Implementation of PROMETHEE-GAIA Method for Lecturer Performance Evaluation

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Abstract. Assessing the progress of lectures ensures the involvement of lectures in the exercise of science dissemination by research, education, and community service. That job affects the performance of lecturers at universities throughout the country. The performance of lecturers is evaluated regularly because of the vast number of evaluation attributes. Manual assessment can take time and cannot be carried out. In the evaluation of lecturer's outcomes, a decision support model is needed to facilitate decision making. This study applies the preference ranking organization method for enrichment assessment (PROMETHEE) as a decision model in Multi-Criteria Decision Making (MCDM) and Geometric Analysis for Interactive Aid (GAIA) as a geometric analysis in determining lecturer performance. This analysis resulted in the maximal value of an alternative of 2 with Phi 0.2333, followed by 1 and 3 alternatives. These results suggest that alternative 2 is the best way to assess the performance of lecturers as the main indicator. Alternative 3 is the least recommendable alternative because of its lowest precision on the basis of visualization results.

1. Introduction

College assessments are processed internally and publicly. External assessment by third parties such as the National Accreditation Board (BAN-PT), internally by universities' quality assurance agencies. Internal appraisal by annually evaluating the success of lecturers [1], [2], [3]. Evaluation of lecturer success guarantees the role of lecturers in performing tasks in disseminating science through education, study, and community service. This role influences lecturers' success in developing universities nationwide [4], [5], [6]. Evaluation of lecturers' results periodically becomes difficult due to the large number of appraisal attributes assessed. Manual evaluation becomes time-consuming and impossible to execute. A decision support model is needed to promote decision-making when evaluating lecturers' results. Performance evaluation necessitates the use of various appraisal measures, which may be aided by a decision support device [7], [8], [9].

This study deployed the preference ranking organization method for enrichment assessment (PROMETHEE) as a decision model in Multi-Criteria Decision Making (MCDM) and Geometrical Analysis for Interactive Aid (GAIA) as a geometric analysis that complemented the PROMETHEE method. PROMETHEE succeeds by prioritizing policymakers in multicritical research [10]. This technique is very good at simplifying and expediting the decision-making process on a variety of criteria [11]. This thesis aimed to develop a decision model for assessing lecturer success using the
PROMETHEE process. This technique is used in conjunction with GAIA (Geometric Analysis for Interactive Aid) to facilitate decision visualization.

2. Methodology

2.1. Decision Support System

A Decision Support System (DSS) is a knowledge-based system for an organization's decision-makers. The framework enables data collection, simulation, and decision-making in favor of future planning. The decision support framework was built through an interpretation of different possible behaviors. DSS accomplishes this task by presenting the optimal alternatives based on computational data. However, DSS is just a mechanism for achieving reliable and productive results; the ultimate decision-making authority remains with the customer [12].

2.2. PROMETHEE II

The Preference Ranking Organization Method for Enrichment Evaluation (PROMETHEE) is a method for sorting a multicriteria study in Multi-Criteria Decision Making (MCDM). This approach is well-known for its simplicity, but it also performs very well in multicriteria problems. The following table summarizes the fundamental assessment data used in the PROMETHEE method [10]:

| Table 1. Basic data evaluation in PROMETHEE |
|---------------------------------------------|
| F1(.) | F2(.) | Fj(.) | Fk(.) |
| W1    | W2    | …     | Wj    | …     | wk    |
| A1    | f1(a1) | f2(a2) | …     | fj(a1) | …     | fk(a1) |
| a2    | f1(a2) | f2(a2) | fj(a2) | …     | fk(a2) |
| …    | …     | …     | …     | …     | …     |
| ai    | f1(ai) | f2(a1) | fj(a1) | …     | fk(a1) |
| an    | f1(an) | F2 (an) | fj(an) | …     | fk(an) |

The data in table 1 reveals a as a selection of alternate set choices for decision-making. While f1, f2, .....fk are criteria that were previously analyzed. Both parameters are weighted based on their value in w1, w2,....,wk. PROMETHEE approach steps:

a. The stage determines the current conditions for inclusion in the evaluation of an alternative by gathering all of the pieces that would be preferred.

b. The stage of constructing an outranking relationship is based on the calculation of all alternative parameters. The degree of choice is an option that outnumbers all other alternatives on the count, resulting in a superior partnership.

c. The stage at which decision interpretation is provided by supplying a partial recall of set A. This ranking is provided fully in PROMETHEE II to provide an alternate counterpoint.

The PROMETHEE approach compares similar alternative contributions using two types of information: the relative value or weight (priority) of the parameters considered and the role of decision-making preferences. The PROMETHEE method's preference framework is based on pair comparisons. Two solutions to those conditions are evaluated. The greater the variance, the greater the preference, while for a minor deviation, the decision-maker would give the better choice a small preference[13].

The preference function makes use of the conditions in the following equation $H(d) = \delta_{d=0}^{0d}$

where d denotes the difference in the values of the criteria:

$$d = f(a) - f(b)$$  \hspace{1cm} (1)

The Promethee system assigns the following rankings [14], [15]:

...
3

a. Leaving Flow
Anode $a$ value in excess of the equation's value:

$$\varphi^+(a) = \frac{1}{n-1} \sum_{x \in A} \vartheta(a, x)$$  \hspace{1cm} (2)

The equation $\vartheta(a, x)$ expresses the preference for claiming that alternative $a$ is superior to alternative $x$.

b. Enter Flow
Entering flow values based on equations:

$$\varphi^-(a) = \frac{1}{n-1} \sum_{x \in A} \vartheta(a, x)$$  \hspace{1cm} (3)

The equation $\vartheta(a, x)$ expresses a preference for declaring that alternative $x$ is preferable to alternative $a$.

c. Net Flow ($\varphi$)
In determining the net flow as determined by equation:

$$\varphi(a) = \varphi^+(a) - \varphi^-(a)$$  \hspace{1cm} (4)

The higher the leaving flow value and the smaller the entering flow value, the more accurate the chosen alternative. PROMETHEE's process is more complicated since it is dependent on the net flow effect of each alternative. Alternatives with the higher net flow have higher scores.

2.3. GAIA (Geometrical Analysis for Interactive Aid) Method
This approach places the decision axis on PROMETHEE ($\pi$). This dimension shows the solution's course based on the weight assigned to the parameters. If the weight is based on a single parameter, the $\pi$ axis in the GAIA region agrees with the criterion's axis. As weights are assigned to all parameters, the axis appears as the weighted resultant of all criteria axes. The long $\pi$ axis has high decision control, and vice versa if the Short $\pi$ axis does not have strong decision making so it has contradictory parameters, making solution selection impossible [16].

Weight changes have little impact on alternate roles and parameters in GAIA areas. Decision-makers can fine-tune their decisions based on vector weights by choosing priorities that support particular parameters. A weight change would cause the PROMETHEE ($w$) decision line and axis $\pi$ to shift, allowing the results of decision making to be seen in the GAIA sector.

![Figure 1. GAIA field][10]
Geometric analysis for interactive aid (GAIA) is available for graphical representation between various iterations of the PROMETHEE approach to assist decision-makers to solve complex decision-making difficulties. The graphical GAIA plane shows in terms of contribution to different parameters the related locations of the alternatives[10].

3. Result and Discussion

The PROMETHEE approach is used to evaluate lecturer performance using empirical data and specific parameters. The first step is to identify the alternatives and conditions that would be used. Alternatives include lecturers who would be graded to decide who does the most.

Table 2. Alternatives

| Alternatives   | Code |
|----------------|------|
| Alternatives 1 | A1   |
| Alternatives 2 | A2   |
| Alternatives 3 | A3   |
| Alternatives 4 | A4   |
| Alternatives 5 | A5   |

Table 2 shows a lecturer that would be an alternate depending on PROMETHEE ratings. Table 3 shows the parameters that were used to determine the metrics of lecturer performance each year.

Table 3. Criteria

| Criterion     | Code | Information                           |
|---------------|------|---------------------------------------|
| Criterion 1   | C1   | International publications in reputable database |
| Criterion 2   | C2   | Patent                                |
| Criterion 3   | C3   | National Publications at SINTA 1-2    |
| Criterion 4   | C4   | National Grants                       |
| Criterion 5   | C5   | National Publications at SINTA 3-4    |

After determining the alternatives and parameters, the next phase is classification depending on the dominance of each parameter. To gain a better alternative ranking, this process is determined based on outflow values.

Table 4. Data

| Weight | Criterion | Rule | Alternatives |
|--------|-----------|------|--------------|
|        |           |      | A1 | A2 | A3 | A4 | A5 |
| 5      | C1        | Max  | 1  | 2  | 2  | 20 | 2  |
| 4      | C2        | Max  | 1  | 0  | 3  | 20 | 3  |
| 3      | C3        | Max  | 2  | 3  | 1  | 20 | 1  |
| 2      | C4        | Max  | 2  | 6  | 1  | 20 | 2  |
| 1      | C5        | Max  | 2  | 4  | 1  | 0  | 3  |

Table 5. PROMETHEE Flow Table

| Rank | Alternative | Phi   | Phi+  | Phi-  |
|------|-------------|-------|-------|-------|
| 1    | Alternative 2 | 0.2333 | 0.3667 | 0.1333 |
| 2    | Alternative 5 | 0.1000 | 0.3333 | 0.2333 |
| 3    | Alternative 1 | -0.0167 | 0.4000 | 0.4167 |
| 4    | Alternative 4 | -0.1333 | 0.1333 | 0.2667 |
| 5    | Alternative 3 | -0.1833 | 0.1167 | 0.3000 |

In deciding the lecturer's performance indicator, Alternative 5 is the top-ranking alternative. Table 5 shows that alternative 2 has the highest meaningful importance. Figure 2 depicts the GAIA Promethee visualization, with alternative two having the highest ranking in measuring lecturer performance.
Alternative 2 is the better alternative depending on the indicator, led by alternatives 1 and 3. Figure 3 depicts the outcomes of this rating such that policy makers can easily determine the best lecturer performance. Decision makers may also examine the numerical significance of net flow phi, as seen in Table 5.

4. Conclusion

The Promethee-based decision support framework assists decision-makers in determining the performance of lecturers based on the guidelines presented. The PROMETHEE and GAIA approaches are used in this analysis to evaluate the performance of lecturers based on five criteria. This study yielded an alternative of 2 with phi 0.2333 as the maximum value, accompanied by alternatives of 1 and 3. These findings indicate that alternative 2 is the better option for assessing lecturer performance as the primary indicator. Alternative 3 is the least recommended choice based on the visualization results since it has the lowest accuracy.

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