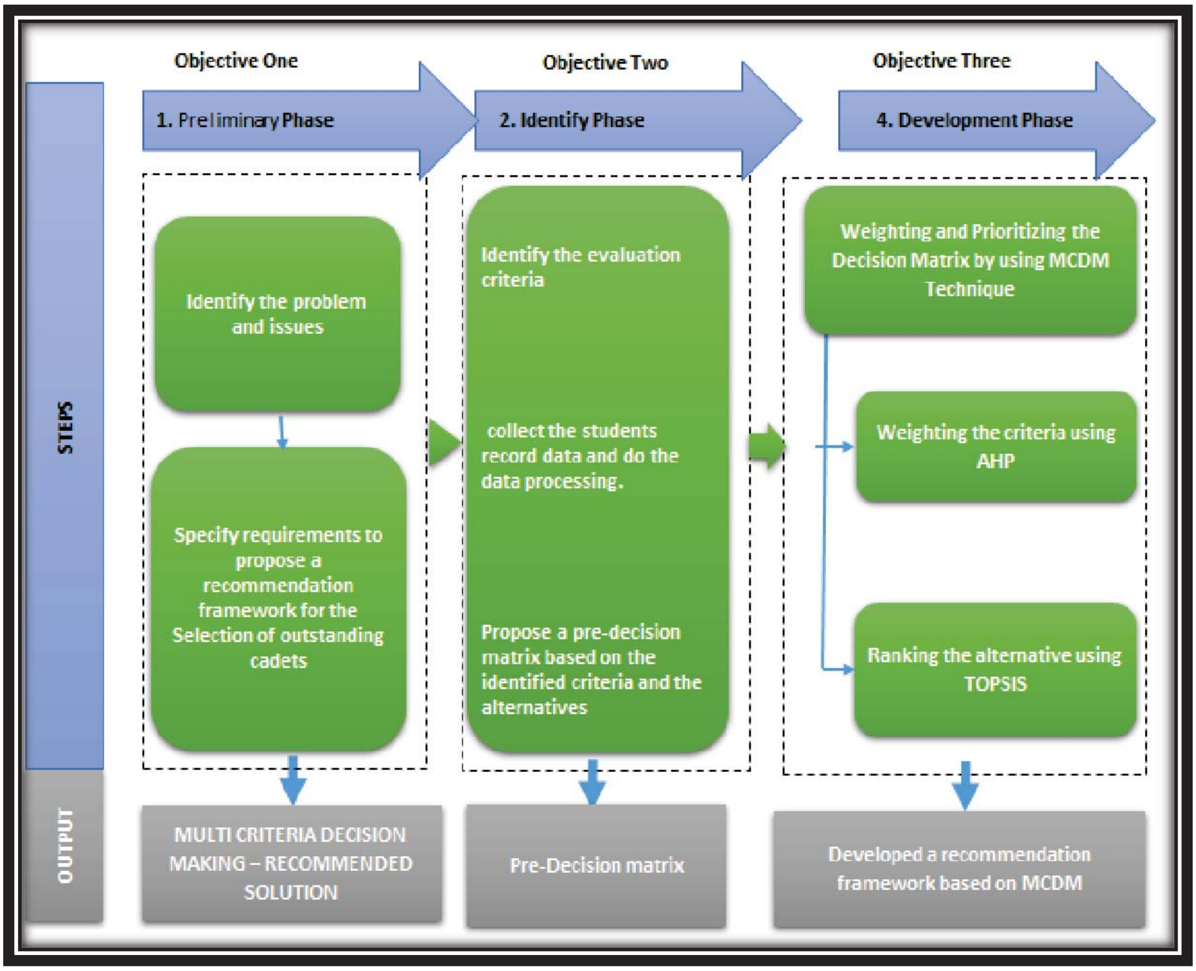

Figure 1 research methodology

3.1. Phase one: Preliminary Study Phase

To accomplish the first goal, a thorough examination of the current cadet evaluation and assessment standards is conducted in this phase. The shortcomings of the earlier research are then examined to identify the study's gaps, primary challenges, and problems. A decision matrix is proposed after an investigation of the needs. Furthermore, there are guidelines for proposing a decision matrix to rank the cadets. The issues are emphasized, and the recommended solution is presented.

3.2. Phase two: Identifications phase

The criteria for evaluating cadets are recognized in the previous phase (phase one). In addition, the data and alternatives are examined to achieve the second objective. The procedure is split into three parts. Firstly, criteria with the procedure, The Dataset processing, Identify and Propose the decision matrix.

The evaluation criteria for university (X) computer information systems and computer science cadets who enroll in the "web service" course for the years 2022 and 2023 are broken down into two main criteria. The course grade is the primary criterion, while soft skills (teamwork, communication skills, and problem-solving) are the second. The soft skills criteria are taken based on experts' opinions who have taught this course for more than five years.

For the alternatives, this research is done in military university (X) computer science and computer information systems cadets who enroll in the "web service" course for the years 2022 and 2023, the number of cadets is 59. Table 1 below shows the decision matrix (Note: W is for weight)

Table 1 decision matrix

Criteria / Alternatives	grade	teamwork	communication skills	problem-solving
cadet 1	(W_{price} with $_{cadet1}$)	($W_{teamwork}$ with $_{cadet1}$)	($W_{communication\ skills}$ with $_{cadet1}$)	($W_{problem\ solving}$ with $_{cadet1}$)
cadet 2	($W_{price}$with $_{cadet2}$)	($W_{teamwork}$ with $_{cadet2}$)	($W_{communication\ skills}$ with $_{cadet2}$)	($W_{problem\ solving}$ with $_{cadet2}$)
cadet 3	(W_{price} with $_{cadet3}$)	($W_{teamwork}$ with $_{cadet3}$)	($W_{communication\ skills}$ with $_{cadet3}$)	($W_{problem\ solving}$ with $_{cadet3}$)
………………	(W_{price} with $_{cadet…..}$)	($W_{teamwork}$ with $_{cadet…}$)	($W_{communication\ skills}$ with $_{cadet…}$)	($W_{problem\ solving}$ with $_{cadet…}$)
cadet 59	($W_{price}$with $_{cadet16}$)	($W_{teamwork}$ with $_{cadet16}$)	($W_{communication\ skills}$ with $_{cadet16}$)	($W_{problem\ solving}$ with $_{cadet16}$)

3.3. Phase three: Development Phase: Developing an integrated between AHP and TOPSIS for ranking cadets

This phase includes a detailed discussion of the development carried out in this research, with the sections that follow demonstrating how MCDM techniques are used to achieve the development. As mentioned earlier, Integrating two or more methods is the newest trend in MCDM studies; this hybrid approach addresses the drawbacks of a single method while utilizing the benefits of two distinct methods. The merging of TOPSIS and AHP forms the basis of the decision matrix used to rank cadets.

The typical procedure for the Analytic Hierarchy Process (AHP) includes these steps: stating the problem, decomposing the goal, identifying criteria by dissecting the attributes necessary for reaching the goal, forming a hierarchy structure based on these criteria and sub-criteria, generating matrices among criteria groups, calculating weights through alternative comparison for each criterion, applying AHP to allocate criteria weights in decision-making, and utilizing TOPSIS to rank the alternatives (cadets) using AHP results to pinpoint the most suitable option. Each of these processes is elaborated upon, showcasing the implementation of AHP and TOPSIS.

Integration between AHP and TOPSIS

To determine an appropriate cadet ranking system, the MCDM methodologies covered in the literature review phase are examined. A mathematical model called TOPSIS is suggested for use in ranking and resolving particular associated problems, such as data variation and the multi-evaluation criteria that the suggested DM must meet. To determine the relative relevance of the criteria that the proposed DM must meet, AHP is utilized to weight the criteria. The integration of TOPSIS and AHP is shown in Figure 2.

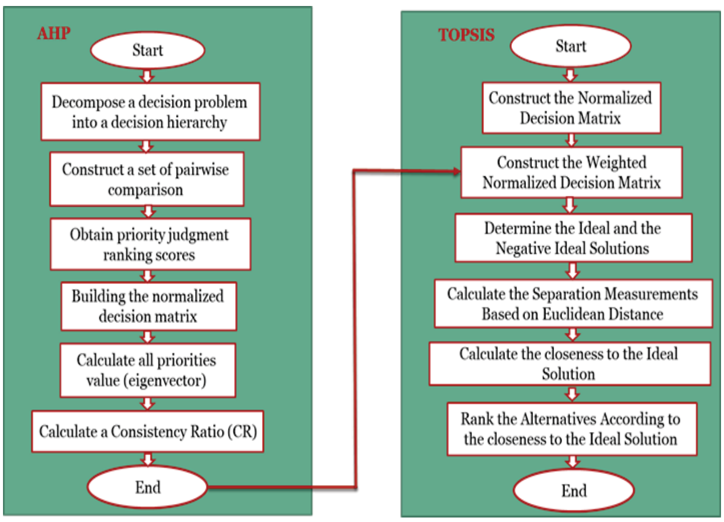

Figure 2 Integrated Between AHP and TOPSIS [18]

Step 1: Setting up the decision hierarchy using the AHP method

To initiate the Analytic Hierarchy Process (AHP), it is essential to create a hierarchical representation of the problem. This hierarchy should encompass the decision objective, criteria, and sub-criteria. Figure 3 illustrates the hierarchical structure that outlines the criteria employed in AHP, emphasizing the pairwise comparisons.

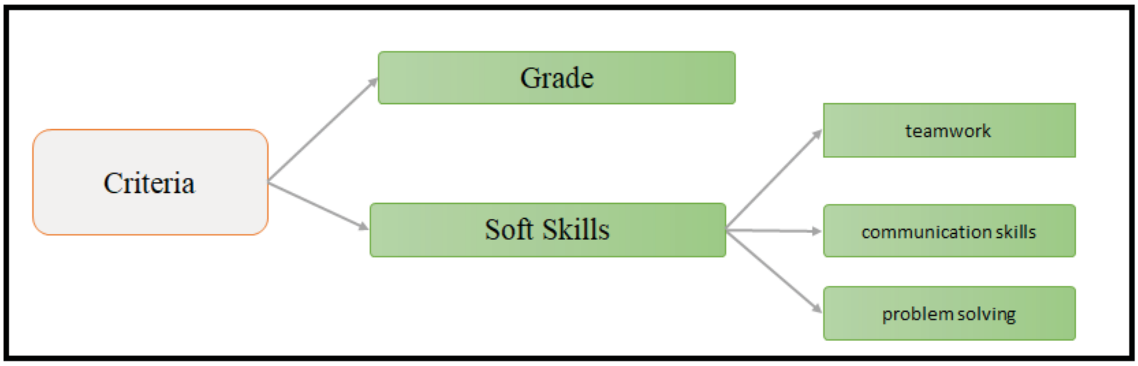

Figure 3 Criteria and sub-criteria

Within the first layer, there are two primary factors: soft skills and Grades. In the subsequent layer, the skills are further segmented into three distinct criteria. To determine their relative importance (weight), a comparative analysis of each criterion is conducted to fulfill the first objective and meet the requirements to construct the decision matrix

Step 2 Building of Pairwise Comparisons

AHP employs paired comparisons to establish ratio scales. The formula for calculating the number of needed pairwise comparisons is $n*(n-1)/2$, where 'n' signifies the count of criteria used for the evaluation by comparing sets of criteria 'n' in pairs, considering their relative importance. These criteria can be denoted as (C_1 .... C_n) and weights as (w_1.....w_n).

The matrix employs a pairwise ratio format, where each row presents the weight ratio of an element in comparison to the others. This approach is centered on determining the weights of various activities based on their significance. Generally, this significance is assessed through various criteria. Sometimes, these criteria are aligned with the goals that have been chosen for the activities under examination [41]

In this research, the specialists in web service courses choose the importance of each criterion to another criterion using SAATY's scale pairwise comparison (Table 2) to select the importance of the criteria (grade and soft skills). Figure 3.2 shows the pairwise comparison as an example.

Figure 4 Salty's Scale For Pairwise Comparison

Table 2 SAATY'S Scale Pairwise Comparison

Saaty's scale	The relative importance of the two sub-elements
1	Equally important
3	Moderately important with one over the other
5	Strongly important
7	Very strongly important
9	Extremely important

Step 3 Developing the Measurement Structure for AHP

In this phase, the primary feature criteria, signifying the significance of each feature in connection to the objective, are determined. The AHP measurement matrix is utilized to ascertain the weights based on the preferences of the evaluators gathered in the prior step. This measurement employs a mathematical approach founded on pairwise comparison, transforming the experts' assessments into calculated weights for each criterion.

In the web service course, the lecturer evaluated the grade and essential soft skills, including teamwork, communication skills, and problem-solving abilities. These skills are considered the most critical soft skills pertinent to the web service course.

Step 4 Determine the Criteria Weights

At this step, the assorted answers received from various assessors are translated to numeric figures within the Decision Matrix (DM). The DM executes methods such as normalization and aggregation to process these values. Following this, the task is to ascertain and rank the importance of each criterion. The calculation of these weights is presented in Table 3.

Table 3 AHP Measuring Steps

Criteria	Original matrix		Normalized matrix		Aggregation	Global Weight
	(grade)	(SS)	(GPA)	(SS)		
grade	grade 1	grade /SS	grade 1/S1	(grade /SS) /S2	SUM- grade	SUM- grade / N(2)
Soft skills (SS)	SS/ grade	SS 1	(SS/ grade)/ S1	SS 1 / S2	SUM-SS	SUM-SS / N(2)
SUM	S1	S2				

Step 5 Apply the TOPSIS to rank the cadets

TOPSIS evaluates cadets by calculating the distances between each cadet and ideal points, based on the principle of ranking cadets who are closest to the Positive Ideal Solution (PIS). The steps involved in the TOPSIS methodology are as follows:

1) Constructing the normalized DM

In the Decision Matrix, alternatives are laid out as decision points along the rows, and assessment criteria along the columns. Here, 'm' denotes the number of decision points, and 'n' the number of evaluation factors. This setup converts the diverse attribute dimensions into non-dimensional attributes, facilitating comparisons across different attributes. The matrix $(x_{ij})_{m*n}$ is normalized to the matrix $R = (r_{ij})_{m*n}$ using a specified normalization method, as demonstrated in the subsequent equation:"

$$r_{ij} = \boldsymbol{x_{ij}} \Big/ \sqrt{\textstyle\sum_{i=1}^{m} \boldsymbol{x_{ij}^2}}$$

This process produced a new matrix R, where R is shown as

$$R = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \cdots & r_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ r_{m1} & r_{m2} & \cdots & r_{mn} \end{bmatrix}$$

2) Constructing the weighted, normalized DM

In this procedure, a series of weights $\mathrm{w} = \mathrm{w}_1, \mathrm{w}_2, \mathrm{w}_3, \cdots, \mathrm{w}_\mathrm{j}, \cdots, \mathrm{w}_\mathrm{n}$ provided by the decision maker and computed in, are integrated into the normalized Decision Matrix (DM). The resultant matrix is formed by multiplying each column of the normalized DM (R) by its corresponding weight w_j. The total of these weights equals 1, as expressed in the formula:

$$\textstyle\sum_{j=1}^{m} w_j = 1$$

This step leads to the creation of a new matrix V, which is defined as follows:

$$\mathrm{V} = \begin{bmatrix} v_{11} & v_{12} & \cdots & v_{1n} \\ v_{21} & v_{22} & \cdots & v_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ v_{m1} & v_{m2} & \cdots & v_{mn} \end{bmatrix} = \begin{bmatrix} w_1 r_{11} & w_2 r_{12} & \cdots & w_n r_{1n} \\ w_1 r_{21} & w_2 r_{22} & \cdots & w_n r_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ w_1 r_{m1} & w_2 r_{m2} & \cdots & w_n r_{mn} \end{bmatrix}$$

3) Determining the ideal and negative ideal solutions

In this stage, two theoretical alternatives are established: A^* (the ideal alternative) and A^- (the negative ideal alternative). These are defined as follows:

$$A^* = \left\{ \left(\left(\max_i \, v_{ij} \,\middle|\, j \in J \right), \left(\min_i v_{ij} \,\middle|\, j \in J^- \right) \,\middle|\, i = 1,2, \ldots, m \right) \right\}$$

$$= \left\{ v_1^*, v_2^*, \ldots, v_j^*, \cdots v_n^* \right\}$$

$$A^- = \left\{\left(\left(\min_i \ v_{ij} \middle| j \in J\right), \left(\max_i v_{ij} \middle| j \in J^-\right) \middle| i = 1,2,\dots,m\right)\right\}$$

$$= \{v_1^-, v_2^-, \dots, v_j^-, \cdots v_n^-\}$$

In this context, J represents a subset of of $\{i = 1,2,\dots,m\}$, which indicates benefit attributes, while J^- is the complementary set of, or (J^c), denoting the set of cost attributes

4) Calculating separation measurement based on the Euclidean distance

The separation measurement involves computing the distance between each alternative in matrix V and the ideal vector A^* using the Euclidean distance method. This is calculated as:

$$S_{i^*} = \sqrt{\sum_{j=1}^{n}\left(v_{ij} - v_j^*\right)^2}, \ i = (1,2,\cdots m)$$

In a similar fashion, the separation measurement for each alternative in V from the negative ideal $A^-$is determined by:

$$S_{i^-} = \sqrt{\sum_{j=1}^{n}\left(v_{ij} - v_j^-\right)^2}, \ i = (1,2,\cdots m)$$

After step 4, two values, S_{i^*} and S_{i^-} , are calculated for each alternative. These values signify the distances between each alternative and both the ideal and the negative ideal points

5) Calculating closeness to the ideal solution

The proximity (closeness) of each alternative $A_i$to the ideal solution $A^*$is quantified by the formula:

$$C_{i^*} = S_{i^-}/(S_{i^-} + S_{i^*}), \ \ 0 < C_{i^*} < 1, \ i = (1,2,\cdots m)$$

Here, C_{i^*} equals 1 if and only if A_i is identical to A^*conversely, C_{i^*} is 0 if and only if $A_i$matches A^-

6) Ranking the alternatives based on their proximity to the ideal solution

Based on the value of A_i, a greater relative closeness indicates a higher rank and better performance of the alternative (cadets). By arranging preferences in descending order, it becomes easier to compare relatively superior performances. Hence, the alternatives A_i can be ordered according to the descending values of C_{i^*}, where a higher value signifies enhanced performance. TOPSIS is applied in various scenarios, and choosing the appropriate context is advisable, guided by experiments involving different aggregation operators.

4. Results and Discussion

Here, the results of the decision matrix for ranking university (X) computer science and information systems cadets who enroll in the "web service" course for the years 2023 and 2024 are presented in detail. The next section illustrates the AHP results to show the weights for the criteria. The judgments of each expert are converted using mathematical calculations to show the overall weights. Then it shows the TOPSIS results. In addition, discusses the results.

4.1. Results of Data presentation

Results of Data Presentation for 20 cadets out of 59 are illustrated in Table 4 below after collected from the “we service “ course. However. As mentioned earlier, there are two main criteria (Grade and soft skills). And, soft skills have three sub-criteria. These criteria are to evaluate and rank computer science and information systems cadets based on expert opinion.

Table 4 data presentation result

Criteria / Alternatives	Grade	Soft skills		
		teamwork	communication skills	problem-solving
cadet 1	76	3	4	4
cadet 2	76	4	3	4
cadet 3	88	3	3	4
cadet 4	90	3	4	3
Cadet 5	66	4	4	4
Cadet 6	59	4	4	4
Cadet 7	62	3	4	4
Cadet 8	66	2	3	2
Cadet 9	63	4	4	3
Cadet 10	70	3	4	4
Cadet 11	82	4	3	3
Cadet 12	91	2	3	4
Cadet 13	56	3	3	3
Cadet 14	61	4	4	3
Cadet 15	69	4	4	3
Cadet 16	77	3	3	4
Cadet 17	62	1	2	4
Cadet 18	83	2	2	2
Cadet 19	86	2	4	1
Cadet 20	54	3	1	3

Table 3 above lists Cadet 1 through Cadet 20, and grades represent overall scores or grades achieved by the cadets in the “web service” course. Soft Skills is further divided into three sub-criteria, each representing a different soft skill:

- Teamwork: Cadets are rated on a scale of 1 to 4 on their teamwork abilities.
- Communication Skills: Similarly, cadets are rated on a scale of 1 to 4 on their communication skills.
- Problem Solving: Cadets are rated on a scale of 1 to 4 on their problem-solving skills.

The cadets' ratings for soft skills mostly fall between 2 and 4, with the majority receiving the highest rating of 4 in problem-solving skills. The variation in grades and soft skills ratings suggests an evaluation of these individuals' overall performance and specific competencies in areas that are key to their roles or functions, likely in a training or educational context.

4.2. Results Discussion of AHP and TOPSIS Decision-Making Contexts

In this research, AHP and TOPSIS methodologies are employed. AHP is used for weighing the criteria, while TOPSIS is utilized for ranking the alternatives. For the criteria, opinions from four experts are considered, and the average of these weights is applied in TOPSIS to rank the cadets. Following the weighting procedure outlined in step 4 for determining the importance of each criterion, we distributed a questionnaire to experts. For example, one expert indicated the significance of the grade criterion over teamwork by selecting "5" for 'Strongly Important'. Figure 5 below depicts the perceived weight of each criterion according to the experts' responses.

Expert	criteria	Original Matrix				Normalized Matrix				Aggregation	Weight
		Grade	teamwork	communication skills	problem solving	Grade	teamwork	communication skills	problem solving		
First Expert	Grade	1.0000	5.0000	5.0000	1.0000	0.4167	0.4167	0.4167	0.4167	1.6667	0.4167
	teamwork	0.2000	1.0000	1.0000	0.2000	0.0833	0.0833	0.0833	0.0833	0.3333	0.0833
	communication skills	0.2000	1.0000	1.0000	0.2000	0.0833	0.0833	0.0833	0.0833	0.3333	0.0833
	problem solving	1.0000	5.0000	5.0000	1.0000	0.4167	0.4167	0.4167	0.4167	1.6667	0.4167
	Sum	2.4000	12.0000	12.0000	2.4000						1.0000
second Expert	Grade	1.0000	5.0000	5.0000	1.0000	0.4167	0.3125	0.5435	0.4167	1.6893	0.4223
	teamwork	0.2000	1.0000	0.2000	0.2000	0.0833	0.0625	0.0217	0.0833	0.2509	0.0627
	communication skills	0.2000	5.0000	1.0000	0.2000	0.0833	0.3125	0.1087	0.0833	0.5879	0.1470
	problem solving	1.0000	5.0000	3.0000	1.0000	0.4167	0.3125	0.3261	0.4167	1.4719	0.3680
	Sum	2.4000	16.0000	9.2000	2.4000						1.0000
third Expert	Grade	1.0000	7.0000	5.0000	5.0000	0.6481	0.7000	0.5000	0.6818	2.5300	0.6325
	teamwork	0.1429	1.0000	1.0000	1.0000	0.0926	0.1000	0.1000	0.1364	0.4290	0.1072
	communication skills	0.2000	1.0000	1.0000	0.3333	0.1296	0.1000	0.1000	0.0455	0.3751	0.0938
	problem solving	0.2000	1.0000	3.0000	1.0000	0.1296	0.1000	0.3000	0.1364	0.6660	0.1665
	Sum	1.5429	10.0000	10.0000	7.3333						1.0000
fourth Expert	Grade	1.0000	5.0000	7.0000	1.0000	0.4268	0.4464	0.3182	0.4327	1.6241	0.4060
	teamwork	0.2000	1.0000	5.0000	0.2000	0.0854	0.0893	0.2273	0.0865	0.4885	0.1221
	communication skills	0.1429	0.2000	1.0000	0.1111	0.0610	0.0179	0.0455	0.0481	0.1724	0.0431
	problem solving	1.0000	5.0000	9.0000	1.0000	0.4268	0.4464	0.4091	0.4327	1.7150	0.4288
	Sum	2.3429	11.2000	22.0000	2.3111						1.0000

Figure 5 weight of the criteria from the four experts

Figure 6 displays the weights assigned by each expert, while Figure 7 presents the average weights for various criteria - Grade (0.469), Teamwork (0.094), Communication Skills (0.092), and

Problem Solving (0.345) - as derived from the views of the four experts. These weights are then employed in the second phase of TOPSIS. The subsequent section outlines the TOPSIS outcomes, which rank the cadets according to these four criteria.

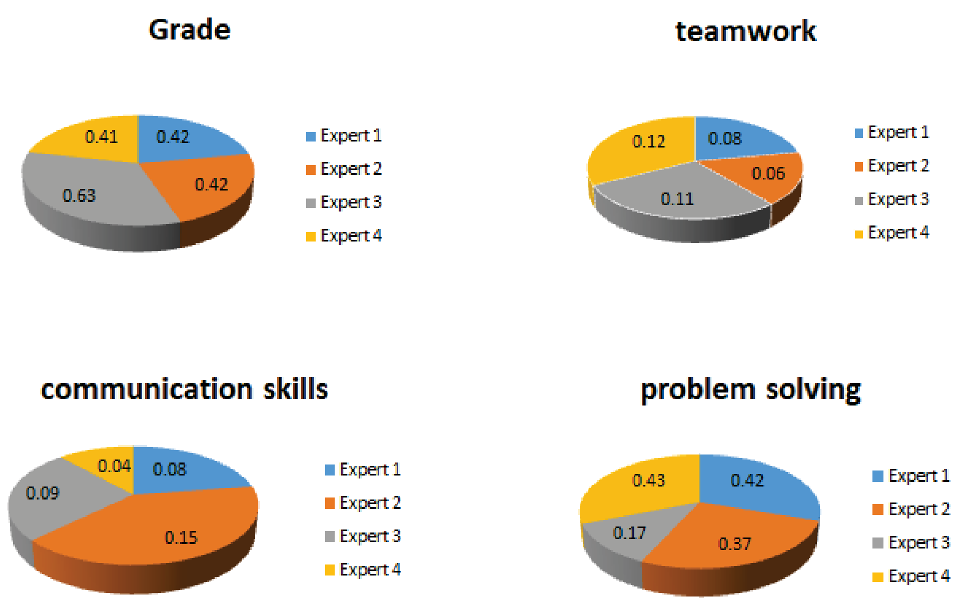

Figure 6 weights given by all experts

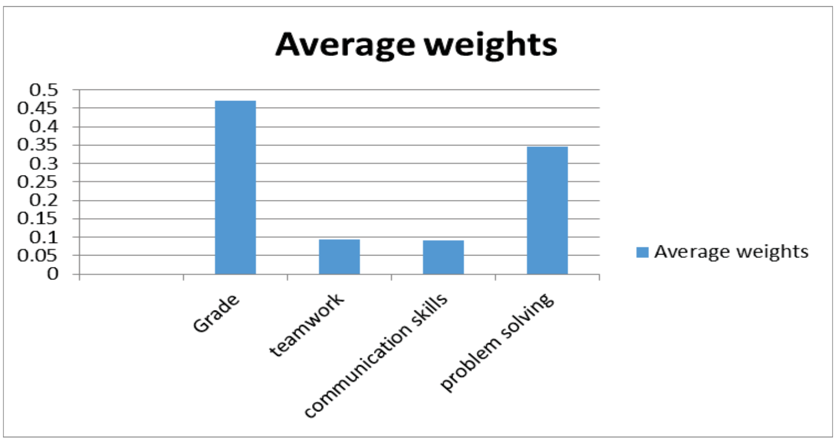

Figure 7 average weight

The available alternative (computer science and information systems cadets) scores are ranked in descending order based on TOPSIS. TOPSIS allocates the scores to each alternative based on its geometric distance from the PISs and NISs. This technique ranks the alternatives with the score, which has the shortest geometric distance to the PIS and the longest geometric distance to the NIS, in this section, DM is created, and they correspond to the number of university (X) computer science and information systems cadets who enroll in the "web service" course for the year 2023, 2024. Table 5 shows the separation measure (Si* and Si−) with the score for 20 cadets out of 59.

Table 5 Separation measure and Score for all CADETS

cadet	Si+	Si-	Score
1	0.02518835	0.039475346	0.610471537
2	0.025202652	0.039429678	0.610061223
3	0.015180776	0.046557372	0.754110285
4	0.012558809	0.049824216	0.798682269
5	0.034752623	0.0364878	0.512178317
6	0.042124391	0.033723545	0.444620469
7	0.039573309	0.031117415	0.440190926
8	0.039087106	0.023361747	0.374094094
9	0.038176391	0.033678916	0.468704645
10	0.031312514	0.035386549	0.53054042
11	0.019726245	0.04289571	0.684994746
12	0.017622507	0.047823837	0.730733512
13	0.046551028	0.022482363	0.325673751
14	0.040268782	0.032879104	0.449488097
15	0.031910138	0.036704293	0.534935471
16	0.025160237	0.037075938	0.595729697
17	0.046283668	0.019730172	0.298879329
18	0.027376003	0.036388564	0.57067061
19	0.023655805	0.043835023	0.649496001
20	0.052441589	0.017009125	0.244909292

Table 4 shows the results for ranking 20 CADETS. The first column shows the cadet number and the second column shows the score of each cadet. Based on these scores, the top-performing cadet is identified as cadet 4, as per expert opinion, due to achieving the highest score. Meanwhile, figure 8 below presents all cadets.

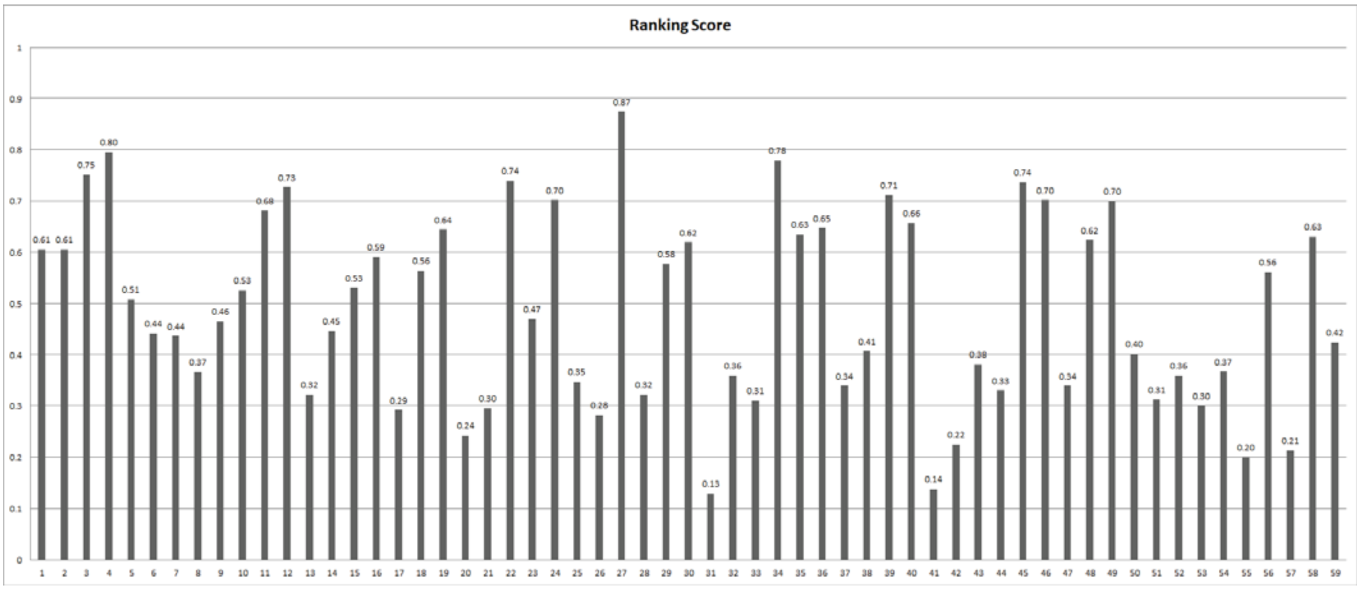

Figure 8 Ranking all cadets

The 59 cadets, each represented by a bar, have been scored on a scale from 0 to 1. The scores are meticulously detailed to nine decimal places, suggesting an assessment of great precision or perhaps a computational outcome from an algorithmic evaluation. The highest score, flirting with the ceiling of perfection, is 0.876012854 “which is the best cadet”, while the lowest is a modest 0.219742699 “which is the worst result”. This range indicates a broad spectrum of performance among the cadets evaluated, hinting at the diversity of capability or achievement.

For decision-makers, this chart is a tool for strategic planning. Those cadets that hover near the top might be recognized and rewarded, their practices studied and replicated. Those at the lower end might be offered support, and their practices scrutinized for improvement.

Conclusion

This study introduces a decision-making optimizer for assessing the capabilities of cadets from university (X), specifically those in the computer information systems and computer science departments enrolled in the 'web service' course for the fall semester of 2023. The approach leverages Multiple-Criteria Decision-Making (MCDM) as a means to address multi-criteria problems. In this study, MCDM methods are applied, starting with a combined AHP and TOPSIS method to rank the cadets. The AHP is utilized to determine the weights of each criterion based on expert judgments. Following this, the TOPSIS method is employed to rank the cadets according to these expert opinions. The proposed framework is adaptable for ranking cadets from various departments and can be used to identify and select outstanding cadets based on multiple evaluation criteria. In addition for future work, this innovative methodology can be applied across various domains, including medicine and beyond. Additionally, in future studies, AI large language models, such as Google Gemini and various chatbots, will be integrated into the methodology steps.

References

1. Iedynak, G., et al., *The effect of training in military pentathlon on the physiological characteristics of academy cadets*. Sport Mont, 2020. 18(3): p. 95-99.
2. Tomes, C., et al., *What is the impact of fitness on injury risk during police academy training? A retrospective cohort study*. BMC sports science, medicine, and rehabilitation, 2020. 12: p. 1-8.
3. Caya, S., *Psychological Profile of the Military Student: Turkey's Example*. Procedia-Social and Behavioral Sciences, 2015. 185: p. 281-285.
4. Terziev, V., et al., *The cadets and the reasons for their drop-out of the National Military University*. IJAEDU-International E-Journal of Advances in Education, 2019. 5(15).
5. Woodward, R., K.N. Jenkings, and A.J. Williams, *Militarisation, universities, and the university armed service units*. Political Geography, 2017. 60: p. 203-212.
6. Boe, O. and T. Holth, *Investigating correlations between personality traits and leadership styles in Norwegian military cadets*. Procedia Economics and F inance, 2015. 26: p. 1173-1184.
7. Stabsskole, F., *Forsvarets fellesoperative doktrine (Norwegian Armed Forces Joint Operational Doctrine)*. Norwegian Armed Forces Defence Staff: Oslo, 2007.
8. Torgersen, G.E., T.J. Steiro, and H. Sæverot. *Strategic education management: Outlines for a didactic planning model for exercises and training of the unexpected in high risk organizations*. in *Proceedings of the 22nd Society for Risk Analysis Europe (SRA E) Conference*. 2013.
9. Chase, A.M., et al., *Improving critical thinking via authenticity: the CASPiE research experience in a military academy chemistry course*. Chemistry Education Research and Practice, 2017. 18(1): p. 55-63.
10. Constantinescu, M., *MILITARY EDUCATION-BETWEEN TRADITION, MODERNITY AND FINDING A PURPOSE*. Romanian Military Thinking, 2022(1).
11. Novoselich, B.J. and D.B. Knight. *Shared leadership in mechanical engineering-centric capstone design teams: A comparison of military and civilian engineering*

programs. in *2016 ASEE Annual Conference & Exposition*. 2016.

12. Perrin, L., et al., *Promoting safety teaching: An essential requirement for the chemical engineering education in the French universities.* Journal of Loss Prevention in the Process Industries, 2018. 54: p. 190-195.
13. Abdeljaber, H.A. and S. Ahmad, *Program Outcomes Assessment Method for Multi-Academic Accreditation Bodies: Computer Science Program as a Case Study.* International Journal of Emerging Technologies in Learning, 2017. 12(5).
14. Myers, J.A., et al., *NBME subject examination in surgery scores correlate with surgery clerkship clinical experience.* Journal of surgical education, 2014. 71(2): p. 205-210.
15. Deni, W., O. Sudana, and A. Sasmita, *Analysis and implementation fuzzy multi-attribute decision making SAW method for selection of high achieving students in faculty level.* International Journal of Computer Science Issues (IJCSI), 2013. 10(1): p. 674.
16. Roszkowska, E., *Rank ordering criteria weighting methods–a comparative overview.* 2013.
17. Leyva López, J.C., *Multicriteria decision aid application to a student selection problem.* Pesquisa Operacional, 2005. 25(1): p. 45-68.
18. Zaidan, A., et al., *Multi-criteria analysis for OS-EMR software selection problem: A comparative study.* Decision Support Systems, 2015. 78: p. 15-27.
19. Keeney, R.L. and H. Raiffa, *Decisions with multiple objectives: preferences and value trade-offs*. 1993: Cambridge university press.
20. Belton, V. and T. Stewart, *Multiple criteria decision analysis: an integrated approachKluwer Academic Publishers*. 2002, Boston.
21. Petrovic-Lazarevic, S. and A. Abraham, *Hybrid fuzzy-linear programming approach for multi criteria decision making problems.* arXiv preprint cs/0405019, 2004.
22. Malczewski, J., *GIS and multicriteria decision analysis*. 1999: John Wiley & Sons.
23. Zionts, S., *MCDM-If not a Roman Numeral, then what?* Interfaces, 1979. 9(4): p. 94-101.

24. Baltussen, R. and L. Niessen, *Priority setting of health interventions: the need for multi-criteria decision analysis*. Cost effectiveness and resource allocation, 2006. 4(1): p. 1.

25. Thokala, P., et al., *Multiple Criteria Decision Analysis for Health Care Decision Making—An Introduction: Report 1 of the ISPOR MCDA Emerging Good Practices Task Force*. Value in health, 2016. 19(1): p. 1-13.

26. Oliveira, M., D.B. Fontes, and T. Pereira, *Multicriteria decision making: a case study in the automobile industry*. Annals of Management Science, 2014. 3(1): p. 109.

27. Jadhav, A. and R. Sonar. *Analytic hierarchy process (AHP), weighted scoring method (WSM), and hybrid knowledge based system (HKBS) for software selection: a comparative study*. in *2009 Second International Conference on Emerging Trends in Engineering & Technology*. 2009. IEEE.

28. Zaidan, A., et al., *Robust Pornography Classification Solving the Image Size Variation Problem Based on Multi-Agent Learning*. Journal of Circuits, Systems and Computers, 2015. 24(02): p. 1550023.

29. Godfrey, B., et al., *Emergency Medical Guidelines, Third Edit. Sunshine Act of Florida*. 2000: p. p.245.

30. Triantaphyllou, E., et al., *Multi-criteria decision making: an operations research approach*. Encyclopedia of electrical and electronics engineering, 1998. 15: p. 175-186.

31. Triantaphyllou, E., *Multi-criteria decision making methods*, in *Multi-criteria Decision Making Methods: A Comparative Study*. 2000, Springer. p. 5-21.

32. Aruldoss, M., T.M. Lakshmi, and V.P. Venkatesan, *A survey on multi criteria decision making methods and its applications*. American Journal of Information Systems, 2013. 1(1): p. 31-43.

33. Yoon, K.P. and C.-L. Hwang, *Multiple attribute decision making: an introduction*. Vol. 104. 1995: Sage publications.

34. P.-E., J. and M. Mollaghasemi, *Technical Briefing: Making Multiple Objective*

Decisions. 1997, IEEE Computer Society Press: Los Alamitos, California.

35. Çalışkan, H., *Selection of boron based tribological hard coatings using multi-criteria decision making methods.* Materials & Design, 2013. 50: p. 742-749.

36. Ortíz, M.A., et al., *An integrated approach of AHP-DEMATEL methods applied for the selection of allied hospitals in outpatient service*. International Journal of Medical Engineering and Informatics, 2016. 8(2): p. 87-107.

37. Barrios, M.A.O., et al., *An AHP-Topsis Integrated Model for Selecting the Most Appropriate Tomography Equipment.* International Journal of Information Technology & Decision Making, 2016. 15(04): p. 861-885.

38. Nilsson, H., E.-M. Nordström, and K. Öhman, *Decision support for participatory forest planning using AHP and TOPSIS.* Forests, 2016. **7**(5): p. 100.

39. Beikkhakhian, Y., et al., *The application of ISM model in evaluating agile suppliers selection criteria and ranking suppliers using fuzzy TOPSIS-AHP methods.* Expert Systems with Applications, 2015. 42(15): p. 6224-6236.

40. Ren, J. and B.K. Sovacool, *Prioritizing low-carbon energy sources to enhance China's energy security.* Energy Conversion and Management, 2015. 92: p. 129-136.

41. Zaidan, A.A., et al., *Evaluation and selection of open-source EMR software packages based on integrated AHP and TOPSIS.* Journal of Biomedical Informatics, 2015. 53(Supplement C): p. 390-404.