Roles selection: a computational approach using ELECTRE and CFFR based on Multi Criteria Tacit Knowledge Acquisition

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Abstract. During the Talent Development Intervention programme, there is a need to provide an effective model to assess awareness, skills and experience among potential academics. To qualify as an Academic Leader or Academic Manager, there are certain characteristics and traits necessary. However, there is a lack of research on the training of talented academicians to improve and avoid the loss of these characteristics and traits. Lack of this training would also contribute to vacancy positions of Academic Administrator without being hired. This paper aims to formulate and compare the Multi-criteria Decision-Making methods using ELECTRE (Elimination and Choice Expressing Reality) and CFPR (Consistent Fuzzy Preference Relations) based on proposed model of Multi Criteria Tacit Knowledge Acquisition (MC-TKAF). One set of empirical study based on proposed model contain seventeen (17) main criteria’s and one hundred eights (108) sub criteria are used to select the best candidate to fill in academic administrator roles. In this study, our focus is to integrate MCDM using CFFR and ELECTRE into implementation of Talent Development Intervention based on MC-TKAF development criteria. This paper also highlighted previous literatures which has shown how MC TKAF is formed and the justification of MCDM technique that will be used. The finding shows that both techniques produce the same results.

1.0 Introduction
The selection of HEI (Higher Education Institution) academic staff is the method of identifying people with qualifications required to perform a given job in the best way. A few studies [1], [2] show that, the academicians who are selected during selection process are probably assessed and evaluated based on explicit assessment such as qualification, experience, and research activities. However, there is evidence of a lack of tacit expertise in the assessment that academicians have established in their institution during the process of entering any talent development intervention based on which the selection is made[3], [4]. While this pattern is important, the selection of criteria/weights for tacit assessment and tacit evaluation should be clearly defined, which will then be sufficient to make the right decisions. This paper aims to formulate and compare the Multi-criteria Decision Making (MCDM) method using ELECTRE and CFFR based on validated multi criteria tacit acquisition
framework. This proposed model is able to be used as a talent performance indicator in Talent Development Intervention Program. This paper is arranged in the following manner: The first section is the discussion on phenomenon of academic administrator selection criteria. The second section discussed literature review regarding multi-criteria decision making (MCDM). Then, the third section will discuss problem formulation using CFPR and ELECTRE and the fourth section will describe result and discussions; the last section is the conclusion.

2.0 Multi-criteria Decision Making (MCDM)

The Multi-Criteria Decision-Making (MCDM) approach discusses different priorities in the decision-making process. From different quantifiable or non-quantifiable parameters, a decision-maker (DM) must choose. One of the key aims of the MCDM is to help DMs combine objective measurements with value judgments based not on people’s opinions, but on collective thoughts [5]. This method gives successful decision-making in areas where the best choice is incredibly difficult. [5]. The priorities are usually incompatible, so the solution relies heavily on the decision-preferences maker's and must be a compromise. MCDM technologies have been employed to various staff selection applications and find the best solution to choose the best alternative, as shown in Table 1. Our focus in this study is to apply ELECTRE and CFPR technique as a talent performance indicator for selecting academic administrator roles.

Several authors [6]–[8] have discussed each method in MCDM which has different kind of formulas and objective to be fulfilled based on the areas needs as illustrated in Table 1. Researchers make a list of parameters to select which one is the best to be used according to the field of use, due to several methods in MCDM. According to [9] MCDM approaches fit different types of decision situation. For instance, AHP is recommended in situations where individuals are unable to measure their preferences for different parameters and alternatives. While for CFPR is purposely used for simplifies the pairwise comparison[8] and ELECTRE[10] is used when binary superiority comparisons between alternative decision points for each rating factor. Many novice users have trouble determining which form of MCDM technique is most appropriate for their situation of preference. As proposed by [5], 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.

| Area/Applications | Criteria | Source of Criteria’s | SAW | TOPSIS | ELECTRE | CFPR | AHP |
|-------------------|----------|----------------------|-----|--------|---------|------|-----|
| Finding the Right Personnel in Academic | Qualification Marks | NONE | [11] | [11] | [11] |
|                   | Experience in years | NONE | | | |
|                   | Salary Expectation | NONE | | | |
|                   | Ability handles different subject | NONE | | | |
|                   | Research Activities | NONE | | | |
|                   | Technical Skill | NONE | | | |
|                   | Presentation/Communication Skill | NONE | | | |
| Academic Staff Selection | Individual Factor | NONE | [12] | | |
|                   | Academic Factor | NONE | | | |
|                   | Work Faculty | NONE | | | |

Table 1. MCDM Approach in Personal Selection as Academician

- Activity: Teaching and Supervision
- Education: Research and Publication
- Internal Factors: Administration and Management
- Business Factors: Professional Contribution to Society, Scholarly Recognition
- NONE
This paper aims to formulate and compare the Multi-criteria Decision-Making methods using ELECTRE (Elimination and Choice Expressing Reality) and CFPR (Consistent Fuzzy Preference Relations) based on proposed model of Multi Criteria Tacit Knowledge Acquisition (MC-TKAF).

2.1 CFPR (Consistent Fuzzy Preference Relations)

CFPR (Consistent Fuzzy Preference Relations) is widely used in solving multi-criteria group decision making problems. This technique offers greater accuracy, as decision times are reduced. The steps in CFPR [13] used in this study are as following :-

Step 1 : Risk Identification

Main criteria and sub-criteria are determined as described in Table 2.

Step 2: Degree of Preference

Linguistic terms and corresponding numbers are shown in Figure 1 is used to achieve pairwise comparisons.

| Definition                   | Relative Importance |
|------------------------------|---------------------|
| Equally important           | 1                   |
| Moderately more important   | 3                   |
| Strongly more important     | 5                   |
| Very strongly more important| ?                   |
| Absolutely more important   | 9                   |
| Intermediate values         | 2, 4, 6, 8          |

Figure 1

Step 3: Comparison

Among the parameters, construct pairwise comparison matrices (Ci, i=1..n). The decision-makers include pairwise comparisons Ci i=...n for a set of n 1 preference values.

Step 4 : Transformation

Transform the preference value \( a_{ij} \in \left[ \frac{1}{9}, 9 \right] \) into \( p_{ij} \in [0,1] \) through (1)

\[
p_{ij} = \frac{1}{2} \times \left( 1 + \log_{10} a_{ij} \right) (1)
\]

Then, calculate the remaining \( p_{ij}^k \) by using (2), (3) and (4)
Instead of the interval $[0,1]$, this preference matrix will contain values included in the interval $[-a, 1, +a]$. In this case, a transformation function is used to maintain reciprocity. The conversion is obtained by (5).

$$f(p_{ij}) = \frac{p_{ij} + a}{1 + 2a} \quad (5)$$

The absolute value of the minimum in this preference matrix is given here. Similarly, for all decision makers, the fuzzy preference relation matrices are determined.

**Step 5: Aggregation**

To obtain the significance weights of the selection criterion, sum the fuzzy preference relationship matrices. Let $p_{ij}^k$ denote the $k^{th}$ decision maker's transformed fuzzy $ij$ preference value for criteria $i$ and criteria $j$. In order to incorporate the decisions of decision makers, the average value approach (6) is used. The total number of decision makers is labelled as $m$.

$$p_{ij} = \frac{1}{m} \left( p_{ij}^1 + p_{ij}^2 + \ldots + p_{ij}^m \right), \quad k = 1, 2, \ldots, m \quad (6)$$

**Step 6: Normalization**

Normalize the matrices of aggregated fuzzy preference relations. $h_{ij}$ is used in (7) to show the standardized fuzzy preference value of each criterion and to obtain the standardized fuzzy preference relationship matrix.

$$h_{ij} = \frac{p_{ij}}{\sum_{i=1}^{n} p_{ij}} \quad i, j = 1, 2, \ldots, n \quad (7)$$

**Step 7 : Prioritization**

Calculate the importance weight of each criterion (8).

$$w = \frac{1}{n} \sum_{j=1}^{n} h_{ij} \quad (8)$$

2.2 **ELECTRE ((Elimination and Choice Expressing Reality)**

The ELECTRE (Elimination and Choice Reflecting Reality) approach is a multi-decision approach first implemented in 1966 by Benayoun and Roy.[10] The steps in ELECTRE [13] are as following :-

**Step 1: Decision Matrix**

**Step 2: Normalized Decision Matrix**

**Step 3: Weighted Normalized Decision Matrix**

All of three mentioned steps (Step 1-3) can be seen from table 3,4,5,6. The next step is Step 4. Concordance and discordance indexes are described in the ELECTRE method as measures of satisfaction and dissatisfaction for decision-makers when choosing one alternative over another. [10].

**Step 4 : Concordance to Discordance set**

The $y$ matrix is used in evaluating the concordance set. The evaluation factor decision points are compared with one another and the sets are calculated using the relationship shown in the formula below (9):
Basically, the formula is based on comparing the line elements’ sizes relative to each other. Every (Ckl) concordance set corresponds to the set of discordances (Dkl). The discordance set elements consist of J values which do not belong to the concordance set. The discordance interval set (Dkl) is obtained by complementation of (Ckl) using (10);

\[ D_{kl} = \{ j, y_{kj} < y_{ij} = j - C_{kl} \} \quad j = 1, 2, 3, \ldots, n \] (10)

By means of the concordance index, the relative value of the elements in the concordance matrix C is determined. The Ckl concordance index is the sum of the weights relevant to the parameters found in the set of concordances. That is;

\[ c_{kl} = \sum_{j \in C_{kl}} w_j \]

\[ C = \begin{bmatrix} c_{11} & c_{12} & \cdots & c_{1m} \\ \vdots & \vdots & \ddots & \vdots \\ c_{m1} & c_{m2} & \cdots & c_{mn} \end{bmatrix} \] (11)

Elements of the discordance matrix Dkl are defined by the formula (12).

\[ D_{kl} = \max_{j \in D_{kl}} \frac{|y_{kdj} - y_{ij}|}{|y_{kdj} - y_{ij}|} \] (12)

\[ D = \begin{bmatrix} d_{11} & d_{12} & \cdots & d_{1m} \\ \vdots & \vdots & \ddots & \vdots \\ d_{m1} & d_{m2} & \cdots & d_{mn} \end{bmatrix} \] (13)

**Step 5 : Corcordance to Discordance Matrix**

For finding matrix (F), it is needed to compute threshold value (c̅) as follow where m is dimension matrix:

\[ \hat{c} = \frac{1}{m(m-1)} \sum_{k=1}^{m} c_{kl} \]

\[ \begin{cases} f_{kl} = 1, \text{if } c_{kl} \geq \hat{c} \\ f_{kl} = 0, \text{if } c_{kl} < \hat{c} \end{cases} \] (14)

To determine discordance dominance matrix, we calculate matrix of (G).

\[ \hat{d} = \frac{1}{m(m-1)} \sum_{k=1}^{m} \sum_{l=1}^{m} d_{kl} \]

\[ \begin{cases} g_{kl} = 1, \text{if } d_{kl} \geq \hat{d} \\ g_{kl} = 0, \text{if } d_{kl} < \hat{d} \end{cases} \] (15)

**Step 6 : Concordance (F) to Discordance Dominance (G) Matrix**

Matrix E is performed by the multiplication of the corresponding F and G elements

\[ e_{kl} = f_{kl} \cdot g_{kl} \] (16)

The (E) matrix is dimensioned in accordance with the (F) and (G) matrixes and consists of values 0 and 1.

**Step 7 : Aggregate Dominance Matrix**

Referring to the steps and formula from 3.2, result of Table 10 is produced.

**Step 8 : Eliminate Less Favourable alternative and rank**
The next section will discuss on research methodology used in this study.

3.0 RESEARCH METHODOLOGY

There are three phases in this study, such as Phase 1: Need Analysis, Phase 2: Design and Development, and Phase 3: Model Evaluation, as shown in Figure 2. The main aim of this analysis is to find the best candidate, based on the proposed model, for ALM’s academic role. This paper will only focus on the Phase 3 which is Model Evaluation. In support of the Talent Development Intervention Program, the goal is to test the practicality of the Tacit Knowledge Acquisition System (TKAF) using Multi Criteria Decision Making Technique (SAW, WPM, TOPSIS, ELECTRE and CFPR).

Figure 2. Research Methodology

This list of criteria in Table 2 has been gone through the process of Fuzzy Delphi [16] by 10 scholars from Public University. Thus, list of validated criteria in Table 2 will be used throughout this study.

Table 2 MC TKAF Main and Sub Criteria

| Main Criteria | Sub criteria | A3: On Job Training Outcome | A4: Coaching Outcome | B: Efficacy | C: Expertise |
|---------------|--------------|----------------------------|---------------------|-------------|-------------|
| A1: Mentoring Outcome | A1a: Professional development | A3a: Reaction | A4a: Organisational Commitment | B1: Affective Processes | C1a: Novice |
|  | A1e: Sense of belonging | A3b: Behaviour | A4d: Organisational Citizenship Behaviour | B2: Selection Processes |  |
|  | A1f: Mentor and mentee expectations | A3d: Learning |  | B3: Cognitive Processes |  |
|  | A1h: Mentee ALM self-efficacy | A3e: Results |  |  |  |
|  | A1i: Mentee ALM self-efficacy |  |  |  |  |
|  | A1j: Culturally responsive |  |  |  |  |
| A2: Job Rotation Outcome | A2a: Social Communication |  |  |  |  |
|  | A2b: Productivity |  |  |  |  |
|  | A2c: Knowledge type |  |  |  |  |
|  | A2d: Knowledge distance |  |  |  |  |
|  | A2e: Motivation |  |  |  |  |
In phase 3, the validated model has followed the steps as described in Figure 2. In previous paper [17], we have already incorporated the usage of SAW, WPM, AHP and TOPSIS. From the result of three prior techniques shows all three techniques have same result consistency. Thus, this paper, will anticipate the technique of ELECTRE and CFPR either they will produce the same consistency. The next section will discuss Result in section 4.

4.0 RESULT

This paper used the empirical set of choosing Deputy Rector for an institution in Malaysia Public University. Ten (10) decision maker among scholar has made their selection to produce Table 5 and 6 (Weighted Normalized Decision Matrix). Scale used for this table is based on Figure 1: Scale of Attributes.

Problem Formulation

Base Data

Referring to the steps and formula from 2.2, Step 1, the result of Table 3 is produced.

Normalized Data

Referring to the steps and formula from 2.2, Step 2, the result of Table 4 is produced.
**Weight Each Attributes**

Referring to the steps and formula from 2.2, Step 3, the result of Table 5 is produced.

**Weight Normalized Data**

Referring to the steps and formula from 2.2, Step 3, the result of Table 6 is produced.

### Table 5 Weight Each Attributes

| WEIGHT FOR EACH ATTRIBUTE | A1 | A2 | A3 | A4 | B1 | B2 | B3 | B4 | C1 | C2 | C3 | C4 | C5 | D1 | D2 | D3 | D4 |
|---------------------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| A1                        | 1.65 | | | | | | | | | | | | | | | |
| A2                        | 0.74 | | | | | | | | | | | | | | | |
| A3                        | 0.75 | | | | | | | | | | | | | | | |
| A4                        | 0.94 | | | | | | | | | | | | | | | |
| B1                        | 1.05 | | | | | | | | | | | | | | | |
| B2                        | 0.32 | | | | | | | | | | | | | | | |
| B3                        | 0.54 | | | | | | | | | | | | | | | |
| B4                        | 0.67 | | | | | | | | | | | | | | | |
| C1                        | 0.92 | | | | | | | | | | | | | | | |
| C2                        | 0.28 | | | | | | | | | | | | | | | |
| C3                        | 0.68 | | | | | | | | | | | | | | | |
| C4                        | 1.13 | | | | | | | | | | | | | | | |
| C5                        | 0.33 | | | | | | | | | | | | | | | |
| D1                        | 0.30 | | | | | | | | | | | | | | | |
| D2                        | 0.50 | | | | | | | | | | | | | | | |
| D3                        | 0.10 | | | | | | | | | | | | | | | |
| D4                        | 0.50 | | | | | | | | | | | | | | | |

### Table 6 Weight Normalized Data

| | A1 | A2 | A3 | A4 | B1 | B2 | B3 | B4 | C1 | C2 | C3 | C4 | C5 | D1 | D2 | D3 | D4 |
|---------------------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| UITM1                     | 0.33 | 0.15 | 0.94 | 0.02 | 5.60 | 1.80 | 2.80 | 3.60 | 0.20 | 0.12 | 2.00 | 1.08 | 0.60 | 10.20 | 15.60 | 3.80 |
| UITM2                     | 1.22 | 0.15 | 0.19 | 0.19 | 5.60 | 1.80 | 2.80 | 3.60 | 0.20 | 0.60 | 1.00 | 0.60 | 0.60 | 10.20 | 15.60 | 3.80 |

### Global versus Local Weight

108 sub-criteria were specified in order to offer priority and 10 experts from academia were identified under 17 main criteria, as can be seen from Table 7. Both experts were asked to determine the importance of the different main criteria and sub-criteria on the basis of Table 2. Formula (6) in 2.1 is used to combine the decisions of 10 decision-makers, and the aggregate pair-wise matrices for the main and sub-criteria are shown in Table 7, respectively.

### Table 7 Global versus Local Weight

| ID | Local weight | MAIN CRITERIA | SUB CRITERIA | A1 | A1a | A1b | A1c | A1d | A1e | A1f | A1g | A1h | A1i | A1j |
|----|--------------|---------------|--------------|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| A1 | 1.65         | A1a           | 2.03         | A2 | 0.74 | A2a | A2b | A2c | A2d | A2e | A2f | A2g | A2h | A2i |
| A2 | 0.74         | A2a           | 2.30         | A3 | 0.94 | A3a | A3b | A3c | A3d | A3e | A3f | A3g | A3h | A3i |
| A3 | 0.94         | A3a           | 1.63         | B1 | 6.00 | B1a | B1b | B1c | B1d | B1e | B1f | B1g | B1h | B1i |
| B1 | 6.00         | B1a           | 1.28         | B2 | 2.00 | B2a | B2b | B2c | B2d | B2e | B2f | B2g | B2h | B2i |
| B2 | 2.00         | B2a           | 1.67         | B3 | 3.00 | B3a | B3b | B3c | B3d | B3e | B3f | B3g | B3h | B3i |
| B3 | 3.00         | B3a           | 1.47         |
ELECTRE ((Elimination and Choice Expressing Reality)) based on base data in Table 3. The next section will elaborate the result produced using ELECTRE ((Elimination and Choice Expressing Reality)) based on base data in Table 3.

**Table 8**

| WEIGHTED NORMALIZED MATRIX | PERFORMANCE SCORE | RANK |
|-----------------------------|-------------------|------|
| A1  A2  A3  A4  B1  B2  B3  B4  C1  C2  C3  C4  C5  D1  D2  D3  D4 |                  |      |
| Uitm1 0.33 0.15 0.94 0.02 0.56 0.61 0.82 0.82 0.60 0.20 0.12 0.01 0.18 0.00 0.20 5.60 0.80 0.20 | 58.04 | 1 |
| Uitm2 2.20 0.15 0.19 0.19 0.95 0.60 0.82 0.80 0.20 0.64 0.00 0.00 0.00 0.60 0.10 20 5.60 0.80 0.20 | 57.35 | 2 |
| Uitm3 2.20 0.15 0.19 0.19 0.95 0.60 0.82 0.80 0.20 0.64 0.00 0.00 0.00 0.60 0.10 20 5.60 0.80 0.20 | 57.35 | 3 |

In this case UITM1 is the best personnel for the position of Deputy Rector followed by UITM2, and UITM3. The next section will elaborate the result produced using ELECTRE ((Elimination and Choice Expressing Reality)) based on base data in Table 3.

ELECTRE ((Elimination and Choice Expressing Reality))

Referring to the steps and formula from 2.2, Step 4-5, the result of Table 9 is produced.

**Table 9**

| Concordance to Discordance set | Score |
|--------------------------------|-------|
| A1  A2  A3  A4  B1  B2  B3  B4  C1  C2  C3  C4  C5  D1  D2  D3  D4 |       |
| -------------------------------- |       |
| S1  0.65 0.74 0.94 0.08 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 0.94 0.08 0.00 0.00 |       |

CFPR (Consistent Fuzzy Preference Relations)

Referring to the steps and formula from 2.1, result of Table 8, Step 4-7 is produced.
Referring to the steps and formula from 2.2, following step 6-7, the result of Table 10 and 11 are produced.

**Table 10**

| Concordance Matrix | S1  | S2  | S3  |
|--------------------|-----|-----|-----|
| S1                 | -   | 12.67 | 12.67 |
| S2                 | 12.02 | -   | 15.21 |
| S3                 | 12.02 | 15.21 | -   |

**Table 11**

| Discordance Dominance Matrix | S1  | S2  | S3  |
|------------------------------|-----|-----|-----|
| S1                           | 1   | 1   | 0   |
| S2                           | 0   | 0   | 1   |
| S3                           | 0   | 1   | 0   |
| Threshold value              | 13.30 |

**Table 12 Aggregate Dominance Matrix**

|                 | UITM1 | UITM2 | UITM3 | TOTAL |
|-----------------|-------|-------|-------|-------|
| UITM1           | 1     | 1     | 1     | 1     |
| UITM2           | 0     | 1     | 1     | 2     |
| UITM3           | 0     | 0     | 1     | 3     |

The matrix line (E), which has the highest score, should be chosen as the best. So in this case, by using ELECTRE formula, UITM1 is the best personnel for the position of Deputy Rector followed by UITM2, and UITM3.

5.0 Discussion

From the results of Table 10 and Table 12, the solution for the academic administrator roles selection for majority methods [4] is consistent for candidate UITM 1 (CFPR and ELECTRE) as the first choice. Thus, to enable decision makers to make decision, researcher of MCDM can use the recommendation of [6] and [4] to choose which result is the best suit with the case. In this paper, by using CFPR and ELECTRE, UITM1 has fulfilled the criteria, followed by UITM2 and UITM3. Also, all of these prioritized criteria can be used for selecting the ALM and will give better understanding for decision maker on which criterias are more important for their selection based on the roles. Managers/human resources teams can easily foresee how they can assess workers according to these requirements.

6.0 Conclusion

The goal of this study is to provide an adequate criterion for academic role selection in HEI using the Multi Criteria Tacit Knowledge Acquisition Framework. It is clear from the finding that the MCDM technique is practically capable of evaluating the selection of ALM roles among academics. In this study, our focus is to integrate MCDM into implementation of Talent Development Intervention based on MC-TKAF development criteria. For future research, we will evaluate all of MCDM techniques.
such as SAW, WPM, AHP, TOPSIS, ELECTRE and CFPR to be evaluated using proof of concept based on decision support system to measure its effectiveness towards ALM selections

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