Student Portfolios Rescoring in an Indonesian Private University Based on a Fuzzy MCDM

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ABSTRACT
Due to today's globalized era, there is a strong need to prepare skilled and competent future generations. This, of course, will involve the contribution from many parties including authorities and universities. In Indonesia, the ministry of education, culture, research, and technology has released a document to recognize student's achievement as well as graduates' competencies. This document will not only describe the academics history from the students, but also encourage Indonesian universities to take part in increasing young generations achievements through various academic programs. Although all universities have implemented the policy with different approaches, there has been a concern in scoring system once recognizing the activities achieved by students. In particular, the issue of unfair weight determined in the scoring system may be appeared. Therefore, this study addresses this issue by employing an MCDM approaches to improve the scoring system of student's portfolio document. A case study in a private university situated in Indonesia is selected to apply the model. This study focuses on criteria within the most preferred category determined by the DMs in the university. The result indicated that there were 11 criteria screened based on the effort and impact variables. These criteria belong to high impact – low effort category. Then, these 11 criteria were weighted using the fuzzy AHP. The obtained weighted can be adopted by the DMs to improve more relevant and accountable student's portfolio scoring system. However, a follow-up study should be carried out by taking into account the whole criteria in all categories.

Keywords: *student portfolio, university, MCDM*

1. INTRODUCTION

A century of Indonesia, in 2045, will be at a historic achievement often proclaimed as the idea of golden generation. This aspiration is also indicated with the situation that in 2045 the country is projected to have demographic bonus in which the productive age of the Indonesian population reaches 70% [1]. This momentum, of course, should be prepared properly so that it can bring significant positive changes to the country. Otherwise, it can actually lead to negative consequences burdening the development of a country such as the high unemployment rate and poor quality of human resources [2].

To respond this situation, the authority of Indonesia through the ministry of education, culture, research, and technology has released a document indicating student development portfolios for all universities nationwide. According to the national regulation, the document describes detailed information about the graduate competencies achieved in a specific field of studies [3]. In addition, the document also presents academic track records, achievement, and qualifications when graduating from the university [4]. It is considered that this instrument should be a tool to enhance the quality of the Indonesian younger generation through the achievement of academic and non-academic activities. Furthermore, the instrument can be an effective communication tool which enables international collaboration with degrees, although there may be some challenges due to different education system [4].

To implement the instruction, all universities in Indonesia have attempted to formulate new policies to improve the quality of prospective graduates. Today, a number of Indonesian universities even apply the achievement credit unit as a form of recognition to students for participating in various extra activities [5,6,7]. In short, the system contains the weight or score of certain qualifications possessed by each graduate [5,6,7]. The weighting, however, is still very subjective and varies. To illustrate, being a head of international committee will be scored of 50 unit in university A, while the others put less than 50 unit [7]. This, of course, also influences the predicate depending on the criteria defined such as excellent, very good, and good in different specific ranges [5,6,7]. Consequently, there will be a concern of unfair weight and even the system will not represent the real predicate that should be awarded to the prospective graduates. Therefore, by addressing this issue, this study rescores the student portfolio weights using a multi-criteria decision-making (MCDM) approach. A case study in a private university is selected to propose the model. Further, the MCDM approach is able to generate good pairwise comparison to avoid the unfair weights among activities or achievement.

Prior to this study, some past studies have widely applied the MCDM techniques in education sector. For instance, Blasco-Blasco et al. [8] evaluated academic performance using TOPSIS, Epifani et al. [9] considered organization factors influencing learning quality outputs by applying SWARA (Step-wise Weight Assessment Ratio Analysis), Liu [10] evaluated the teaching quality of physical education using the *Intuitionistic Fuzzy* TOPSIS (IF-TOPSIS), Sutiah et al. [11] proposed fuzzy TOPSIS to find out core competence and student achievement, Mynit [12] and Kong [13] employed the AHP method to select the best student with regards to all round excellent award as well as to evaluate scientific innovative model.

Besides, several MCDM techniques were popular to address complex decision-making problem in education sector such as AHP, VIKOR and TOPSIS. For instance, the TOPSIS method and Ranked Base on Percentage were utilized to identify the success factor on Knowledge Sharing Behavior (KSB) [14]; a developed AHP and *Fuzzy Interference System* (FIS) to evaluate success factors and a case dropping out [15]; a combined AHP – VIKOR to enhance the accuracy of course assessment rating [16]; and hesitant fuzzy linguistic judgement and TOPSIS were selected to evaluate the potential learning for prospective university freshmen [17]. On the other hand, several past studies conducted by Yunan and Ali [18] and Pratama et al. [19] selected the best student using combined MCDM techniques such as VIKOR, TOPSIS, and fuzzy Mamdani and Sugeno. In this paper, we selected the fuzzy AHP method to re-score the identified criteria included on the student portfolios' document. The method is able to compare the criteria through pairwise comparison so that the unfair weights can be avoided. In addition, the method is easy to understand by the decision-makers (DMs) with simple computation. A fuzzy environment is proposed in order to determine more precise criteria weights. Hence, this study suggests the relevant weights that can be adopted by the DMs in a university to improve the scoring system for student portfolios document.

2. METHOD

This study comprises two main stages, namely screening criteria and re-scoring criteria. In the first stage, screening criteria, the student portfolio document including recognized activities and achievements are mapped and classified into four quadrants using impact and effort scores. Then, the screened criteria within high impact – low effort group are weighted using fuzzy AHP. The fuzzy AHP's steps follows [20].

a. Defining the fuzzy triangular scales
   As can be seen in table 1 that the fuzzy scales consist of the lower value (*l*), the mean value (*m*), and the upper value (*u*) corresponding the Saaty's scales from 1 to 9.
b. Developing the fuzzy pairwise comparison matrices
   The pairwise comparison matrice (1) indicates the elements of $\widetilde{d_{ij}^k}$ in AHP fuzzy scales which represents k^{th}decision makers' preference of the i^{th}criterion over the j^{th}criterion.

$$\tilde{A}^k = \begin{bmatrix} \widetilde{d_{11}^k} & \widetilde{d_{12}^k} & \dots & \widetilde{d_{1n}^k} \\ \widetilde{d_{21}^k} & \dots & \dots & \widetilde{d_{2n}^k} \\ \dots & \dots & \dots & \dots \\ \widetilde{d_{n1}^k} & \widetilde{d_{n2}^k} & \dots & \widetilde{d_{nn}^k} \end{bmatrix} \quad (1)$$

Table 1. Linguistic terms and the corresponding TFNs [20]

Saaty Scale	Definition	Fuzzy Triangular Scale
1	Equally important	(1,1,1)
3	Weakly important	(2,3,4)
5	Fairly important	(4,5,6)
7	Strongly important	(6,7,8)
9	Absolutely important	(9,9,9)
2	Intermittent values between two adjacent scales	(1,2,3)
4		(3,4,5)
6		(5,6,7)
8		(7,8,9)

c. Calculating the fuzzy weight of criteria
   The fuzzy weights are obtained using the geometrical technique (2) so that the fuzzy weights can be calculated using equation (3).

$$\bar{r}_i = \left(\prod_{j=1}^{n} \bar{d}_{ij}\right)^{1/n}, i = 1,2,\dots,n \quad (2)$$

$$\bar{w}_i = \bar{r}_i \otimes (\bar{r}_1 \oplus \bar{r}_2 \oplus \dots \oplus \bar{r}_n)^{-1} \quad (3)$$

d. Calculating the average and the normalized weight criteria
   The normalized weight represents the criteria weight is calculated using equation (4).

$$M_i = \frac{\bar{w}_1 \oplus \bar{w}_2 \oplus \dots \oplus \bar{w}_n}{n} \quad (4)$$

$$N_i = \frac{M_i}{M_1 \oplus M_2 \oplus \dots \oplus M_n} \quad (5)$$

3. RESULT AND DISCUSSION

Screening criteria

At this stage, initially there were 57 criteria based on the SKPI SK applied at the university which were categorized into four groups, which were: 1) category 1 (*A*) includes attitude, spirituality, ethics, and leadership, 2) category 2 (*B*) includes achievement and self-development activities, 3) category 3 (*C*) includes social and community service activities, and 4) category 4 (*D*) includes research and community

service outputs. To screen criteria, two groups of respondents were involved, namely selected students due to their outstanding achievements and the decision-makers (DMs) at university as shown in table 2. The selected student group provided effort variable scores and the DMs provided impact variable scores. The scales were given according to a Likert scale ranged between 1 and 5 where 1 indicates very low and 5 indicates very high.

Table 2. Group of respondents

Group's name	Count
The decision-makers (DMs)	
1. Vice Rector in Academic Affairs	1
2. Vice Dean	5
The outstanding students	
1. National achievers	16
2. International achievers	4
3. Others (trainer, committee, etc.)	1

After the respondents provided the impact and effort scores, the 57 criteria can be plotted into a Cartesian diagram containing four quadrants, namely quadrant I for high impact – high effort activities, quadrant II for high impact – low effort activities, quadrant III for low impact – high effort activities, and quadrant IV for low impact – low effort activities. Figure 1 shows the plotting 57 criteria into each quadrant.

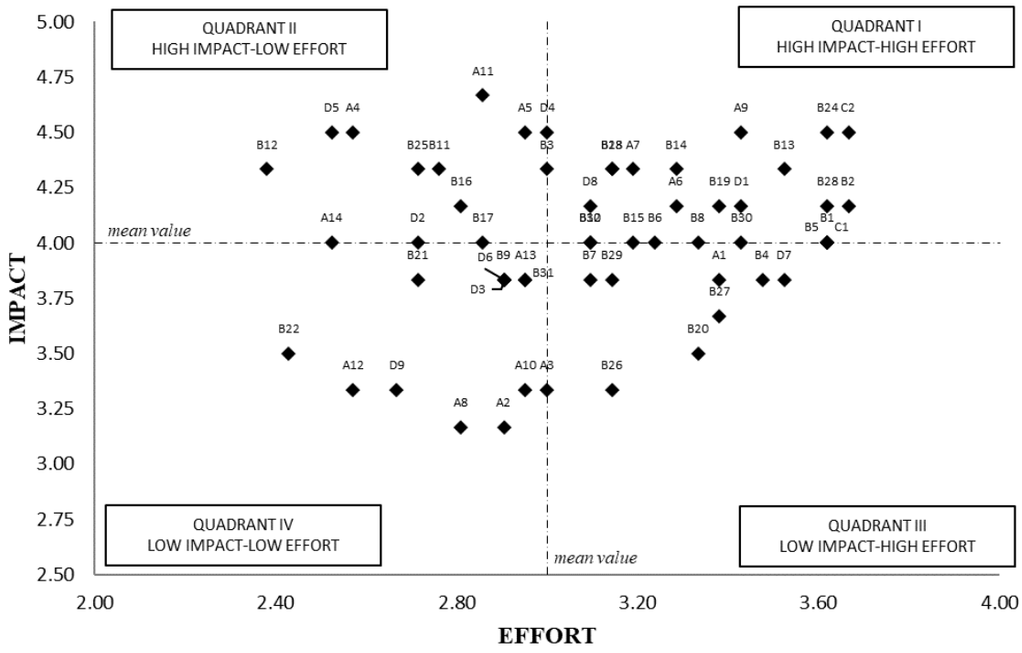

Figure 1. A Cartesian diagram visualizing the plotting of 57 criteria into four quadrants

As seen in the figure 1 that there are 11 activities grouped into the quadrant of high impact – low effort. This category is prioritized by the DMs since in private universities, limited resources need to be managed prudentially to gain effective outcomes. These activities are students actively participate in Tamansiswa seminar (*A*4), activities for cultural preservation and development (*A*5), becoming organizing committee for student leadership training (*A*11), participating in advance course training (*A*14), becoming the university's delegates for national competition (*B*11), becoming the university's delegates for local competition (*B*12), becoming a speaker or a parallel presenter in national-scale seminar/ training/ workshop/ conferences (*B*16), becoming a speaker or a parallel presenter in local-scale seminar/ training/ workshop/ conferences (*B*17), gaining Bahasa Indonesia proficiency test score (*B*25), joint research and community services (*D*2), and publishing research and community service results in scientific forums/ journals (*D*5). The 11 screened criteria are categorized into the *A* category with four criteria (*A*4, *A*5, *A*11, *A*14), the *B* category with five criteria (*B*11, *B*12, *B*16, *B*17, *B*25), and the *D* category with two criteria (*D*2 and *D*5). Meanwhile, there is no criteria included from the *C* category.

Rescoring using the fuzzy AHP method

In this stage the screened criteria are reweighted using the fuzzy AHP. Firstly, the DMs involved gave preference scores for pairwise comparisons between criteria using the Saaty's scale. By using the TFN's rule table 1, a fuzzy pairwise comparison matrix is shown in table 3. The crisp weights are computed by using the geometric mean method as can be seen in table 4.

Table 3. A fuzzy comparison matrix

Criteria	*A*4			*A*5			*A*11 – *B*16	*B*17			*B*25		
	l	*m*	*u*	*l*	*m*	*u*		*l*	*m*	*u*	*l*	*m*	*u*
*A*4	1	1	1	0.63	0.87	1.26	…	0.93	1.08	1.26	0.61	0.75	0.93
*A*5	0.79	1.14	1.59	1	1	1	…	0.91	1.13	1.36	0.66	1.08	1.34
*A*11	…	…	…	…	…	…	…	…	…	…	…	…	…
*A*14	…	…	…	…	…	…	…	…	…	…	…	…	…
*B*11	…	…	…	…	…	…	…	…	…	…	…	…	…
*B*12	…	…	…	…	…	…	…	…	…	…	…	…	…
*B*16	…	…	…	…	…	…	…	…	…	…	…	…	…
*B*17	0.79	0.93	1.08	0.74	0.89	1.10	…	1	1	1	0.46	0.58	0.74
*B*25	1.08	1.34	1.64	0.75	0.93	1.21	…	1.36	1.71	2.19	1	1	1

Table 4. Weights of the screened criteria

Category	Criteria	Weights	Sub-criteria	Global Weights	Rank
A	*A*4	0.140		0.140	1
	*A*5	0.136		0.136	2
	*A*11	0.105		0.105	5
	*A*14	0.095		0.095	8
B	*B*11/*B*12	0.097	1	0.097	7
			0	0	10
	*B*16/*B*17	0.093	1	0.093	9
			0	0	10
	*B*25	0.112		0.112	4
D	*D*2	0.104		0.104	6
	*D*5	0.117		0.117	3

It can be seen from the table that the top three criteria are *A*4, *A*5, and *D*5 with the weights of 0.140, 0.136, and 0.117, respectively. Meanwhile, there are two criteria with the lowest weight, namely *B*12 and *B*16. The result indicates that the criteria *A*4 and *A*5 are relevant to university's values in terms of bringing up the student's character. In addition, the *D*5 achieved may have positive impacts on the overall performance of research and community service as it involves the contribution from the academic staffs. On the other hand, both *B*12 and *B*16 criteria have the least weights due to the coverage of achievement at local scale, while there are a limited number of events provided at local scale. Alternatively, the national-scale activities are preferred as these activities may bring greater impact for university accreditation scores.

4. CONCLUSION

This study provides a simple procedure for recognizing student achievement using a more accountable method. In this case, the MCDM method can determine more relevant weights and address unfair weights which emphasize subjectivity. The obtained weights can be implemented by the DMs for improved scoring system which also gives more appropriate predicate to outstanding students. However, the result of this study can only be applied partially since the ideal situation should be achieved if the method is applied to all criteria. For future studies, therefore, it is strongly recommended to consider all criteria scores and even comparing categories in order to improve the whole scoring system.

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