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# The quality classification of professional teacher using fuzzy-analytical hierarchy process

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**Abstract.** Teachers are required to carry out their duties and responsibilities based on the four fundamental teacher competencies. Teacher competencies are pedagogic, personality, social, and professional. The quality of professional teacher determines based on an assessment of the four fundamental competencies of teachers above. The focus of this study is the classification of professional teacher quality assessment results based on teacher competencies. The quality classification of professional teachers uses a fuzzy rule-based method. The purpose of this study is to provide better measurement and classification of professional teacher quality; it easier to make policy decision-making processes for improving the quality performance of professional teachers. The results of this study show the quality of the professional teacher 66.7% in medium class and 33.3% in high class with no professional teacher in low class.

## 1. Introduction

In the Indonesian Big Dictionary, the teacher is the person whose job (his livelihood, profession) is teaching [1]. The teacher, as an educator, is responsible for educating, teaching, guiding, directing, training, and evaluating students on the formal education path. Teacher's duties and responsibilities regulated in Law No. 14 of 2005 concerning Teachers and Lecturers and Regulation of the State Minister for Administrative Reform and Bureaucratic Reform No. 16/2009 concerning Teacher Functional Position and Credit Scores. The Minister's laws and regulations clearly emphasize that teachers must implement four basic competencies, namely pedagogical competence, personal competence, social competence, and professional competence. Teacher professionalism measurement standards in Indonesia are measured based on these four competencies.

Data from the Ministry of Education and Culture in the 2018/2019 school year show that the number of teachers in Indonesia is 2,736,010 teachers [2]. While the percentage of professional teacher data in Indonesia is each Elementary School with 45.77%; Junior High School with 48.44%; High School with 41.09%; Vocational High School with 28.49%; and Special Education 45.07%. In other words, the number of professional teachers in Indonesia as a whole is still below 50%. Data from Centre of Analysis and Policy Synchronization (*Pusat Analisis dan Sinkronisasi Kebijakan*-PASKA) Ministry of Education and Culture states that the low competence of teachers shown from the low Teacher Competency Test Results (UKG) conducted in 2019 where the results 54.05 points [3]. It below the average minimum standard competency (SKM) 2019, which is expected by the government to reach 80 points. Besides, the existence of Professional Teacher Allowance (TPG) for professional teachers expected to provide strong motivation for teachers to improve teaching professionalism for improving the quality of



education. But in reality, the existence of the TPG is currently not felt to be directly proportional to the improvement in the quality and professionalism of teachers or educators [4].

Assessment of the quality and professionalism of teachers needs continuously done. Of course, it must begin with a certification system provided by the central government and must also allocate for regular and adequate training (re-training or refitting) for teachers [4].

Research on various forms of assessment of teacher competency conducted. Research conducted by M Panggabean and K K Himawan determines Teacher Competence Questionnaire (TCQ) is a valid and reliable instrument to measure teacher competence [5]. A Rahman suggested that Teachers Professional Development (TDP) is multidimensional. It argues that the presence of good or ideal TPD activity of learning, individual of the teacher, and condition within schools is not enough to ensure success in TPD [6]. Alwi designs and makes a Decision Support System (DSS) application that can provide alternative solutions in decision making for the achievement of teachers [7].

According to Sujianto, in Runtuwene and Tangkawarow [8], the assessment of professional teacher professional development is divided into categories, namely high, medium, and low. According to Jaedun in Runtuwene and Tangkawarow [8] stated that the efforts of the Government of the Republic of Indonesia would be in vain if the performance of certified teachers (professional teachers) did not improve compared to the performance of teachers before being certified.

Previous research has measured teacher quality using a multi-criteria decision method (MCDM). This approach chooses because the teacher's competence consists of six competencies, which will henceforth be called criteria and 19 sub-competencies (sub-criteria) [8]. Determination of competencies/criteria is no longer the focus of this study because teacher competencies are regulated in laws and government regulations.

Based on the previous research, we improve the MCDM method with the combination method of analytical hierarchy process and fuzzy rule base to classifying the quality of professional teachers based on the assessment result. The focus of our research lies in how to weight each competency that is the teacher's criteria and how to classify it. The calculation results classify into three categories, namely high, medium, and low. This research will use the Fuzzy-Analytical Hierarchy Process (FAHP) approach. The results of this study can provide better measurement and classification of teacher quality, making it easier to make policy decision-making processes to improve teacher quality. A more measurable, systematic recommendation with real numbers makes this research useful at the managerial level.

## 2. Proposed Method

### 2.1. Professional teacher

In the research of Bahari, et al. [9] the teacher performance assessment determined using the Fuzzy-Analytic Hierarchy Process (F-AHP) case study of the Brawijaya Smart School High School by using six criteria, namely pedagogical competence, professional competence, innovation development competency, utilization competency technology, social competence, and personality competence. Table 1 shows the criteria and sub-criteria of professional teachers.

The six criteria and 19 sub-criteria above used to find the weight on each criterion. The results of the next teacher assessment will be the classification of teacher quality — the classification using thirty collected data of teacher competency assessment results in one school.

**Table 1.** Professional teacher criteria and sub criteria [9].

No	Criteria	Sub Criteria
1.	Pedagogic (Pe)	Understanding of students (Pe1) RPP Design (Pe2) Implementation of RPP (Pe3) Evaluation of learning outcomes (Pe4) Development of students (Pe5)
2.	Personality (K)	The personality that is steady, stable, mature, wise and authoritative (K1) Be a role model for students (K2) Be a role model for the community (K3) Precious (K4)
3.	Social (S)	Capable of communicating and socializing effectively with participants students (S1) Capable of communicating and getting along effectively with other educators (S2) Capable of communicating and socializing effectively with Parents / Guardians of Students (S3) Capable of communicating and socializing effectively with the surrounding community (S4)
4.	Professional (Pr)	Broad mastery of learning material (Pr1) Mastery of curriculum material and scientific substance overshadow the material (Pr2) Mastery of the structure and scientific methodology (Pr3)
5.	Innovation (Pi)	Scientific publications (Pi1) The creation of innovative works (Pi2)
6.	The utility of technology (Pt)	Utilization of information technology in teaching and learning activities (Pt1)

## 2.2. Fuzzy Analytical Hierarchy Process (FAHP)

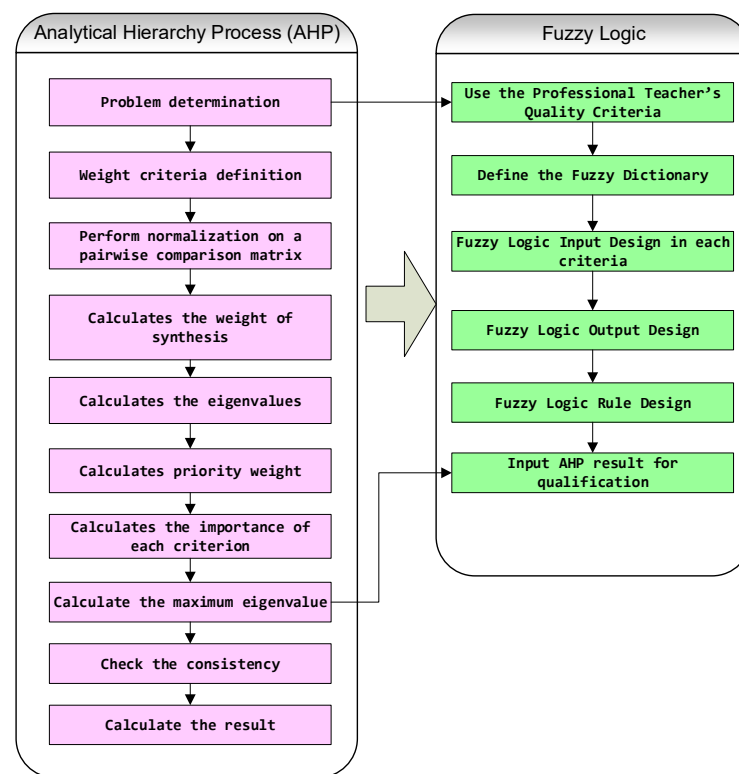
The AHP method developed by Thomas L. Saaty. This method is a framework for making effective decisions on complex problems by simplifying and speeding up the decision-making process by solving problems into simple parts. This method will arrange parts or variables in a hierarchical arrangement, give numerical values to subjective considerations about the importance of each variable and synthesize these considerations to determine which variable has the highest priority and act to influence the outcome of the situation [10]. Fuzzy Analytical Hierarchy Process (FAHP) was a classical AHP method synthetic extension when the fuzziness considered the decision-makers [10-11].

L N. Safitri, R Sarno, and G I Budianto use fuzzy rule-based focuses on the business processes classification based on business process models and indicators of sustainability [13]. S. Huda, R. Sarno, and T Ahmad propose detecting method for process-based fraud with low deviation with correctly detect fraudulent cases. Chan and Kumar proposed a model on global supplier development problems by utilizing FAHP as a multiple criteria decision-making approach [14]. Bouyssou in Ozdagoglu said the FAHP technique developed to view an advanced analytical method from the traditional AHP [11]. Notwithstanding the benefit of AHP in advising both quantitative and qualitative criteria of multi-criteria decision-making problems based on decision-makers judgment, fuzziness and vagueness existing in many decision-making problems may provide to the imprecise decisions of decision-makers in traditional AHP approaches. U Yudatama, R Sarno used Fuzzy AHP to determine the weight of the specified criteria and Fuzzy TOPSIS to the rank of selected options [15]. Buckley in E Pane proposed the implementation of a fuzzy set to replace the mapping perception criteria crisp number of AHP [16]. Y Tang and T W. Lin use a systems approach with the fuzzy analytic hierarchy process (FAHP) method

to help decision-makers making better choices both concerning tangible criteria and intangible criteria to the lead-free equipment selection judgment [17]. We use ten steps in the analytical hierarchy process (AHP) based on Xu [18] in Runtuwene [7,16].

Shortly, the FAHP method of this research shows in Figure 1 below. There are ten steps of AHP and six steps of fuzzy logic.

Fuzzy triangular membership function (MF), denoted by  $M = \{a,b,c\}$ , where  $M$  is the set of fuzzy numbers consisting of  $a$ ,  $b$  and  $c$  have respectively expressed the smallest possible value, the value of the closest, and the largest possible value [15]. Before the Fuzzy calculations, we declared fuzzy grade membership. Clustering aims to divide the quality of the professional teachers into three quality categories in low, medium, and high quality. Furthermore, we aligned the classification of professional teacher quality; each classification rated verbally in low, medium, and high. Then, the points of the verbal score are defined to calculate fuzzy logic with range null until ten (0-10) — the dictionary of fuzzy logic described in **Error! Reference source not found..**



**Figure 1.** Steps of Fuzzy AHP (FAHP) method.

**Table 2.** Fuzzy dictionary of the quality of professional teacher.

Verbal score	Specific Points		
	a	b	c
Low	0	1	4
Medium	3.5	6	7
High	7	10	10

### 3. Result and discussion

Assessment data that we got from the school inspector, we made table comparison matrices. When all the matrices of the six criteria of teacher quality define, we analyze the matrices criteria by determining

normalization to all PCJM in all criteria [8]. Then, calculate the priority vector shows in Table . We find the priority vector in pedagogic criteria, personality criteria, social criteria, professional criteria, innovation development criteria, the utility of technology criteria. Then, we use the priority vector in each sub-criteria to calculate the result of the quality of the professional teachers in each criterion. The assessment results from each criterion shown in **Error! Reference source not found.**

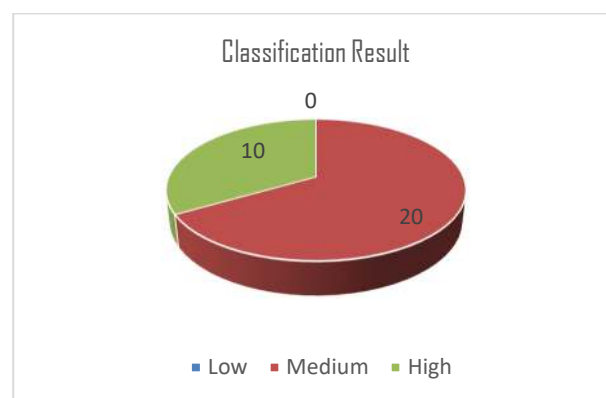
**Table 3.** Normalization and priority vector of Social criteria.

Social Criteria Normalization	S1	S2	S3	S4	Priority Vector
S1	0.49	0.52	0.46	0.45	0.48
S2	0.25	0.26	0.31	0.27	0.27
S3	0.16	0.13	0.15	0.18	0.16
S4	0.10	0.09	0.08	0.09	0.09

**Table 4.** Result of each criterion.

ID_No	Criteria	Pedagogic (Pe)					Personality (K)					Social (S)					Professional (Pr)				Innovation				Utility of Technology	
		P1	P2	P3	P4	P5	Weight	K1	K2	K3	K4	Weight	S1	S2	S3	S4	Weigh	t S	Pr1	Pr2	Pr3	Weight	Pi1	Pi2	Weight Pi	Pt
	Priority Vector	0.39	0.17	0.11	0.06	0.28		Pe	0.26	0.17	0.12		0.45	K	0.48	0.27		0.16	0.09	0.54	0.30		0.16	Pr		0.25
	T1	7.0	8.0	5.0	8.0	7.0	7.00	6.0	8.0	6.0	6.0	6.34	9.0	9.0	8.0	8.0	8.75	7.0	8.0	8.0	7.46	7.0	6.0	6.25	8.0	8.00
T2	8.0	9.0	7.0	8.0	8.0	8.06	8.0	6.0	8.0	6.0	6.76	7.0	6.0	6.0	8.0	6.66	4.0	5.0	5.0	4.46	4.0	4.0	4.00	7.0	7.00	
T3	9.0	9.0	9.0	7.0	9.0	8.89	5.0	8.0	5.0	5.0	5.51	8.0	7.0	6.0	7.0	7.32	7.0	8.0	8.0	7.46	5.0	6.0	5.75	8.0	8.00	
T4	8.0	8.0	6.0	8.0	7.0	7.50	7.0	8.0	7.0	6.0	6.72	7.0	6.0	5.0	8.0	6.50	8.0	7.0	8.0	7.70	4.0	3.0	3.25	4.0	4.00	
T5	7.0	7.0	7.0	8.0	7.0	7.06	8.0	6.0	8.0	7.0	7.21	8.0	8.0	6.0	6.0	7.51	7.0	8.0	8.0	7.46	7.0	6.0	6.25	6.0	6.00	
T6	5.0	5.0	5.0	8.0	5.0	5.17	7.0	8.0	7.0	8.0	7.62	8.0	8.0	9.0	7.0	8.07	8.0	8.0	8.0	8.00	8.0	8.0	8.00	5.0	5.00	
T7	8.0	9.0	8.0	8.0	8.0	8.17	8.0	8.0	8.0	6.0	7.10	8.0	7.0	8.0	5.0	7.46	6.0	6.0	5.0	5.84	6.0	6.0	6.00	8.0	8.00	
T8	7.0	8.0	8.0	8.0	4.0	6.50	6.0	6.0	8.0	9.0	7.59	5.0	4.0	5.0	5.0	4.73	5.0	6.0	5.0	5.30	7.0	6.0	6.25	9.0	9.00	
T9	8.0	8.0	5.0	8.0	8.0	7.67	8.0	9.0	8.0	7.0	7.72	8.0	8.0	6.0	7.0	7.60	8.0	8.0	8.0	8.00	8.0	9.0	8.75	3.0	3.00	
T10	7.0	8.0	7.0	8.0	4.0	6.39	7.0	6.0	9.0	9.0	7.97	7.0	6.0	5.0	5.0	6.24	7.0	6.0	8.0	6.87	3.0	4.0	3.75	8.0	8.00	
T11	6.0	7.0	8.0	8.0	7.0	6.78	8.0	8.0	7.0	6.0	6.98	8.0	7.0	6.0	5.0	7.15	4.0	5.0	4.0	4.30	7.0	4.0	4.75	2.0	2.00	
T12	5.0	4.0	5.0	8.0	7.0	5.56	9.0	7.0	9.0	8.0	8.21	7.0	8.0	5.0	6.0	6.87	7.0	8.0	8.0	7.46	7.0	6.0	6.25	1.0	1.00	
T13	8.0	7.0	8.0	7.0	8.0	7.78	4.0	5.0	4.0	5.0	4.62	8.0	6.0	8.0	9.0	7.54	5.0	6.0	4.0	5.13	7.0	8.0	7.75	7.0	7.00	

After the determination of professional teacher quality based on six criteria, we define results then classified the result based on a fuzzy rule-based method [13,20]. In the fuzzy dictionary in **Error! Reference source not found.**, the fuzzy logic input and output design determined. Seven hundred twenty-nine (729) rules generated from the combination of six criteria of professional teacher's quality. The result of the professional teacher quality and its classification shows in **Error! Reference source not found.**. The result of classification shows that there is no teacher in low quality, twenty teachers in medium quality, and ten teachers in high quality.



**Figure 2.** Quality classification of professional teacher result.

**Table 5.** Result and classification of professional teacher quality

ID_No	Pedag ogic	Person ality	Social (S)	Profesio nal (Pr)	Inovation	Utility of Technology	Result	Classification
T1	7.00	6.34	8.75	7.46	6.25	8.00	8.550	High
T2	8.06	6.76	6.66	4.46	4.00	7.00	5.000	Medium
T3	8.89	5.51	7.32	7.46	5.75	8.00	8.606	High
T4	7.50	6.72	6.50	7.70	3.25	4.00	5.231	Medium
T5	7.06	7.21	7.51	7.46	6.25	6.00	8.550	High
T6	5.17	7.62	8.07	8.00	8.00	5.00	8.675	High
T7	8.17	7.10	7.46	5.84	6.00	8.00	8.551	High
T8	6.50	7.59	4.73	5.30	6.25	9.00	5.226	Medium
T9	7.67	7.72	7.60	8.00	8.75	3.00	8.669	High
T10	6.39	7.97	6.24	6.87	3.75	8.00	5.242	Medium
T11	6.78	6.98	7.15	4.30	4.75	2.00	5.250	Medium
T12	5.56	8.21	6.87	7.46	6.25	1.00	5.232	Medium
T13	7.78	4.62	7.54	5.13	7.75	7.00	5.000	Medium

#### 4. Conclusion

We have proposed to classify the professional teacher quality use FAHP. The classification classifies three quality categories, namely low, medium, and high. This research determines and evaluates the teacher's quality based on the assessment result uses six criteria with nineteen sub-criteria. It shows the quality of twenty professional teachers in medium and ten professional teachers in high, where the highest quality is in medium quality 66.7% and 33.3% high quality with no low quality. The recommendation for professional teacher improvement can use the result to indicate which competencies are needed to improve.

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