A Study on the performance appraisal method of vocational education teachers using Promethee II

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Abstract: *Evaluating vocational education teachers' performance is an important link of teaching management and an important guarantee of improving teaching quality. In conducting teaching, research and community service, vocational education teachers should weight more on quality than quantity. In this context, individual habit reacts to the demanded jobs which are influenced by his/her knowledge, attitude, and skill. The aim of this study is to develop the vocational education teachers' performance quantitative appraisal and determine the evaluation index based on academic performance. Criteria for performance are: teaching load, publication, research, conferencing, consultancy, services, teaching attitude, teaching content, teaching method, and teaching effect. The Analytic Hierarchy Process (AHP) and PROMETHEE (Preference Ranking Organisation METHod for Enrichment Evaluations) II analyses were used in the performance appraisal. The findings show that the MCDM approach is a viable tool in solving the teacher selection decision problems. It allows the decision maker to rank the candidate alternatives more efficiently and easily.*

Keywords: *performance, appraisal method, vocational education teacher, analytic hierarchy process, PROMETHEE II*

1. Introduction

Entering an age of rapid economic growth, it is common for universities to elevate their existing universities to World Class stature or to becoming World Class universities. This issue is heard from presidents of universities all the way to the minister of education. There are several approaches that Indonesian universities can focus on in response to these challenges; but first and foremost there needs to be a realization that a university is also a business and therefore reform strategy needs to focus on market principles. Making efforts to attract more foreign students will be necessary. In order to attract international students, Indonesian universities are going to have to make greater efforts in improving the quality of their course offerings and move towards a new paradigm of a world class university.

Although the terminology of World Class University has been used widely in discussion about academic institutions, there has been little attempt to define the term carefully. The definition of what makes a university become a world class university is subjective. By definition, a world class university is one on which there is wide-spread agreement of an international reputation, that it is one of the best in the world. The lack of an absolute set of performance criteria and measures may mean that world class statures will always be positional. Indeed, even when criteria are used to rank and measure university performance, they are incomplete and difficult to measure, and the ones that do exist are not very powerful predictors, especially for universities in non-English speaking countries. The subjective nature of a world class status means that institutions will attempt to address those dimensions that are considered in assessing reputations and that are visible.

With the development of higher vocational education and large-scale expansion of enrollment of vocational education institutions and universities, the difficulty in obtaining work and the quality of higher education has aroused extensive attention. The difficult employment of vocational education institution graduates not only has relation with government employment measures, job creating, development of the rhythm of vocational education institution and professional settings, but also, more importantly, has relation with the reform of teaching models and the quality of training. However, the core of solving the problem is how to improve the overall quality of vocational education teachers to improve their core competitiveness.

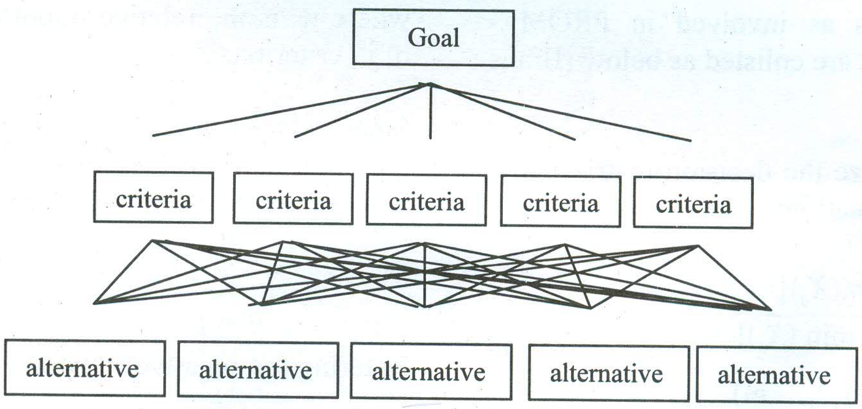
Teacher assessment is an important task. How to establish and improve the performance appraisal system is very important to the development of vocational education institutions, universities, and training. However, there are many problems in current performance appraisal of teachers in vocational education institutions and universities, for example: evaluation index system is not sound, the main measure of assessment is single, so many qualitative indicators and lack of quantitative assessment, unfair causes by so many subjective evaluation, and so forth. These problems have greatly affected the enthusiasm of teachers, which affect academic performances. Domestic scholars mostly have theoretical research of performance appraisal of teachers from the point of view of quality, which do not have a strong maneuvearability.

This paper attempts to use decision analyses approach to compound the qualitative assessment and quantitative assessment to establish a reasonable teacher performance evaluation system to ensure generalization. The development of an organization is measured from the performance achieved by that organization. Performance achievement of an organization is mainly based on the behavior of human resources within the organization. Organization needs a well-managed structural mechanism in assessing work force performance in correlation to work (Oshagbemi, 2000). Performance appraisal is a measurement conducted on workers to evaluate how they achieve work targets and productivity (Nasution and Marzuki, 2011). Various factors can be regarded in applying performance appraisal. Some researchers state that performance appraisal can be viewed from various aspects relating to the aims of research or what is going to be analyzed. Some evaluate working activity aspects, while others evaluate behavior or personality aspects.

The concept of performance was defined differently by a few people. Performance measures must be based on a set of objectives that are linked to the mission of the department and its visions for the future (Al-Turki and Duffuaa, 2003). Pritchard et al. (1990) defined performance measures as “the numerical or quantitative indicators that show how well each objective is being met”. Alternatively, Neely et al., (1995) defined a performance measure as “a parameter used to quantify the efficiency and/or effectiveness of past action”. In the educational sector, each school of faculty need to establish its core competencies based on its mission and vision, besides thinking of its current resources and state of competitiveness (Chen et al., 2006).

Decision making for academic staff promotion often involves such criteria as tasks, activities, teaching, supervision, publication, research, consulting, conferencing, administration and community service. Oshabegmi (2000) indicated that the main tasks of the academic staff can be divided into three categories namely teaching, research, and management. Academic staff promotion appraisal is evaluated based on three components such as teaching, research, and services. Academic staff appraisal can also be evaluated through items such as research article produced, teaching method, presentation style, and involvement in university and community activities (Badri and Abdulla, 2004). A technique usually used in multi criteria decision making is Analytical Hierarchy Process (AHP) which was introduced by Thomas L. Saaty in 1980. The advantage of using this technique is in conducting the subjective evaluation situation on the important components or variables in the decision making process. AHP was developed based on three principles which are the principle of constructing hierarchy, the principle of developing priority, and the principle of logical consistency (Islam and Rasad, 2006). Saaty in his book *The Analytical Hierarchy Process* developed the hierarchy for the selection of academic staff position and promotion. This hierarchy was developed to make the basic appraisal on the selection based on two main criteria which are teaching and research. However, the criteria became more complicated for a higher level education. At the same time, the application of the AHP technique for the purpose of reward and excellent awards at the higher education institution was also formulated at United Arab Emirates University (Badri and Abdulla, 2004). The model is described in Figure 1 and also can be used to evaluate and assess the qualified candidates. The model built is based on three components which are teaching, research and publication, and services. Every component has sub criteria which are related. The analysis indicated that the most important component is research and publication. Preference function based outranking method is a special type of MCDM tool that can provide a ranking ordering of the decision options. The PROMETHEE (preference ranking organization method for enrichment evaluation) method was developed by Brans and Vincke in 1985 (Brans et al., 1986). The PROMETHEE I method can provide the partial

Figure 1. AHP Model of Alternative Performance



ordering of the decision alternatives, whereas, PROMETHEE II method can derive the full ranking of the alternatives.

2. Method

This study uses qualitative and quantitative methods to achieve the objectives. The qualitative method in principle focuses on gaining meaning and insight into the area of interest (Rubin and Rubin, 2005). It is not used to draw any definitive conclusion. It is associated with "face-to-face" contact with people, together with verbal data and observations (Rubin and Rubin, 2005). The quantitative method was used to gather measurable data. The research objectives are as follows: (1) To identify the preferred indicators to measure performance based on teacher perspectives. and (2) To develop a valid and reliable performance measurement system using AHP and PROMETHEE II to measure teacher performance with regard to teaching, research and servicing that link to strategies.

3. Findings and Discussions

PROMETHEE II

In this paper, the PROMETHEE II method is employed to obtain the full ranking of the alternative teachers for a given vocational education institution. The procedural steps as involved in PROMETHEE II method are enlisted as below (Brans et al., 1986):

Step 1: Normalize the decision matrix using the following equation:

$$R_{ij} = \frac{[X_{ij} - min\,(X_{ij})]}{[max\,(X_{ij}) - \min\,(X_{ij})]} \quad (1)$$

(i = 1,2,…,n; j = 1,2,…,m)

$$R_{ij} = \frac{[max\,(X_{ij}) - X_{ij}]}{[max\,(X_{ij}) - \min\,(X_{ij})]} \quad (2)$$

Step 2: Calculate the evaluative differences of i^{th} alternative with respect to other alternatives. This step involves the calculation of differences in criteria values between different alternatives pair-wise.

Step 3: Calculate the preference function, $P_j(i,i^1)$.

There are mainly six types of generalized preference functions as proposed by Brans et al. (1984). But these preference functions require the definition of some preferential parameters, such as the preference and indifference thresholds. However, in real time applications, it may be difficult for the decision maker to specify which specific form of preference function is suitable for each criterion and also to determine the parameters involved. To avoid this problem, the following simplified preference function is adopted here:

$$P_{ij}(i,i^1) = 0 \text{ } if\, R_{ij} < R_{i^1j} \quad (3)$$

$$P_{ij}(i,i^1) = 1 \text{ } if\, R_{ij} < R_{i^1j} \quad (4)$$

Step 4: Calculate the aggregated preference function taking into account the criteria weights.

Aggregated preference function

$$\pi(i,i^1) = \left[\sum_{j=1}^{m} W_j X P_j(i,i^1)\right] / \sum_{j=1}^{m} w_j \quad (5)$$

where w_j is the relative importance (weight) of j^{th} criterion.

Step 5: Determine the leaving and entering outranking flows as follows:
Leaving (or positive) flow for i^{th} alternative,

$$\varphi(i) = \frac{1}{n-1} \sum_{i^1=1}^{n} \pi(i,i^1) \; (i \neq i^1) \quad (6)$$

Entering (or negative) flow for i^{th} alternative

$$\varphi^{-}(i) = \frac{1}{n-1} \sum_{i^1=1}^{n} \pi(i^1,i) \; (i \neq i^1) \quad (7)$$

where n is the number of alternatives. Here, each alternative faces (n – 1) number of other alternatives. The leaving flow expresses how much an alternative dominates the other alternatives, while the entering flow denotes how much an alternative is dominated by the other alternatives. Based on these outranking flows, the PROMETHEE I method can provide a partial pre-order of the alternatives, whereas, the PROMETHEE II method can give the complete pre-order by using a net flow, though it loses much information of preference relations.

Step 6: Calculate the net outranking flow for each alternative.

$$\varphi(i) = \varphi^{+}(i) - \varphi^{-}(i) \qquad (8)$$

Step 7: Determine the ranking of all the considered alternatives depending on the values of φ(i). The higher value of φ(i), the better is the alternative. Thus, the best alternative is the one having the highest φ(i) value. The PROMETHEE method is an interactive multi-criteria decision-making approach designed to handle quantitative as well as qualitative criteria with discrete alternatives. All qualitative criteria are expressed subjectively in linguistic terms. The objective values for these criteria are assigned from an 5-point scale, as given in Table 1.

Table 1
Fuzzy Scale of Weight Criteria

Criteria	Weight
Weak: W	0.1
Fairly weak: FW	0.3
Average: A	0.5
Fairly high: FH	0.7
High:H	0.9

In this method, pair-wise comparison of the alternatives is performed to compute a preference function for each criterion. Based on this preference function, a preference index for alternative i over i^1 is determined. This preference index is the measure to support the hypothesis that alternative i is preferred to i'. The PROMETHEE method has significant advantages over the other MCDM approaches, e.g. multi-attribute utility theory (MAUT) and AHP. The PROMETHEE method can classify the alternatives which are difficult to be compared because of a trade-off relation of evaluation standards as non-comparable alternatives. It is quite different from AHP in that there is no need to perform a pair-wise comparison again when comparative alternatives are added or deleted.

Analytical Hierarchy Process

Analytic Hierarchy Process (AHP) was originally designed to solve complicated multi-criteria decision problem (Saaty, 1980), beside that AHP is appropriate whenever a target is obviously declared and a set of relevant criteria and alternatives are offered (Bayazita and Karpakb, 2005). AHP has been proposed for study program selection problems to support Higher Education managers through the decision making activity, which aims to select the right study program to be promoted as an international class (Jati, 2011). The AHP technique assists decision makers to identify and determine the priority of criteria for promoting academic staff (Salmuni et al., 2007). The result is calculated by multiplying the weight of each criterion with the weight of each teacher. The teacher who has got the highest score is suggested as the best teacher and management may consider that one as the best decision choice for promoting academic career. In AHP the problems are usually presented in a hierarchical structure and the decision maker is guided throughout a subsequent series of pairwise comparisons to express the relative strength of the elements in the hierarchy. In general the hierarchy structure encompasses three levels, where the top level represents the goal, and the lowest level has the teacher under consideration. The intermediate level contains the criteria under which each teacher is evaluated. The final score obtained for each teacher across each criterion is calculated by multiplying the weight of each criterion with the weight of each teacher. A teacher who has got the highest score is suggested as the best teacher and decision makers may consider that one as the best decision choice for promotion.

Generally, AHP has the following steps:

1. Employ a pair-wise comparison approach. Fundamental scale for pair-wise comparisons developed to solve this problem (Saaty, 1980). The pair-wise comparison matrix A, in which the element a_{ij} of the matrix is the relative importance of the i^{th} factor with respect to the j^{th} factor, could be calculated as
$$A = [a_{ij}] = \begin{bmatrix} 1 & a_{12} & \cdots & a_{1n} \\ 1/a_{12} & 1 & \cdots & a_{2n} \\ \vdots & \vdots & \cdots & \vdots \\ 1/a_{1n} & 1/a_{2n} & \cdots & 1 \end{bmatrix} \quad (9)$$
2. There are $n(n-1)$/judgments required for developing the set of matrices in step 1. Reciprocals are automatically assigned to each pair-wise comparison, where n is the matrix size.
3. Hierarchical synthesis is now utilized to weight the eigenvectors according to weights of criteria. The sum is for all weighted eigenvectors corresponding to those in the next lower hierarchy level.
4. Having made all pair-wise comparisons, consistency is identified by using the eigenvalue λ *max*, to calculate the consistency index. The largest eigenvalue, λ max, will be:
$$\lambda \max = \sum_{j=1}^{n} a_{ij} \frac{W_j}{W_i} \quad (10)$$
where:
λ *max* is the principal or largest eigenvalue of positive real values in a judgment matrix; W_j is the weight of j^{th} factor; W_i is the weight of i^{th} factor.
5. Consistency test. Each pair-wise comparison contains numerous decision elements for the consistency index (CI), which measures the entire consistency judgment for each comparison matrix and the hierarchy structure. CI and consistency ration (CR) is utilized to assess the consistency of the comparison matrix. The CI and CR are defined as:
$$CI = \frac{\lambda \max - n}{n-1} \quad (11)$$
where n is the matrix size.
6. $$CR = \frac{Ci}{Ri} \quad (12)$$
where the judgment consistency can be checked by taking the CR of CI with the appropriate value. The CR is acceptable if it does not exceed 0.10. The CR is > 0.10, the judgment matrix is inconsistent. To acquire a consistent matrix, judgments should be reviewed and improved.

Numerical Example

Yan (Yan and Fan, 2009) employed the Analytical Hierarchy Process for ranking college teachers' performance appraisal quantitatively and determines the evaluation index qualitatively from teaching attitude, teaching content, teaching method and teaching effect. The same example is considered here to demonstrate the applicability and effectiveness of PROMETHEE II method as a MCDM tool. This example takes into account ten selection criteria and three alternative teachers. The objective and subjective information regarding different selection criteria are given in Table 2. All these criteria are expressed subjectively in linguistic terms and numeric values. The objective values for these criteria are assigned from an 5-point scale, as given in Table 2. The fuzzy judgments weak (W), fairly weak (FW), average (A) and fairly high (FH), and high (H) shown in Table 1 with respect to different criteria. The ten selection criteria as considered here to affect the decision are teaching load (A), publication (B), research (C), conferencing (D), consultancy (E), services (F), teaching attitude (G), teaching content (H), teaching method (I), and teaching effect (J). and the remaining are the beneficial attributes.

At first, the information for teacher alternatives with respect to different criteria, as shown in Table 2, is converted to crisp scores using the 5-point scale, as given in Table 3. The transformed objective data, as given in Table 3, are then normalized using Eqn. (1) or (2) and are given in Table 4. Determined the criteria weights for the considered criteria as wA = 0.1267, wB= 0.1267, wC = 0.0883, wD = 0.0517, wE = 0.0929, wF = 0.0706, wG = 0.0834, wH = 0.0834, wI=0.1382, and wJ = 0.1382 using AHP method and the same criteria weights are used here for PROMETHEE II method-based analysis.

Now, the preference functions are calculated for all the pairs of alternatives, using Eqns. (3) and (4), and are given in Table 5. Table 6 exhibits the aggregated preference function values for all the paired

Table 2.
Result for Teacher Performance

Teacher	A	B	C	D	E	F	G	H	I	J
Teacher A	14	6	25000	10	3	18	FW	A	H	FW
Teacher B	16	4	50000	6	5	12	A	H	W	FH
Teacher C	20	2	14000	4	6	24	FH	FH	A	H

Table 3
Objective Data for Teacher Performance Selection Problem

Teacher	A	B	C	D	E	F	G	H	I	J	K
Teacher A	14	6	25000	10	3	18	0.3	0.5	0.9	0.3	14
Teacher B	16	4	50000	6	5	12	0.5	0.9	0.1	0.7	16
Teacher C	20	2	14000	4	6	24	0.7	0.7	0.5	0.9	20

Table 4
Normalized Decision Matrix

Teacher	A	B	C	D	E	F	G	H	I	J	K
Teacher A	1	1	0.306	1	0	0.5	0	0	1	0	1
Teacher B	0.667	0.5	1	0.333	0.667	0	0.5	1	0	0.667	0.667
Teacher C	0	0	0	0	1	1	1	0.5	0.5	1	0

Table 5
Preference Functions for All the Pairs of Alternatives

	A	B	C	D	E	F	G	H	I	J
(A,B)	0.333	0.5	0	4	0	0.5	0	0	1	0
(A,C)	1	1	0.306	6	0	0	0	0	0.5	0
(B,A)	0	0	0.694	0	2	0	0.5	1	0	0.667
(B,C)	0.667	0.5	1	2	0	0	0	0.5	0	0

alternatives, as calculated using Eqn. (5). The leaving and the entering flows for different teacher alternatives are now computed using Eqns. (6) and (7) respectively, and are shown in Table 7.

Table 6
Aggregated Preference Function

	Teacher A	Teacher B	Teacher C
Teacher A		0.485883	0.659681
Teacher B	0.464353		0.381217
Teacher C	0.3915	0.258433	

Table 7
Leaving and Entering Flows for Different Teachers

Teacher	Leaving flow	Entering flow
Teacher A	0.572782	0.427926
Teacher B	0.422785	0.372158
Teacher C	0.324967	0.520449

The net outranking flow values for different alternative teachers and their relative rankings are given in Table 8. Now, the alternative teachers are arranged in descending order according to their net outranking flow values. The best teacher performance of vocational education institution is teacher A. This proves the applicability and potentiality of the PROMETHEE II method for solving complex decision-making problems in the academic domain.

Table 8
Net Outranking Flow Values for Different Teacher (Alternatives)

Teacher Performance	Net Outranking Flow	Rank
Teacher A	0.144856	1
Teacher B	0.050626	2
Teacher C	-0.19548	3

4. Conclusion and Suggestion

Schools and universities are organizations which are based on science which is not overtly competitive. The competitive advantage should lie on the academic staffs as the main resource. With behavior appraisal, academic staffs will make the school and university become more globally competitive as a science-based organization and as the main producer of human capital. The statement correlates with the main function of a vocational education institution as the main producer of human resources which is based on science and competency, and which shows its competitive advantage. Teacher appraisal performance decision has long-term implications. It is therefore important to select the best teacher for a given educational institution. The problem of teacher appraisal performance is a strategic issue and has significant impacts on the performance of the vocational education institutions. The present study explores the use of PROMETHEE II method in solving a teacher selection problem and the results obtained can be valuable to the decision maker in framing the teacher selection strategies. It is observed that this MCDM approach is a viable tool in solving the teacher selection decision problems. It allows the decision maker to rank the candidate alternatives more efficiently and easily. The cited real time vocational education institution example demonstrates the computational process of the PROMETHEE II method and the same method can also be applied to other strategic decision-making problems.

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