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A Sensitivity Analysis for Roles Selection in Hybrid Multi-Criteria Decision Making

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ABSTRACT

The process of retaining leadership succession at higher education institutions (HEI) is crucial since it has entailed the process of selecting the ideal candidate. The goal is to guide universities toward maintaining organizations' excellence in their academic leadership and management (ALM) positions. Due to the lack of established standards for assessing the competency of possible successors at their home institutions, many ALM of Malaysia HEIs is difficult to identify the proper replacement for their posts. This study aims to propose a multi-criteria tacit knowledge acquisition framework (MC-TKAF) for supporting talent development intervention programs in Malaysia HEIs. It will be based on cognitive apprenticeship, socialization, and informal learning theory which is mostly used in acquiring knowledge from expertise to overcome talent bottlenecks among novices. Fuzzy Delphi will be used as the primary methodology in this study to gather agreement regarding the appropriate indicator to measure tacit knowledge competency among ALMs at Malaysian HEIs. There are three phases: Phase 1 involves analysing the current tacit knowledge acquisition (TKA) and identifying the appropriate parameters to build the intended framework. Phase 2 involves using the results of Phase 1 to create a new framework of tacit knowledge acquisition (TKAF) that is appropriate for the HEI environment. Phase 3's final objective is to assess the viability of the Talent Development Intervention Program's (TDIP) Tacit Knowledge Acquisition Framework (TKAF) utilizing the Multi-Criteria Decision Making (MCDM) approach. This paper's goal is to offer the hybrid MCDM approach as a talent performance indicator for the multi-criteria tacit acquisition framework. The final Phase 3 of the study design will essentially be the subject of this paper. The built-in indicators in this document may be utilized as a guide for the HEI sectors to create talent performance metrics that are appropriate for each TKA applied.

1. Introduction

In recent years, succession planning and managing executive transitions in higher learning institutions have appeared as significant problems [1-2]. These result from the loss of the implicit talent and leadership abilities of previous academic leaders. The majority of them are members of

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the baby boomer generation, who will eventually retire and depart the company. Academic leadership and management (ALM) at HEIs have a history of proven abilities and knowledge that may serve the entire institution in addition to their organizational units. Some people at most institutions are still confused about how intellectual capital is created and how tacit knowledge is distributed among staff members [3]. Yet the expertise and knowledge embedded in the predecessor of ALM are not able to be moulded with specific acquisition formulation due to unknown reasons. If we can understand the underlying reason behind what causes knowledge to be tacit, especially during the process of transfer, we can select a transfer mechanism that targets the cause, making the transfer more efficient and, in some cases, saving it from failure. One of the factors contributing to this phenomenon is lacking effective evaluation of tacit knowledge acquisition that should be adopted in the HEI environment as an intrapersonal catalyst [4] in the Talent Development Intervention (TDI) Program.

A few rules have been created in Malaysian higher education institutions (HEI) to guarantee that academic workers are not only assessed for their academic performance but also to improve their ability and potential by providing an appropriate talent development intervention program. The process of identifying persons with the necessary credentials to carry out a certain task in the best possible manner is known as academic staff selection in higher education institutions. A few studies [4-5] show that, in the selection process, academicians who are chosen are likely to be evaluated and assessed based on explicit evaluations such as qualification, experience, and research activities. When academicians join any talent development intervention in their institution, no evaluation is conducted on them.

1.1 Phenomenon in Malaysia HEI Selection Process for ALM Roles

According to Orange Book [6], only 9% of academics at Malaysia's public HEI saw themselves as transformative leaders. This is less than the number of projected ratios that were anticipated to be needed in [6] which are 10-20% number of academicians who should be ready to hold the position as ALM. The study's readiness factor for various job pathways demonstrates that academics and universities are not yet ready for various career pathways. If no proactive steps are done to intervene in the process of choosing, and developing prospective candidates when it is due, this present occurrence will result in a reduced number of shortlisted possible applicants for ALM posts. The necessity for a talent pool to fill open ALM positions in HEI is critical, especially for hiring and firing decisions and performance reviews. Both evaluations are often conducted individually. Both of these require a reliable model to assess knowledge, competence, and experience. Therefore, there has not yet been a specific model developed to assess the tacit knowledge competence that academicians insist upon having to become successful academic leaders or managers. The following section will go into more detail about how this model is suggested: Multi-Criteria Tacit Knowledge Acquisition Framework in section 1.2.

1.2 Multi-Criteria Tacit Knowledge Acquisition Framework (MC-TKAF)

Competency is one of the required elements in evaluating potential ALM in an academic setting background such as managerial competence [7] and leadership competence [8]. However, the skill and experience can only be gained from the process of acquisition and elicitation [9] which is known as tacit knowledge competence. The assessment of tacit evaluation necessitates the application of intuition, judgment, and sentiment and is fundamental to determining novices' tacit knowledge competence. This kind of review requires a lot more consideration. However, it is a sort of evaluation

that is most likely to gauge how well staff members use their tacit knowledge. Our suggested approach to choosing the best indication to gauge tacit knowledge development among ALM candidates is based on five theoretical frameworks. Table 1 lists the definitions of the Cognitive Apprenticeship Model (CAM), Socialization: SECI, Informal Learning, Self-Efficacy Theory, and the Dreyfus Model. The elaboration of this framework was explained in detail in [9]. The next section will discuss the method that was used to verify the criteria to evaluate the proposed model by using the Fuzzy Delphi Method in section 1.3

Table 1
MC-TKAF Underlying Theory

Author	Theory/Model	Parameter
[10]	Apprenticeship (CAM)	Coaching
[11]	Socialization (SECI)	Mentoring Job rotation
[12]	Informal Learning	On-Job Training (OJT)
[13]	Expertise	Novice Advanced Beginner Competent Proficient Expert
[14]	Self-Efficacy	Cognitive Motivational Affective Selection

1.3 Fuzzy Delphi Method (FDM)

The idea of conventional Delphi which is quite time-consuming has been given a new approach by [15] to avoid weaknesses such as repetitive surveys of the experts which means more costly, and the response rate becomes lower, particularly for a complicated survey. According to [15], the Fuzzy Delphi Method as proposed, has the advantage to reduce

i. Fuzziness, which is inescapably incorporated in the findings
ii. enables the reduction in the number of surveys
iii. The semantic structure of forecast items is clarified
iv. Individual attributes of the expert (forecaster) are elucidated.

The improvement is made to rectify the imperfection of the traditional Delphi Method (DM) that leads to low convergence in retrieving outcomes, loss of important information, and long progress of investigation [16]. Due to the flexibility of this study, the FDM has been used to be one of the tools to verify the criteria to obtain expert consensus findings. The selected criteria that have been chosen among experts via consensus for this MCTKAF are elaborated on in this paper [17]. Figure 1 shows the flow chart for choosing the consensus view. The next section will discuss the MCDM techniques that have been chosen for this study.

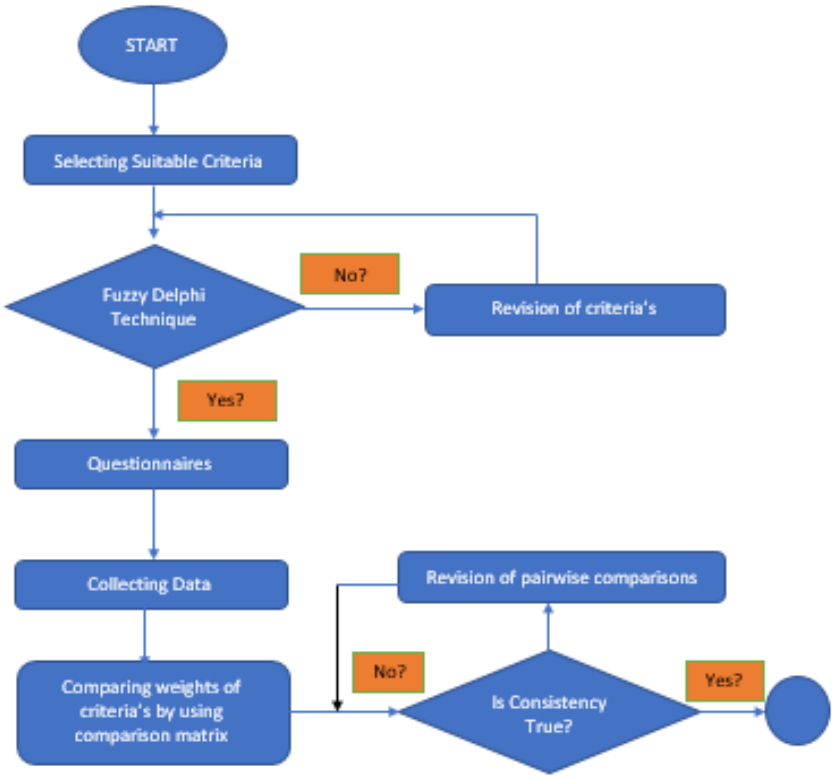

Fig. 1. Fuzzy Delphi Method

1.4 Multi-Criteria Decision Making (MCDM)

Multi-criteria decision-making (MCDM) method addresses the decision-making process with various goals. A decision-maker (DM) must select from various quantifiable or non-quantifiable criteria. One of MCDM's primary objectives is to help DMs integrate objective measurements with value judgments that are not based on the view of people but on collective thoughts [18]. This method provides powerful decision-making in areas where the best option is extremely complicated [18]. The goals are generally conflicting, so the solution depends heavily on the decision maker's preferences and must be a compromise.

There are various situations where making decisions requires weighing several competing factors. A decision-maker must typically rank and choose from a finite number of choices in MCDM models. It is frequently necessary to also weigh a limited number of criteria in accordance with their relative relevance. As shown in Table 2, MCDM techniques have been used in a variety of human selection applications to determine the optimum course of action. The application of the MCDM approach as a talent performance indicator for choosing academic administration posts for aspiring academics is the main goal of this study.

Several authors [19–21] have discussed each method in MCDM which has different kinds of formulas and objectives to be fulfilled based on the area's needs as illustrated in Table 2. Due to the many methods in MCDM, researchers make a list of criteria to choose which one is the best to be used according to the area of application. According to [22] different MCDM methods suit different kinds of decision situations for example, AHP is recommended in cases where people are not able to quantify their preferences for various criteria and alternatives.

Table 2
MCDM Approach in Personal Selection as Academician

Area/Applications	Criteria	Source of Criteria	SAW	TOPSIS	ELECTRE	CFPR	AHP
Finding the Right Personnel in Academic Institutions	Qualification Marks Experience in years Salary Expectation Ability to handle different subject Research Activities Technical Skill Presentation/Communication Skill	NONE	[23]	[23]			[23]
Academic Staff Selection	Individual Factor Academic Factor Work Faculty	NONE			[24]		
Evaluation of Personnel Selection Criteria Using Consistent Fuzzy Preference Relations	Activity Fee Education Internal Factors Business Factors	NONE				[25]	
Academic staff promotion in higher education by using Analytic Hierarchy Process (AHP)	Teaching and Supervision Research and Publication Administration and Management Professional Contribution to Society Scholarly Recognition	NONE					
Fuzzy Analytic Hierarchy Process for Multi-criteria Academic Successor Selection.	Personal and Interpersonal Outcomes Learning and Teaching Outcomes Recognition and Reputation Financial Performance Effective Implementation	[26]					[27]

For example in the study done by [20] in the area of real estate and land management, they used seven (7) methods such as (ELECTRE), (MAUT), (ANP), (MACBETH), (AHP), (TOPSIS), (PROMETHEE) and four (4) criteria of choosing MCDM method that is suitable for the proposed model. Another

study [18] also comes with numerous methods and criteria such as fuzzy TOPSIS, fuzzy VIKOR, and fuzzy GRA for the evaluation of urban mobility projects. As proposed by [18], the best alternative method can also use the veto rule to select. In another word, the alternative(s) that the majority of methods rank the highest will lastly be selected. The summary can be seen in Table 3.

Table 3
MCDM criteria selection

Author	Area	Criteria of MCDM selection
Kolios *et al.,* [20]	Real estate and land management	The weighting of variables (optional action) Determining the framework of expected properties Calculation of the overall index of suitability The identification of the method best suited to resolve the decision-making problem
Aruldoss *et al.,* [18]	Urban mobility projects	The alternative (s) that is ranked as the highest by the majority of methods

1.5 Hybrid MCDM

Hybrid MCDM is widely used by many researchers to find the best solution in their prospect [28-31]. For example in [32], compared to the ELECTRE approach, the TOPSIS method provides more accurate and trustworthy findings in personnel selection. Comparison between the MCDM method also been used in [33] to the proposed hybrid fuzzy DEMATEL- AEW-FVIKOR method shows its advantage in flexibility concerning the decision makers' preference. Six techniques of MCDM have been discovered as in TABLE 4 to solve the nature of the MC TKAF which are SAW, WPM, AHP, TOPSIS, CFPR, and ELECTRE. As shown in TABLE 4, each technique in MCDM has its own set of formulas and objectives that must be accomplished based on the needs of the various regions. Because there are numerous approaches in MCDM, researchers create a list of parameters to determine which one is the best to employ based on the field of application. According to [22] different for instance, AHP is recommended in situations where individuals are unable to measure their preferences for different parameters and alternatives. MCDM approaches fit different types of decision situations. While CFPR is purposely used for simplifying the pairwise comparison [21] and ELECTRE [32], is used when comparing binary, superiority between different decision points for each rating factor is employed. Many new users have difficulty identifying which type of MCDM technique is best for their particular situation. Each of MCDM technique do have their own strength and weakness and rationale of using them as described in [34–37].

1.6 Sensitivity Analysis

In multi-criteria decision making (MCDM) research that sought to choose the best option from a number of competing choices, a sensitivity analysis may provide unexpected insights. This is a crucial step in the decision-making process. Each possibility is outlined in this situation using a set of criteria for evaluation. There is disagreement over how to assess the "quality" of a decision technique and the dependability of the findings, which is the sensitivity analysis [38]. In a model proposed by [39] based on Figure 2, as a consequence of sensitivity analysis, the best MCDM technique is chosen in order to address the issue at hand and choose the best course of action.

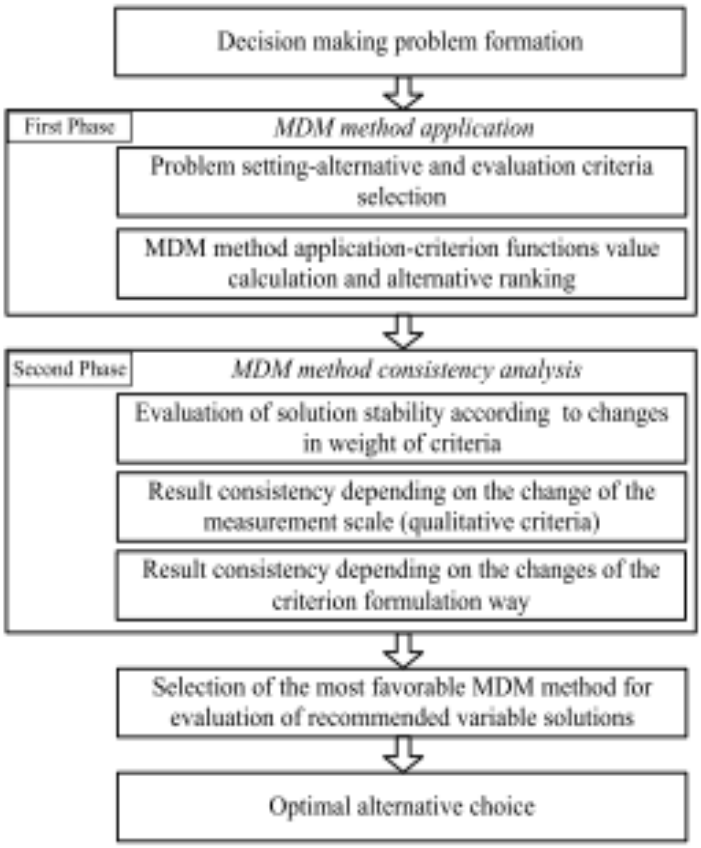

Fig. 2. Model of result consistency evaluation in MCDM

Most current work on this topic normally focus on single or multiple approach on using MCDM techniques [40–43].Detailed reviews on Multi Criteria Decision Making can be seen in review papers by several authors [44]. Many inexperienced users have difficulty in deciding which kind of MCDM technique will be the most suitable for their decision situation. Several methods are reported in the literature to address this issue; however, the existing research has many problems in helping the decision makers to choose the right option [44–47]. In this case, this paper which highlighted on assessing how well the Talent Development Intervention Program (TDIP) will complement the Tacit Knowledge Acquisition Framework (TKAF) on utilizing a multi-criteria decision-making process offers a test of using Sensitivity Analysis to help decision makers in selecting the best option via hybrid MCDM model.

2. Methodology

Phases 1, 2, and 3 comprise the three sections of this study, as shown in Figure 3. Analysing the current tacit knowledge acquisition (TKA), which contains three subphases, is done in phase one. document analysis, validation, and the fuzzy Delphi technique, in that order. Phase 2 is the stage in which Phase 1's findings are used to create a new framework for Tacit Knowledge Acquisition Framework (TKAF) that is compatible with the HEI environment and uses Fuzzy Delphi to achieve consensus agreement. Phase 3's final step is to assess how well the Talent Development Intervention Program (TDIP) will complement the Tacit Knowledge Acquisition Framework (TKAF) utilizing a multi-criteria decision-making process.

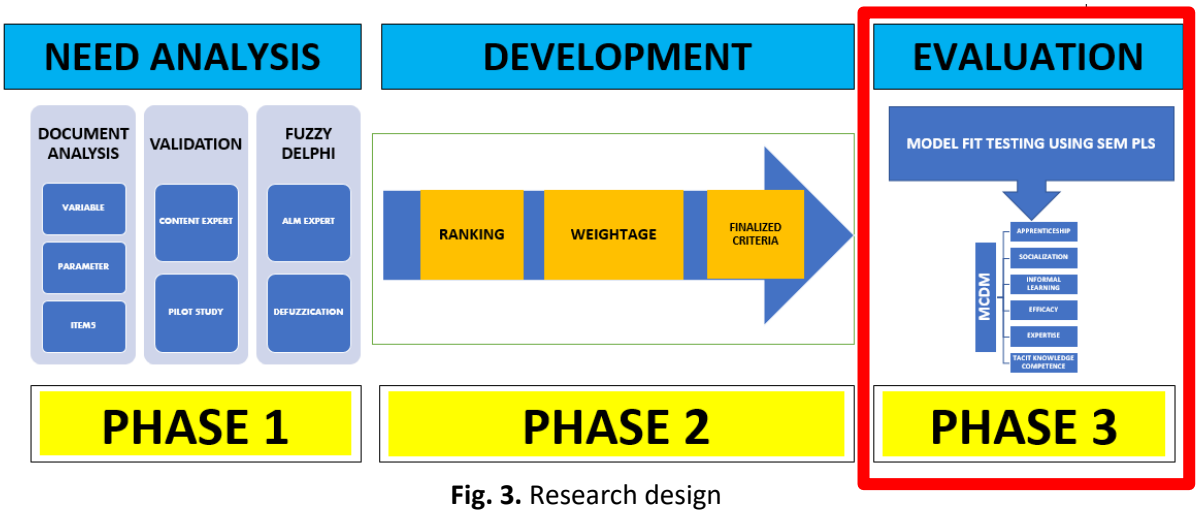

Fig. 3. Research design

2.1 Proposed Hybrid MCDM Model

The decision Support System on MC-TKAF is based on the flowchart in Figure 4 below. The algorithm within the system will allow the decision maker to choose the right candidate to fill in the roles. A model of hybrid MCDM model that was designed as shown in Figure 4 below. The designed was exactly based on the proposed MC TKAF as elaborated in [17] . Many other techniques in MCDM should be explored but for this paper, only six are being discussed. The argument for using the MCDM approach, which is appropriate for this investigation, is also presented in Table 4.

Fig. 4. Hybrid MCDM Selection

Table 4
Result

	CFFR	ELECTRE	SAW	WPM	AHP	TOPSIS
Result	In this case, UITM1 is the best personnel for the position of Deputy Rector followed by UITM2, and UITM3 +: used to solve problems involving multi-criteria group decision-making -: dependent on linguistic terms Further discussion on results can be referred to [49]	So, in this case, by using ELECTRE formula, UITM1 is the best personnel for the position of Deputy Rector followed by UITM2, and UITM3 +: a multi-decision technique -: alternative approach Further discussion on results can be referred to [49]	SAW formula showed that UITM3 is the best personnel for the position of Deputy Rector followed by UITM2, and UITM1 +: aid in decision-making in specific cases, with the computation that yields the highest value -: based on the weighted average Further discussion on results can be referred to [48]	WPM formula finalized UITM 1 as the first choice, followed by UITM2, and UITM1 +: model includes multiplication -: issues with a single dimension Further discussion on results can be referred to [48]	AHP formula finalized UITM 1 as the first choice, followed by UITM2, and UITM1 +: produce measures of judgment consistency, determine priority among criteria and alternatives -: Multiple, often competing criteria Further discussion on results can be referred to [48]	TOPSIS formula finalized UITM 1 as the first choice, followed by UITM2, and UITM1 +: returns the solution that is not only the most hypothetically great, but also the least hypothetically bad -: optimal alternative is as near to an ideal solution as feasible Further discussion on results can be referred to [48]

The selection criteria are based on a technique that must enable multicriteria, linguistic fuzziness, and the Fuzzy Delphi procedure, as recommended by [18,20]. According to [18],the method must be chosen in such a way for different issues that must be solved, for example, the method must be chosen based on the research of own scope performance. This is equivalent to [20] said that one approach beats the others because predictive precision is dependent on the nature of the problem, as well as the gathering and management of data in the most appropriate manner for each technique and implementation. As a result, only six (6) MCDM approaches will be employed in this study due to the nature of the suggested MC TKAF. The main objective of the hybrid MCDM model presented in this was to validate the results of each formula paper by using sensitive analysis and to obtain a more detailed experimental data. However, there is no proven assumption in this model indicating that it can produce similar result. Thus , the detailed sensitivity analysis using [39] was used to support the findings as described in section 3.1.

3. Results

The finalized result has been transformed using six (6) different techniques of MCDM in which almost all of the techniques produce similar results. The conclusion of each of technique has been explained in Table 5. The result that concludes all the analysis have been discussed in this [48,49] whereby the result concludes similar result.

To rank the candidates, the final normalized weight is computed. The candidate for that position who ranks first or has the highest final weight value is shown. The three candidates will be ranked for possible jobs as stated in Table 5 based on the final weight results for all techniques.

The results of Table 5 and Figure 5 show that the selection for majority techniques provides a solution for the academic administrator jobs [18] is consistent for candidate UITM 1 (ELECTRE, CFFR, WPM, AHP, and TOPSIS) as the first choice. As proposed by [18] the best alternative technique can also use the veto rule to select. In other words, the option(s) that the majority of ways score the highest will be chosen last. The criteria of selection are based on the technique that must support Multicriteria, Linguistic Fuzziness, and including the Fuzzy Delphi process as suggested by [20] and [18]. According to [18], the selection of which MCDM technique is based on the study of its scope performance, for example, the method has to be chosen in such a way for different problems have to be solved. This is equivalent to [20] saying that one technique outperforms the remainder since predictive precision depends on the nature of the issue, as well as the collection and handling of information in a manner that best suits each technique and implementation. Candidate UITM 1 (WPM, AHP, TOPSIS, CFPR, and ELECTRE) is the first choice in the majority of methods [18] solution for academic administrator job selection. We can use the recommendation of [20] and [18] to choose which result is the best suited to the case. The next section will explain how the sensitivity analysis will help decision maker to choose optimal choices in alternatives for calculating the result of consistency analysis.

Table 5
Summary of Integrated MCDM

	SAW			WPM			TOPSIS			AHP			CFFR			ELECTRE		
Performance Candidate	UITM 1	UITM2	UITM3	UITM 1	UITM2	UITM3	UITM 1	UITM2	UITM3	UITM 1	UITM2	UITM3	UITM 1	UITM2	UITM3	UITM 1	UITM2	UITM3
score	9.01	9.36	9.5	8.94	8.89	8.89	0.76	0.25	0.22	16.13	15.73	15.73	58.04	57.35	57.35	16.13	15.73	15.73
RANK	3	2	1	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3

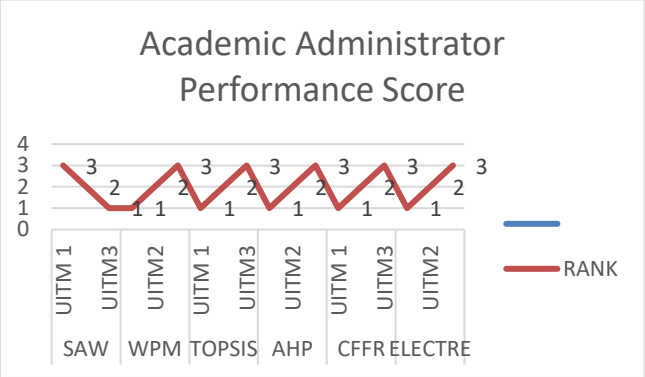

Fig. 5. Academic administrator performance score

3.1 Sensitivity Analysis

The sensitivity analysis model is tested on an example of the roles selection [50]. The goal is to find a right person which generates better result and at the same time fulfils roles selections needs [51]. In Table 6, the initial ranking calculation for all of the techniques is shown. Later on, the basis of Table 6 will be used to be reanalysed using scenario given in Table 7.

Table 6
Initial alternative ranking

	SAW	RANK	WPM	RANK	TOPSIS	RANK	AHP	RANK	CFFR	RANK	ELECTRE	RANK
UITM1	9.01	3	8.94	1	0.76	1	16.13	1	58.04	1	16.13	1
UITM2	9.36	2	8.89	2	0.25	2	15.73	2	57.35	2	15.73	2
UITM3	9.5	1	8.89	2	0.22	3	15.73	2	57.35	2	15.73	2

3.2 Scenario Presentation

In this case , the authors used 7 criteria's which were identified by [50] in based on which the personnel selection of tri-modal is going to be conducted. Table 7 shows the scenario based on different choice of weightage based on selected criteria's.

Table 7
Scenarios with different criteria weights and preferences by certain alternatives selections

S1 Scenario 1	Uniform Weight Criteria
S2 Scenario 2	Priority of Criterion C1
S3 Scenario 3	Priority of Criterion C2
S4 Scenario 4	Priority of Criterion C3 & C4
S5 Scenario 5	Priority of Criterion C5& C6
S6 Scenario 6	Priority of Criterion C7

3.3 Change of Criteria Weights

Most of the time, the results of MCDM approaches depend on specific criteria, not only the relative value we give to the attributes of the alternatives. Alternatives are occasionally used as well. Because the MCDM selection phase, which is to objectify the findings, is followed by the study of their method selection process, this indicates the requirement to rankings change with very little changes of removing randomness from the MCDM weight coefficients [39]. To determine how adjustments to the weights given to the criterion might affect the ranking of the alternatives, a sensitivity analysis was carried out. This can be seen from Table 7 which shows there are six possibilities that can illustrate sensitivity analysis by favouring particular in the work's subsequent section, criteria-based outcomes.

3.4 Change of Measurement Scale

The so-called independence of value scale condition, which is used in the normative theory of decision making in risk and uncertainty settings, is the foundation for the measurement scale independence (MSI) condition [52]. The formula used for these changes is based on formula as given below;

$$v_{ij}^{+} = av_{ij} + b \quad (1)$$

where a and b are constants under condition of a > 0.

3.5 Change in Formulation Criteria

Based on the descriptive invariability condition, which is referred to in the behavioural theory of decision making as the condition of an individual decision maker's rationality of choice, the criteria formulation independence (CFI) condition is defined [53] and the result from this analysis for this scenario of roles selection is shown in Table 8.

Table 8
MSI-Alternatives Ranking

	SAW		WPM		TOPSIS		AHP		ELECTRE		CFFR	
	S-1	S-2	S-1	S-2	S-1	S-2	S-1	S-2	S-1	S-2	S-1	S-2
UITM 1	1	3	1	3	1	3	1	3	1	3	1	3
UITM 2	2	2	2	2	2	2	2	2	2	2	2	2
UITM 3	3	1	3	1	3	1	3	1	3	1	3	1

This works of MSI condition is tailored to the requirements of the consistency analysis of MCDM approaches. We obtain a consistent conclusion by using the decision-making technique that meets the MSI requirement, which is a distinct ranking list of options independent of the scale that we employed to evaluate their outcomes. So, the list of Scenario 1 and Scenario 2 have used different weightage scale for each linguistic term as shown in Table 9.

Table 9
Scales S1 and S2

No	Linguistic Term	S1	S2
1	Very Good (VG)	(4,5,5)	(8,9,9)
2	Good (G)	(3,5,4,4,5)	(6,7,8)
3	Fair (F)	(2,5,3,3,5)	(4,5,6)
4	Poor (P)	(1,5,2,2,5)	(2,3,4)
5	Very Poor (VP)	(1,1,1)	(1,1,1)

In Table 10, the result of sensitivity analysis demonstrates the effectiveness of WPM, TOPSIS, AHP, ELECTRE and CFFR, techniques. The inconsistent results provided by SAW methods demonstrated how responsive they were to fixes. During the process of selecting the optimal method for ranking based on the consistency of the number of obtained results, almost no MCDM method emerged as the most dependable option. It is essential to emphasise the results given are specific to the observed instance and cannot be generalised. The recommended mode represents the general paradigm for sensitivity analysis of MCDM methods, so it is necessary to conduct sensitivity analysis of methods based on the scenarios outlined in Table 7.

Table 10
Sensitivity analysis of methods to changes of measurement scale and criteria formulation

Sensitivity Criteria	MCDM METHOD					
	SAW	WPM	TOPSIS	AHP	ELECTRE	CFFR
MSI	x	√	√	√	√	√
CFI Scenario 1	x	√	√	√	√	√
CFI Scenario 2	x	x	x	x	x	x
CFI Scenario 3	x	x	x	x	x	x

4. Conclusions

By having hybrid MCDM as proposed, the manager and HR may be able to see via pattern rather than numbers. Managers and HR teams may envision how they would evaluate employees in light of these criteria. Finally, it is important to stress that MCDM techniques are merely instruments for suggesting solutions to decision-makers. Some approaches offer better solutions than others in particular circumstances, but we should remember that none of them is completely reliable. Accordingly, after applying a variety of MCDM techniques and reliability analysis, the decision-maker might decide based on personal preferences. This paper presented the experimental results of the hybrid MCDM model using the MC TKAF framework. This provides information and aids academic higher education sectors in choosing a preferred roles selection management strategy for ALM positions.

In future study, we will include proof of concept from targeted ALMs who are developing their potential successor for their current position. The proposed hybrid MCDM which has been transformed into the Decision Support System of MCTKAF is hoped to give new insight to the ALM for intervening in talent acquisition by targeting new ways of designing talent development intervention programs in public universities to be the main priority. This will widen and expand the understanding of current and future research regarding this topic especially in making an alternative talent development intervention program in Higher Education Institutions.

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