Comparing Scoring and Fuzzy Logic Method for Teacher Certification DSS in Indonesia

Purnama-Dewi[1], Oka-Sudana[2] and Darma-Putra[3]

**[1] Department of Information Technology, Udayana University
Bali, 80361, Indonesia**

**[2] Department of Information Technology, Udayana University
Bali, 80361, Indonesia**

**[3] Department of Information Technology, Udayana University
Bali, 80361, Indonesia**

Abstract

Graduation of teacher certification participants plays an important role in improving the quality of education in Indonesia. This paper presents a decision support system using a Scoring and Fuzzy Logic method to determine the participants graduation of teacher certification based on requirements fulfilled. Five criteria were used as the input of the system. In Fuzzy Logic method, each criteria is divided into three parts: low, medium and high; while scoring method is determined by using a 1 - 5 scale for each requirement fulfilled. Graduation and participants ranking using Scoring and Fuzzy Logic is the output of the system. In this paper, the assessment using Scoring and Fuzzy Logic showed different ranks and results in some scores, particularly in practice assessment by using scoring method for score 64,5 would not graduated the participants since the score of practice assessment is 65. While Fuzzy Logic would observe the scores of the four different methods, if those four criteria in the fuzzy were in high parts, then the participants graduated the tests. This means Fuzzy Logic more equitable to present decision and determine the ranks. In this paper was successful comparing Scoring and Fuzzy Logic method.

Keywords: *Teacher Certification, Scoring, Fuzzy Logic.*

1. Introduction

Education plays very important role for the citizens to improve human resources. A teacher education is one of important role in improving the quality of learning process to achieve the quality of education. A teacher as a professional staff requires an educator certificate through systematic process called Teacher Certification. A teacher certification is required in order to improve the professionalism of teachers in Indonesia.

Scoring is the grant of points for each fulfilled requirements [1]. Scoring system method will establish accurate data that is presented in the standarization eligibility score in the quantitative form. This eligibility is used as a requirement to take decision. Lotfi Zadeh, the father of fuzzy logic decided to extend two-valued logic, defined by the binary pair {0, 1}, to the whole continuous interval [0, 1], thereby introducing a gradual transition from falsehood to truth [2]. Several approaches on fuzzy logic based edge detection have been reported based on fuzzy If-Then rules [3], [4]. The Mamdani rule base takes crisp inputs and produces crisp outputs. Mamdani rule base to model crisp system can be easily described by humans in terms of fuzzy variables.

Scoring system and fuzzy logic has been done in many studies. Many studies related to scoring method for example a study for the client server-based micro-finance in the case study on finance company Bandar Lampung using the scoring system [1]. Many studies in decision support system related using fuzzy logic method Mamdani, for example Adaptation of Mamdani Fuzzy Inference System Using Neuro-Genetic Approach for Tactical Air Combat Decision Support System. This system presents a hybrid neuro-genetic learning approach for the adaptation a Mamdani fuzzy inference system for the Tactical Air Combat Decision Support System (TACDSS), the results shows the difference of the learning techniques and are also provided [5]. Decision model using fuzzy inference system to identify the likelihoods of purchasing health insurance based on the selected risk factors, the input and output data were governed by the Mamdani inference rules of the system to decide the best linguistic term [6].

Both Scoring and Fuzzy Logic Method can be used to evaluate, establish the graduation and the rankings of each participants. The number of participants to become certified teacher also requires time to do the assessment thus slowing down the distribution of the assessments result. This paper will explain the comparison of 2 methods Scoring System and Fuzzy Logic to determine the graduation and the ranking of the teacher certification participants.

2. Methodology

The overview diagram of this research is shown in Fig. 1.

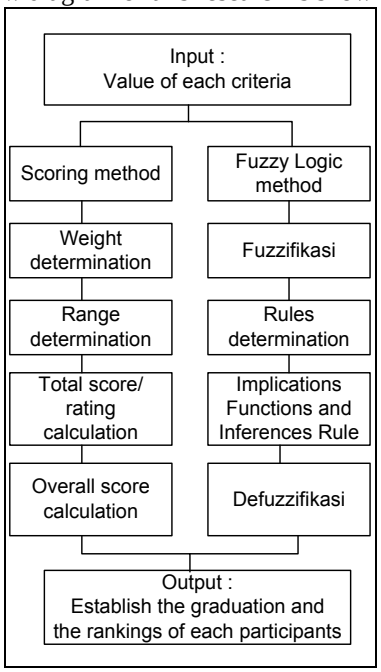


Fig. 1 General Overview System

2.1 Criteria

Five criteria were used as the input of the system in the following terms: written test assessment, practice test learning, workshop's yielding assessment, participation in learning theory and practice assessment, and Colleague friend assessment. Those data are based on the criteria in the guidelines book 4 the implementation of PLPG Teachers Certification from the directorate general of higher education ministries of national education [7]. Each criteria rated by the assessor and colleague. The Assessor will evaluate the written test assessment, practice test assessment, workshop's yielding assessment, participation in learning theory and practice assessment; while the colleague will do the colleague friend assessment.

2.2 Scoring Method

Scoring is a number of points assigned for each fulfilled requirements. The teacher certification assessment using Scoring Method is determined by using a 1 - 5 scale for each requirement fulfilled [1]. The following table describes scoring and weights for each criteria:

Table 1: Weight Scoring System

Criteria	*Weight*	*Question*	*Scoring*
Written test assessment	25%	80 to 100 65 to 80 55 to 65 40 to 55 < 40	5 4 3 2 1
Practice test assessment	30%	80 to 100 65 to 80 55 to 65 40 to 55 < 40	5 4 3 2 1
Workshop's yielding assessment	25%	80 to 100 65 to 80 55 to 65 40 to 55 < 40	5 4 3 2 1
Participation in learning theory and practice assessment	10%	80 to 100 65 to 80 55 to 65 40 to 55 < 40	5 4 3 2 1
A colleague friend assessment	10%	80 to 100 65 to 80 55 to 65 40 to 55 < 40	5 4 3 2 1

In the Scoring Method each criteria has points that will be classified based on scoring (Table 1). The scoring result in each of criteria is used to acquire the total scores, by multiplying rates of assessment and scores for each criteria of. The formula to calculating the total score/rating as follows:

$$total\ score = \frac{weig\ ht\ rating}{100} \times scoring \quad (1)$$

After each criteria has a total score, it will be sum up to establish overall total score that is used to determine whether the participants of teacher certification graduated or not graduated the assessment. Overall total score is said graduated when generating value 3.5 to 5.0, if the result is less than the value of 3.5 will result in a conclusion that the participants did not graduated teacher certification. The formula to calculating the overall total score as follows:

$$overall\ total\ score = \sum_1^n total\ score \quad (2)$$

The example of calculation with scoring method as follows

Table 2: Example calculating with scoring method

Criteria	*Value*	*Score*	*Total value/rating*
Written test assessment	100	5	1,25
Practice test assessment	100	5	1,5
Workshop's yielding assessment	100	5	1,25
Participation in learning theory and practice assessment	100	5	0,5
A colleague friend assessment	100	5	0,5
Overall Total Score			5

Table 3: Table inference scoring method

√	Graduated	≥ 3,5 – 5,0
	Not Graduated	0,0 – 3,5

2.3 Fuzzy Logic Method

Fuzzy logic represents a powerful approach to decision making [8], [9], [10]. In fuzzy logic method each criteria is divided into three parts, low, medium and high. Each of them using triangular and shoulder membership functions as an approach to produce a value in the method. On this paper the fuzzy's model which is utilized is fuzzy Mamdani's method. Mamdani's method frequent also recognized by the name of method Max Min. To get output necessary 4 steps which is establishment of fuzzy set (fuzzification), rules's determination, implications functions application and inferences rule and the implication of assertion (deffuzification) [11].

Step 1 Fuzzification

In the assessment of teacher certification in PLPG form The Fuzzy Logic has 5 (five) input variables and an output variable. The following describes each of the input and output variables fuzzy logic method.

1. Written test assessment
   Written test assessment variable is divided into three parts: low, medium, and high.

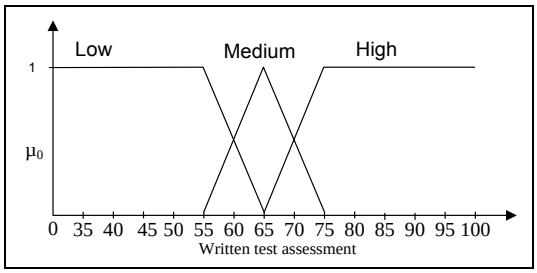


Fig. 2 Variable membership function graph on the written test assessment

Based on the picture shows the degree of membership on a scale that ranges from 0 to 55. The fuzzy area in the Fuzzy part applies within the ranges 55 to 65. Score ranges from 55 to 74 is an average score for the participants. The fuzzy area in the fuzzy high part applies on a scale that ranges from 65 to 100. The formula of variable membership function on the written test assessment as follows :

$$\mu_r(a) = \begin{cases} 1; & a \leq 55 \\ \frac{65-a}{10}; & 55 \leq a \leq 65 \\ 0; & a \geq 65 \end{cases} \quad (3)$$

$$\mu_s(a) = \begin{cases} 0; & a \leq 55 \text{ or } a \geq 80 \\ \frac{a-55}{10}; & 55 \leq a \leq 65 \\ \frac{75-a}{10}; & 65 \leq a \leq 75 \end{cases} \quad (4)$$

$$\mu_t(a) = \begin{cases} 0; & a \leq 65 \\ \frac{a-65}{10}; & 65 \leq a \leq 75 \\ 1; & 75 \leq a \leq 100 \end{cases} \quad (5)$$

2. Practice test assessment
   Practice test assessment is divided into three parts: low, medium, and high.

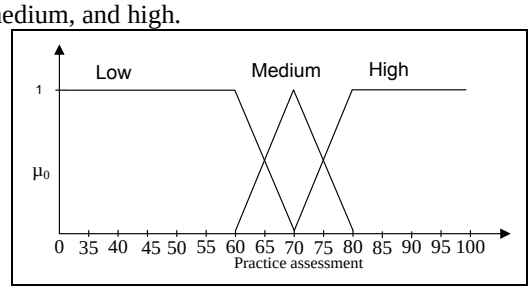


Fig. 3 Variable membership function graph on the learning practice assessment

The formula of variable membership function on the practice test assessment as follows :

$$\mu_r(b) = \begin{cases} 1; & b \leq 60 \\ \frac{70-b}{10}; & 60 \leq b \leq 70 \\ 0; & b \geq 70 \end{cases} \quad (6)$$

$$\mu_s(b) = \begin{cases} 0; & b \le 60 \text{ or } b \ge 80 \\ \frac{b-60}{10}; & 60 \le b \le 70 \\ \frac{80-b}{10}; & 70 \le b \le 80 \end{cases} \quad (7)$$

$$\mu_t(b) = \begin{cases} 0; & b \le 70 \\ \frac{b-70}{10}; & 70 \le b \le 80 \\ 1; & 80 \le b \le 100 \end{cases} \quad (8)$$

3. Workshop's yielding assessment
Workshop's yielding assessment is divided into three part, which are: low, medium, high.

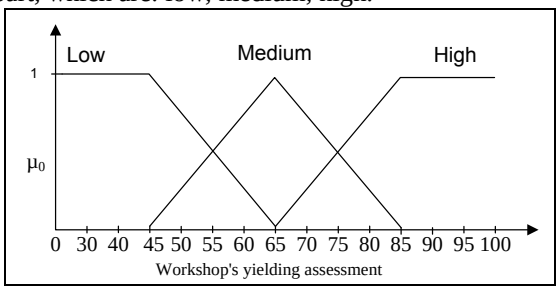


Fig. 4 Variable membership function graph on the workshop yielding assessment

The formula of variable membership function on the workshop yielding assessment as follows :

$$\mu_r(c) = \begin{cases} 1; & c \le 45 \\ \frac{65-c}{20}; & 45 \le c \le 65 \\ 0; & c \ge 65 \end{cases} \quad (9)$$

$$\mu_s(c) = \begin{cases} 0; & c \le 45 \text{ or } c \ge 85 \\ \frac{c-45}{20}; & 45 \le c \le 65 \\ \frac{85-c}{20}; & 65 \le c \le 85 \end{cases} \quad (10)$$

$$\mu_t(c) = \begin{cases} 0; & c \le 65 \\ \frac{c-65}{20}; & 65 \le c \le 85 \\ 1; & 85 \le c \le 100 \end{cases} \quad (11)$$

4. Participation in learning theory and practice assessment
Participation in learning theory and practice assessment is divided into three part, which are: low, medium, high.

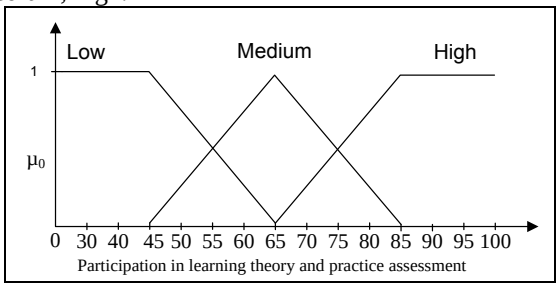


Fig. 5 Variable membership function graph on the participation in learning theory and practice assessment

The formula of variable membership function on the participation in learning theory and practice assessment as follows :

$$\mu_r(d) = \begin{cases} 1; & d \le 45 \\ \frac{65-d}{20}; & 45 \le d \le 65 \\ 0; & d \ge 65 \end{cases} \quad (12)$$

$$\mu_s(d) = \begin{cases} 0; & d \le 45 \text{ atau } d \ge 85 \\ \frac{d-45}{20}; & 45 \le d \le 65 \\ \frac{85-d}{20}; & 65 \le d \le 85 \end{cases} \quad (13)$$

$$\mu_t(d) = \begin{cases} 0; & d \le 65 \\ \frac{d-65}{20}; & 65 \le d \le 85 \\ 1; & 85 \le d \le 100 \end{cases} \quad (14)$$

5. A colleague friend assessment
A colleague friend assessment is divided into three part, which are: low, medium, high.

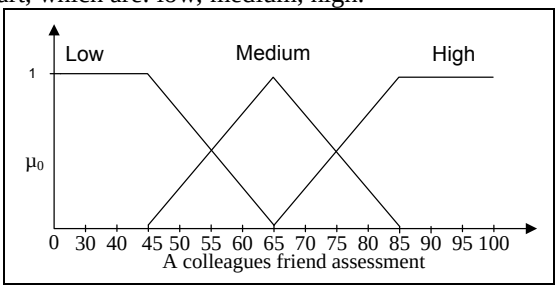


Fig. 6 Variable membership function graph on a colleague friend assessment

The formula of variable membership function on a colleague friend assessment as follows :

$$\mu_r(e) = \begin{cases} 1; & e \le 45 \\ \frac{65-e}{20}; & 45 \le e \le 65 \\ 0; & e \ge 65 \end{cases} \quad (15)$$

$$\mu_s(e) = \begin{cases} 0; & e \le 45 \text{ atau } e \ge 85 \\ \frac{e-45}{20}; & 45 \le e \le 65 \\ \frac{85-e}{20}; & 65 \le e \le 85 \end{cases} \quad (16)$$

$$\mu_t(e) = \begin{cases} 0; & e \le 65 \\ \frac{e-65}{20}; & 65 \le e \le 85 \\ 1; & 85 \le e \le 100 \end{cases} \quad (17)$$

6. The result of assessment
The result of assessment is divided into two: graduated and not graduated.

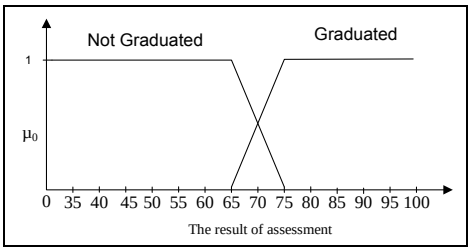


Fig. 7 Variable membership function graph The result of assessment

The formula of the result of assessment as follows

$$\mu_{not\ graduated} = \begin{cases} 1; & f \leq 65 \\ \frac{75-f}{15}; & 65 \leq f \leq 75 \\ 0; & f \geq 75 \end{cases} \quad (18)$$

$$\mu_{graduate} = \begin{cases} 0; & f \leq 65 \\ \frac{f-65}{15}; & 65 \leq f \leq 75 \\ 1; & f \geq 75 \end{cases} \quad (19)$$

Step 2 Rules Determination

Rules is qualitative statements applies into if then forms, thus clearly understandable. Rules DSS Teacher Certification in PLPG Form consists of 243 rules. The following are few Rules DSS Teacher Certification in PLPG Form.

(Rule 1) IF written test assessment = low AND learning test assessment = low AND workshop's yielding assessment = low AND participation in learning theory and practice assessment = low AND a colleague friend assessment = low THEN the result of assessment = not graduated

(Rule 6) IF written test assessment = low AND practice test assessment = low AND workshop's yielding assessment = low AND Participation in learning theory and practice assessment = medium AND a colleague friend assessment = high THEN the result of assessment = not graduated

(Rule 162) IF written test assessment = high AND practice test assessment = high AND workshop's yielding assessment = medium AND participation in learning theory and practice assessment = high AND a colleague friend assessment = high THEN the result of assessment = graduated

(Rule 243) IF written test assessment = high AND practice test assessment = high AND workshop's yielding assessment = high AND participation in learning theory and practice assessment = high AND a Colleague friend assessment = high THEN the result of assessment = graduated

Step 3 Implications Functions and Inferences Rule

Implications Functions

In Mamdani method, Minimum method applies as implications function. It combines each of degree of memberships from each if then rules that has been made into validity scale. The example of minimum method application in rule 99 as follows.

IF written test assessment = medium AND learning test assessment = low AND workshop's yielding assessment = medium AND participation in learning theory and practice assessment = high AND a colleague friend assessment = high THEN the result of assessment = not graduated.

$$\begin{aligned} a_{99} &= \mu_s(a) \cap \mu_r(b) \cap \mu_s(c) \cap \mu_t(d) \cap \mu_t(e) \\ &= \min\ (\mu_s(83) \cap \mu_r(67) \cap \mu_s(74) \cap \mu_t(89) \\ &\qquad \cap \mu_t(90)) \\ &= \min\ (0{,}15 \cap 0{,}6 \cap 0{,}8 \cap 1 \cap 1) \\ &= 0{,}15 \end{aligned}$$

The Inference Rules

Maximum method applies in the inferences rules is, as written.

$$\mu sf[Xi] = \text{Max}(\mu sf[Xi], \mu kf[Xi]) \quad (20)$$

$with:$

$\mu sf[Xi]$ = membership value of fuzzy solution to rules i

$\mu kf[Xi]$ = membership value of fuzzy consequent rules to i

The example of the inferences rules :

The result of assessment

Not Graduated $= Max\ (a_{99}) = 0{,}1$

Graduated $= Max\ (a_{126}, a_{108}, a_{135})$

$= Max\ (0{,}1, 0{,}6\ 0{,}2)$

$= 0{,}6$

Step 4 Deffuzification

In Mamdani method, deffuzification method can be chosen from another deffuzification methods. Centroid method applies in this paper. Crisp solution is earned by extracting center point (d^*) output fuzzy area. The formula of score (d^*) in general as follows:

$$d^* = \frac{\int_x x\mu(x)dx}{D} \quad (21)$$

x : Output score

d^* : Centre point output fuzzy area

$\mu(x)$: Membership function of fuzzy output area

D : Range of fuzzy output area

The example of deffuzification

$$d^* = \frac{\left(\int_{65}^{75}\left(\frac{x-65}{10}\right)x\,dx\right)+\left(\int_{65}^{71}\left(\frac{x-65}{10}\right)x\,dx\right)+\left(\int_{71}^{100}(0{,}6)x\,dx\right)}{L1+L2+L3}$$
$$= \frac{211{,}25+124{,}2+1487{,}7}{6{,}5+2{,}1+17{,}4}$$
$$= \frac{1823{,}15}{26}$$
$$= 70{,}12$$

3. Experiments and Results

In this experiments, Fig. 8 dan 9 is system view on the calculation scoring and Fuzzy Logic Method to achieve participants rankings as showed in Fig. 10 and 11. Here is attached to the system view on the calculation scoring and fuzzy logic method.

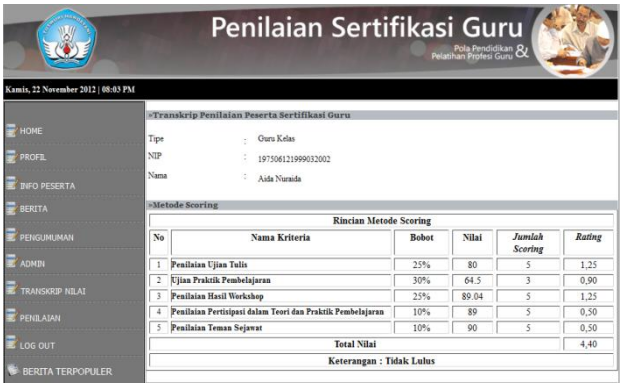
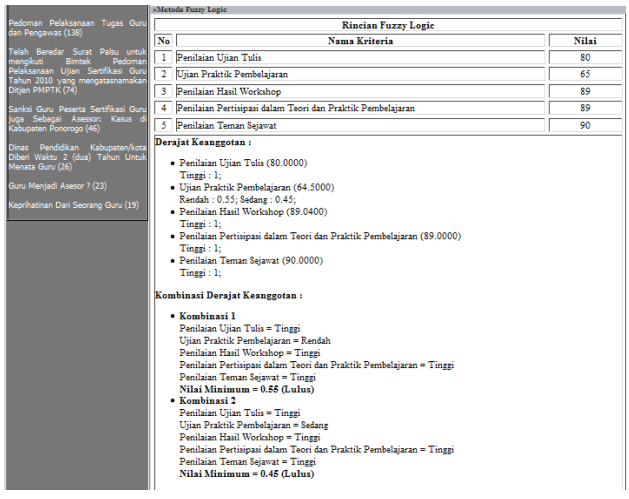


Fig. 8 System view on the calculation scoring method



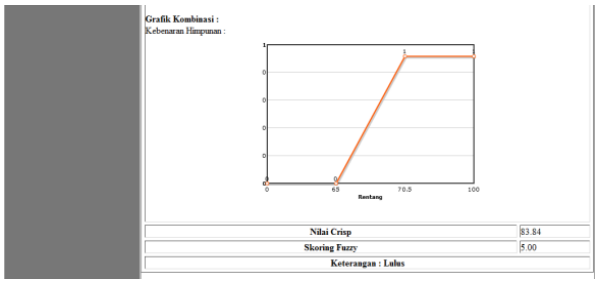


Fig. 9 System view on the calculation fuzzy logic method

The result of the scoring system ranking showed in the figure as follows.

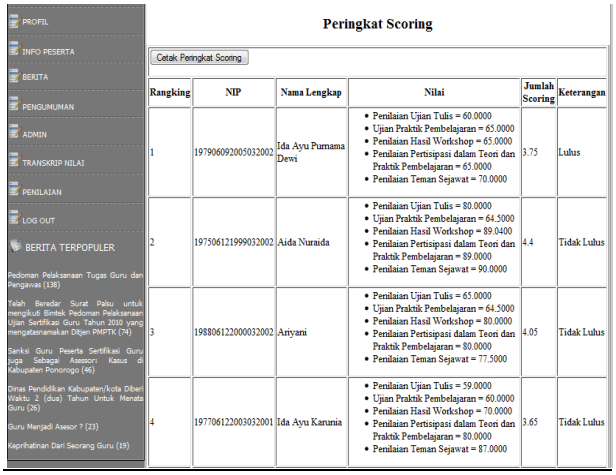


Fig. 10 Scoring system ranking

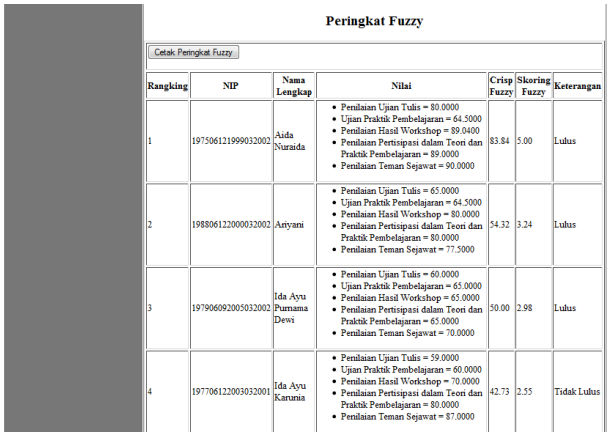


Fig. 11 Fuzzy logic ranking

Based on the Fig. 10 and 11 above, there was difference result showed by using Scoring and Fuzzy Logic Method if the participants score was in the assessment of written test and practice category within the not graduated scale. The rank differences of those methods is shown at ranking

number 2 (Fig.10) and number 1 (Fig. 11). Ranking number 1 in Fuzzy shown rank reduction in Scoring into ranking number 2. Scoring ranking stated the participant was not graduated, while Fuzzy ranking indicated she was graduated.

The graduation requirements in Scoring emphasizes minimum graduation requirements to each method. One of the requirement in Scoring method is the participants ranking in the written test assessment variable is bigger or equal to score 60, and practice test assessment is bigger or equal to score 65. The graduation requirements in Fuzzy based on rules that contains rules of the assessor desire. Fuzzy method graduation requirements used 5 input variables within each variable consists three Fuzzy set, therefore were drawn 243 rules to determine participants graduation.

The calculation of the participant name Aida using Scoring (Fig. 8) and Fuzzy method (Fig. 9) shown its differences as result. Her total score of practice test assessment was 4,00 which was out of Scoring graduation range, therefore she was not graduated. Scoring method provided score 3 in practice test assessment criterion. Scoring method does not observe the other scores criteria in the high range. It is different with Fuzzy method with its two rules combination stated she was graduated.

1. IF written test assessment = high, AND practice test assessment = low AND workshop's yielding assessment = high AND participation in learning theory and practice assessment = high AND a colleague friend assessment = high THEN the result = graduated.
2. IF written test assessment = high, AND practice test assessment = medium AND workshop's yielding assessment = high AND participation in learning theory and practice assessment = high AND a colleague friend assessment = high THEN the result = graduated.

Based on that rules, it is concluded that she was graduated in teacher certification assessment. Fuzzy proves an equitable result because observe another four criteria. Based on the comparison above, it can be concluded that Fuzzy logic is more equitable to determine participants ranking than Scoring System method. Fuzzy Logic method observes overall used variables combined with Fuzzy rule in performing rankings and assessment result. If the rules combination score which stated graduated is bigger than the rules combination score which stated failed in the inference rules, thus it will show assessment result stated graduated. Based on this data, the writer concluded that Fuzzy logic is more equitable to determine the participants ranking than Scoring.

4. Conclusions

There is comparative relevant in Scoring and Fuzzy logic method in this paper. Fuzzy logic method is better than Scoring System because it is more flexible and equitable in showing the result and determining participants ranking. All fuzzy logic result showed flexibility, available to set in assessment criteria and the evaluation from the assessor also used in the fuzzy calculation. Fuzzy logic is simple and easy to implement because “fuzzy” has similar language with human being. Based on this data, the writer concluded fuzzy logic is new way in completing cases of Fuzzy.

Acknowledgments

Our thank goes to Department of Information Technology Udayana University, Bali, who has helped organize this research's Indonesia.

References

[1] Ernain, et al, “Sistem Pendukung Keputusan Pembiayaan Mikro berbasis Client Server Studi Kasus Pada Perusahaan Pembiayaan Bandar Lampung”, Seminar Nasional Aplikasi Teknologi Informasi (SNATI), 2011, ISSN. 1907 – 5022.
[2] J. Jantzen, "Tutorial on Fuzzy Logic", Technical University of Denmark, Department of Automation, Technical report number 98-E 868, 19 Aug 1998.
[3] C. W. Tao, et al, “A Fuzzy if-then approach to edge detection”, Proc. of 2nd IEEE intl.conf. on fuzzy systems, 1993, pp. 1356–1361.
[4] Li. W, “Recognizing white line markings for vision-guided vehicle navigation by fuzzy reasoning”, Pattern Recognition Letters, 18: 771–780.
[5] Fakhry. Hussein, “A Fuzzy Logic Based Decision Support System for Business Situation Assessment and e-Business Models Selection”, Journal of Communications of the IIMA, Vol. 10, Issue 4, 2010.
[6] Lazim. Abdullah, and Mohd. Nordin. Rarhman, “Employee Likehood of Purchasing Health Insurance using Fuzzy Inference System”, IJCSI International Journal of Computer Science Issues, Vol. 9, Issue 1, No 2, January 2012
[7] Tim Penyusun. Buku 4 Rambu-Rambu Pelaksanaan Pendidikan dan Pelatihan Profesi Guru (PLPG), Jakarta : Kementrian Pendidikan Nasional. 2011.
[8] L. A. Zadeh, “Fuzzy sets, Information and Control”, 8: 1965, pp. 338-353.
[9] A. Kaufmann, Introduction to the Theory of Fuzzy Subsets– Fundamentals Theoretical Elements, New York:Academic Press, Vol. 1 , 1975.
[10] L.C. Bezdek, Pattern Recognition with fuzzy Objective Function Algorithm, New York:Plenum Press, 1981.
[11] S. Kusumadewi, Analisis & Desain Sistem Fuzzy Menggunakan Tool Box MathLab. Yogyakarta:Graha Ilmu, 2002.

Ida Ayu Purnama Dewi studied Information Technology in Departement of Information Technology Udayana University since August 2008, and now woking her research for S.Ti. degree in Information Technology.

A.A. Kompiang Oka Sudana, S.Kom, MT received his S.Kom degree in Informatics Engineering from Institut Teknologi Sepuluh Nopember University in 1997, and his MT. degree in Informatics and Computer System from Gajah Mada University in 2001. He was Technical Manager at PT. INFOS Teknologi Indonesia (Software Developer) during April 2008-Sept. 2008, Information Technology Leader-Human Resources and General Affair Division at PT JAS Catering Internasional Airport Ngurah Rai Bali during April 2003-July 2006, Person in Charge of Technological and Professional Skills Development Sector Project (TPSDP)-Asian Development Bank (ADB) Loan, Batch II in Electrical Engineering Study Program during 2002-2006, and now he is lecturer at Managisterial Program of Electrical Engineering Departement of Udayana University, lecturer at Electrical Engineering Department (major in Computer System and Informatics) of Udayana University, lecturer at Information Technology Department of Udayana University, and member of Development Project Team of Academic Management Information System and Networking Implementation of Udayana University. His research experiences are in Analysis and Design of Information System Biometric Identification and Recognition.

Dr. I Ketut Gede Darma Putra, S.Kom. MT received his S.Kom degree in Informatics Engineering from Institut Teknologi Sepuluh Nopember University, his MT. degree in Informatics and Computer System from Gajah Mada University in 2000 and his Dr. degree in Informatics and Computer System from Gajah Mada University. He is lecturer at Electrical Engineering Department (major in Computer System and Informatics) and at Information Technology Department of Udayana University.