

Decision support system on quality assessment of the prospective civil servant's education and training using fuzzy method

Aris Susanto¹, Omar Wahid², Hazriani³, Yuyun⁴

^{1,2}Department of Information System, STMIK Bina Bangsa, Kendari, Indonesia

^{1,2,3,4}Department of Computer System, STMIK Handayani, Makassar, Indonesia

Article Info

Article history:

Received Dec 30, 2020

Revised Aug 9, 2021

Accepted Aug 19, 2021

Keywords:

DSS

Evaluation

Fuzzy

Training

ABSTRACT

This study aims to develop a decision support system using the fuzzy method in order to assess the quality of education and training of prospective civil servants and highlight possible improvement considerations. The assessment consists of six criterias, namely coaches, lecturers, preachers, mentors, examiners, and administrators. Based on the evaluation result of the quality level of each criterion, it is obtained that the top two criterion are examiners and preachers, followed by coaches, lecturers, advisors, and the lowest is organizer. In addition, the quality of the civil servant class III training is better than the class II civil servant training. It also shows that the value of the organizers criterion has different level of satisfactions. Overall, the quality of the training (according to the participants' opinion) was very good with a score of 92.50 for training class II and 95.20 for training class III. Furthermore, it is necessary to conduct research to determine the quality of the training each year by looking at the achievements of the participants. The system testing obtained an accuracy of 100%, which implies that the system can be used to assess the quality of education and training appropriately.

This is an open access article under the [CC BY-SA](#) license.



Corresponding Author:

Aris Susanto

Department of Information System

School of Management Informatics and Computer Bina Bangsa Kendari

Kendari, Southeast Sulawesi, Indonesia

Email: arissusantoh@gmail.com

1. INTRODUCTION

Information technology has been widely applied in various fields in order to improve work productivity or performance within the organization including in the field of education and training. One of the government agency that provide education and training is the human resources development agency of Southeast Sulawesi Province. The implementation of the education and training at this institution is a program based on the government regulation number 17 of 2020 concerning the management of civil servants [1], as well as under the guidance of the State Administration Institution which determines the completeness of the training facilities and infrastructure through State Administration Institute regulations. State Administration Institute regulation number 12 of 2018 article 17 states that evaluation of basic civil servants training consists of evaluating participants, training personnel, as well as administration [2].

Concerning that the education and training for the prospective civil servant is a mandatory program, evaluation must be conducted continuously in order to maintain its quality. The evaluation determines and assess quality level of each evaluation aspect. The evaluation results then will be conveyed to the leaders of the participant's agencies as well as the head of human resources development agency to be used as a

reference in improving the quality of the civil servants basic training program. Currently, the training committee conducting the evaluation process by distributing paper-based questionnaire to the participants, which are then processed using the Microsoft Excel application to find out the results of the evaluation. However, the data processing method only presents average value of each assessment criterion. In addition, the processing time also takes a long time due to the large amount of data. considering that human resources development agency organizes training every year with thousand registered participants each year and (consists of 39 to 40 people per batch per type of training), data continuously grows every year. Therefore, a specific evaluation approach is needed to ease the evaluation process as well as to perform more comprehensive data analyzes, and to obtain more complete information.

Previous researches on training evaluation has been conducted by developing questionnaire [3], investigating participant perspective [4], on several aspects, namely: reaction, learning, and potential behavior change [5], training effectiveness [6], and training facilities [7]. This research introduces a new evaluation approach that is a decision support system to facilitate logical, rational and structured assessments by implemented fuzzy method, which can accelerate performance and accuracy of the evaluation. The process is carried out by forming a set on each criterion consisting of: not-satisfactory, less-satisfactory, quite satisfying, satisfying and very satisfying. Based on the formed sets, inference is carried out by matching the value of the set against the fuzzy rules. The rules (to obtain a decision which states that the quality of the training) are not good, moderate, good, or very good.

A lot of studies implementing the fuzzy method for evaluation have been conducted so far, namely fuzzy metode for evaluating the performance of cloud services in an uncertain environment [8], evaluation of computing systems [9], evaluation and supplier selection [10], [11], evaluation workers [12], evaluation of the performance of small and medium enterprises [13], city service performance evaluation [14], employee performance evaluation [15], [16], evaluation of student performance [17]-[20], online learning evaluation [21], and a course recommendation system [22]. It can be concluded that those study only used maximum two assessment aspects/assessment indicators. While this research employs six assessment parameters of the training quality evaluation, including coach, lecturer, preacher, mentor, examiner and organizer. Furthermore, the fuzzy method is used in this study since it indicates a good performance in most of the previous studies. Moreover, this study has significant similarity with those studies as well.

2. RESEARCH METHOD

2.1. Method

This research was conducted using a decision support system approach with the Fuzzy method. A decision support system is an interactive computer-based system that is used to assist users in the right decision-making process [23], where a computer-based system supports processing data into information for explicit decision-making from semi-structured problems [24], meanwhile, fuzzy is a logic that can describe the input space into output and has a sustainable value. Fuzzy logic is expressed by the degree of authenticity and membership. Therefore all of them are false or true at the same time with a truth value ranging from 0 to 1 [25]. There are several things that are done in processing data using fuzzy, namely determining the variables and the value of each variable. Next, form a set based on variable values by doing fuzzification in order to know the membership value of each criteria. The formation of fuzzy sets in input and output variables is divided into one or more fuzzy sets. To obtain membership value is done through a functional approach. The membership function used is a triangle curve representation shown in Figure 1.

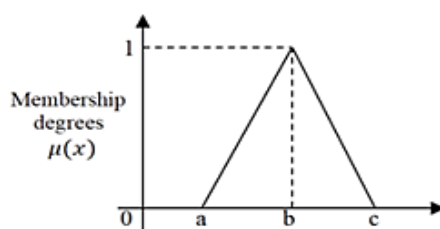


Figure 1. Triangle curve representation

The following is the formula used to represent the membership function of the triangle curve. Description of the formula to represent the triangular curve membership function, namely $\mu[x]$ (degree of membership of x), x (variable universe of speech), a (linguistic value I), b (linguistic value II), and c (linguistic value III).

$$\mu[x] = \begin{cases} 0; & x \leq a \text{ or } x \geq c \\ \frac{x-a}{b-a}; & a \leq x \leq b \\ \frac{c-x}{c-b}; & b \leq x \leq c \end{cases} \tag{1}$$

Based on the set value formed, inference is carried out to obtain rules that match the fuzzy set value. The inference engine has inference rules to evaluate linguistic values and map them to fuzzy sets which require a defuzzification process to convert them into crisp values [26]. One of the FIS methods used for decision making is the Tsukamoto method. The Tsukamoto method is an extension of menoton reasoning where every consequence of the IF-then rule must be presented with a fuzzy set with a membership function that counts. As a result, the inference output of each rule is crisp based on a-predicate (firestrenght). The final results are obtained using weighted averages. To determine the crisp solution, a defuzzification formula called the centered average method is used. The fuzzy inference system diagram is shown in Figure 2. As for making conclusions about the evaluation of the quality of the implementation of education and training in this study, the ordinal measurement scale published by the State Administration Institute in the socialization module of the performance accountability system of government agencies is used [27].

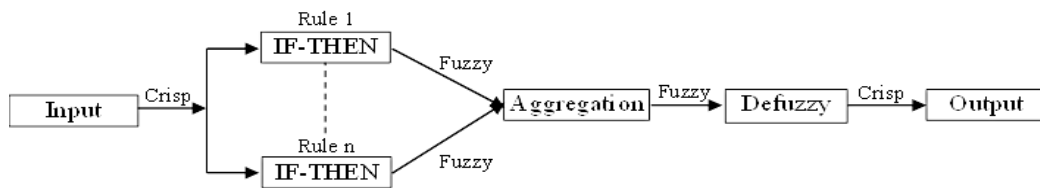


Figure 2. Fuzzy inference system diagram

2.2. Dataset

The data processed in this study are obtained from questionnaires filled by the training participants through the education and training information system application. The participants divided into two classes civil servant class II and civil servant class III, where each class consists of four (4) batches. Total participants for class II are 158 persons, while for class III are 155 persons. Those participants gave feedback on six criteria, namely; coach, lecture, preacher, mentor, examiner, and organizer. Each criterion has more specific sub-criterias as provided in the questionnaire. Number of participant’s feedbacks for each criterion in each batch are recapitulate in Table 1, which were processed as data training in this research.

Table 1. Feedback recapitulation of civil servants class ii and class III training

No.	Criteria	Class II				Total	Class III				Total
		Force					Force				
		VIII	IX	X	XI		LXI	LXII	LXIII	LXIV	
1	Coach	39	40	39	40	158	38	39	39	39	155
2	Lecturer	809	730	761	719	3019	720	711	697	675	2803
3	Preacher	114	117	122	114	467	105	110	114	103	432
4	Mentor	40	40	40	40	160	38	38	38	39	153
5	Examiner	50	51	47	52	200	46	41	44	46	177
6	Organizer	38	39	40	41	158	36	39	37	37	149

Number of respondents for the lecturer, preacher, and examiner criteria have more data than criteria coach, mentor, and organizer criteria since there are more lecturers, preachers, and examiners in charge in each batch. The topics taught by lecturer are: 1) group dynamics, 2) national insights, 3) analysis of contemporary issues, 4) accountability, 5) nationalism, 6) public ethics, 7) quality commitment, 8) anti-corruption, 9) ASN management, 10) whole of government (WOG), 11) public services, 12) state defense, 13) actualization concept, 14) explanation of actualization. While topics delivered by preachers, namely: 1) human resources development policy for apparatus and ASN values, 2) technical substantive content of Institution I, 3) substantive technical contents of Institution II. Meanwhile, examiners are assessed based on the test results on the actualization design exam and the actualization results. Furthermore, based on the results of the participant's assessment, evaluation data were obtained. Table 2 shows an example on participant's assessment result for coach criteria.

Based on the variables and domains of the predetermined fuzzy set, the next step is to calculate the value of the degree of membership based on the membership function of the coach, lecturer, preacher,

mentor, examiner, and organizer variables as a percentage of the average value of the training participants' questionnaires. To show the data processing in this study, civil servant class II training data were used where the average score of the coach's assessment was 92, the lecturer was 92, the preacher was 93, the mentor was 92, the examiner was 93, and the organizer was 85.

Table 2. Coach criteria evaluation data

Respondents	X1	X2	X3	X4	X5	X6
1	97	95	95	97	98	95
2	98	97	98	99	98	98
-	-	-	-	-	-	-
313	92	93	93	93	92	92

2.3. Fuzzification

The set of input variables consists of not satisfactory (0 50 60), unsatisfactory (50 60 70), quite satisfactory (60 70 80), satisfactory (70 80 90), very satisfactory (80 90 100). While the set of output variables consists of poor (0 54), medium (55 69), good (70 84), and very good (85 100). To determine the association group, refer to the government agency performance accountability system [27]. The formulated that are used in performing fuzzy calculations are, the criteria for the membership function of the coach are formulated,

$$\begin{aligned} \mu[x_1] &= \text{Not satisfactory} \\ \mu(92) &= \begin{cases} 1; & x_1 \leq 50 \\ \frac{60-x_1}{60-50}; & 50 \leq x_1 \leq 60 \\ 0; & x_1 \geq 60 \end{cases} \\ &= 0 \end{aligned} \tag{2}$$

$$\begin{aligned} \mu[x_1] &= \text{Unsatisfactory} \\ \mu(92) &= \begin{cases} \frac{(x_1-50)}{60-50}; & 50 \leq x_1 \leq 60 \\ \frac{70-x_1}{70-60}; & 60 \leq x_1 \leq 70 \\ 0; & x_1 \geq 70 \end{cases} \\ &= 0 \end{aligned} \tag{3}$$

$$\begin{aligned} \mu[x_1] &= \text{Quite satisfactory} \\ \mu(92) &= \begin{cases} \frac{(x_1-60)}{70-60}; & 60 \leq x_1 \leq 70 \\ \frac{80-x_1}{80-70}; & 70 \leq x_1 \leq 80 \\ 0; & x_1 \geq 80 \end{cases} \\ &= 0 \end{aligned} \tag{4}$$

$$\begin{aligned} \mu[x_1] &= \text{Satisfactory} \\ \mu(92) &= \begin{cases} \frac{(x_1-70)}{80-70}; & 70 \leq x_1 \leq 80 \\ \frac{90-x_1}{90-80}; & 80 \leq x_1 \leq 90 \\ 0; & x_1 \geq 90 \end{cases} \\ &= 0 \end{aligned} \tag{5}$$

$$\begin{aligned} \mu[x_1] &= \text{Very satisfactory} \\ \mu(92) &= \begin{cases} 0; & x_1 \leq 80 \\ \frac{x_1-80}{90-80}; & 80 \leq x_1 \leq 90 \\ 1; & x_1 \geq 90 \end{cases} \\ &= 1 \end{aligned} \tag{6}$$

the membership function of the lecturer's criterion is formulated,

$$\begin{aligned} \mu[x_2] &= \text{Not satisfactory} \\ \mu(92) &= \begin{cases} 1; & x_2 \leq 50 \\ \frac{60-x_2}{60-50}; & 50 \leq x_2 \leq 60 \\ 0; & x_2 \geq 60 \end{cases} \\ &= 0 \end{aligned} \tag{7}$$

$$\mu[x_2] = \text{Unsatisfactory}$$

$$\mu(92) = \begin{cases} \frac{(x_2-50)}{60-50}; & 50 \leq x_2 \leq 60 \\ \frac{70-x_2}{70-60}; & 60 \leq x_2 \leq 70 \\ 0; & x_2 \geq 70 \end{cases} \quad (8)$$

$$\begin{aligned} \mu[x_2] &= \text{Quite satisfactory} \\ \mu(92) &= \begin{cases} \frac{(x_2-60)}{70-60}; & 60 \leq x_2 \leq 70 \\ \frac{80-x_2}{80-70}; & 70 \leq x_2 \leq 80 \\ 0; & x_2 \geq 80 \end{cases} \end{aligned} \quad (9)$$

$$\begin{aligned} \mu[x_2] &= \text{Satisfactory} \\ \mu(92) &= \begin{cases} \frac{(x_2-70)}{80-70}; & 70 \leq x_2 \leq 80 \\ \frac{90-x_2}{90-80}; & 80 \leq x_2 \leq 90 \\ 0; & x_2 \geq 90 \end{cases} \end{aligned} \quad (10)$$

$$\begin{aligned} \mu[x_2] &= \text{Very satisfactory} \\ \mu(92) &= \begin{cases} 0; & x_2 \leq 80 \\ \frac{x_2-80}{90-80}; & 80 \leq x_2 \leq 90 \\ 1; & x_2 \geq 90 \end{cases} \end{aligned} \quad (11)$$

the membership function of the preacher's criterion is formulated,

$$\begin{aligned} \mu[x_3] &= \text{Not satisfactory} \\ \mu(93) &= \begin{cases} 1; & x_3 \leq 50 \\ \frac{60-x_3}{60-50}; & 50 \leq x_3 \leq 60 \\ 0; & x_3 \geq 60 \end{cases} \end{aligned} \quad (12)$$

$$\begin{aligned} \mu[x_3] &= \text{Unsatisfactory} \\ \mu(93) &= \begin{cases} \frac{(x_3-50)}{60-50}; & 50 \leq x_3 \leq 60 \\ \frac{70-x_3}{70-60}; & 60 \leq x_3 \leq 70 \\ 0; & x_3 \geq 70 \end{cases} \end{aligned} \quad (13)$$

$$\begin{aligned} \mu[x_3] &= \text{Quite satisfactory} \\ \mu(93) &= \begin{cases} \frac{(x_3-60)}{70-60}; & 60 \leq x_3 \leq 70 \\ \frac{80-x_3}{80-70}; & 70 \leq x_3 \leq 80 \\ 0; & x_3 \geq 80 \end{cases} \end{aligned} \quad (14)$$

$$\begin{aligned} \mu[x_3] &= \text{Satisfactory} \\ \mu(93) &= \begin{cases} \frac{(x_3-70)}{80-70}; & 70 \leq x_3 \leq 80 \\ \frac{90-x_3}{90-80}; & 80 \leq x_3 \leq 90 \\ 0; & x_3 \geq 90 \end{cases} \end{aligned} \quad (15)$$

$$\begin{aligned} \mu[x_3] &= \text{Very satisfactory} \\ \mu(93) &= \begin{cases} 0; & x_3 \leq 80 \\ \frac{x_3-80}{90-80}; & 80 \leq x_3 \leq 90 \\ 1; & x_3 \geq 90 \end{cases} \end{aligned} \quad (16)$$

the mentor's criterion membership function is formulated,

$$\begin{aligned} \mu[x_4] &= \text{Not satisfactory} \\ \mu(92) &= \begin{cases} 1; & x_4 \leq 50 \\ \frac{60-x_4}{60-50}; & 50 \leq x_4 \leq 60 \\ 0; & x_4 \geq 60 \end{cases} \\ &= 0 \end{aligned} \tag{17}$$

$$\begin{aligned} \mu[x_4] &= \text{Unsatisfactory} \\ \mu(92) &= \begin{cases} \frac{(x_4-50)}{60-50}; & 50 \leq x_4 \leq 60 \\ \frac{70-x_4}{70-60}; & 60 \leq x_4 \leq 70 \\ 0; & x_4 \geq 70 \end{cases} \\ &= 0 \end{aligned} \tag{18}$$

$$\begin{aligned} \mu[x_4] &= \text{Quite satisfactory} \\ \mu(92) &= \begin{cases} \frac{(x_4-60)}{70-60}; & 60 \leq x_4 \leq 70 \\ \frac{80-x_4}{80-70}; & 70 \leq x_4 \leq 80 \\ 0; & x_4 \geq 80 \end{cases} \\ &= 0 \end{aligned} \tag{19}$$

$$\begin{aligned} \mu[x_4] &= \text{Satisfactory} \\ \mu(92) &= \begin{cases} \frac{(x_4-70)}{80-70}; & 70 \leq x_4 \leq 80 \\ \frac{90-x_4}{90-80}; & 80 \leq x_4 \leq 90 \\ 0; & x_4 \geq 90 \end{cases} \\ &= 0 \end{aligned} \tag{20}$$

$$\begin{aligned} \mu[x_4] &= \text{Very satisfactory} \\ \mu(92) &= \begin{cases} 0; & x_4 \leq 80 \\ \frac{x_4-80}{90-80}; & 80 \leq x_4 \leq 90 \\ 1; & x_4 \geq 90 \end{cases} \\ &= 1 \end{aligned} \tag{21}$$

the membership function of the examiner's criterion is formulated,

$$\begin{aligned} \mu[x_5] &= \text{Not satisfactory} \\ \mu(93) &= \begin{cases} 1; & x_5 \leq 50 \\ \frac{60-x_5}{60-50}; & 50 \leq x_5 \leq 60 \\ 0; & x_5 \geq 60 \end{cases} \\ &= 0 \end{aligned} \tag{22}$$

$$\begin{aligned} \mu[x_5] &= \text{Unsatisfactory} \\ \mu(93) &= \begin{cases} \frac{(x_5-50)}{60-50}; & 50 \leq x_5 \leq 60 \\ \frac{70-x_5}{70-60}; & 60 \leq x_5 \leq 70 \\ 0; & x_5 \geq 70 \end{cases} \\ &= 0 \end{aligned} \tag{23}$$

$$\begin{aligned} \mu[x_5] &= \text{Quite satisfactory} \\ \mu(93) &= \begin{cases} \frac{(x_5-60)}{70-60}; & 60 \leq x_5 \leq 70 \\ \frac{80-x_5}{80-70}; & 70 \leq x_5 \leq 80 \\ 0; & x_5 \geq 80 \end{cases} \\ &= 0 \end{aligned} \tag{24}$$

$$\begin{aligned} \mu[x_5] &= \text{Satisfactory} \\ \mu(93) &= \begin{cases} \frac{(x_5-70)}{80-70}; & 70 \leq x_5 \leq 80 \\ \frac{90-x_5}{90-80}; & 80 \leq x_5 \leq 90 \\ 0; & x_5 \geq 90 \end{cases} \\ &= 0 \end{aligned} \tag{25}$$

$$\begin{aligned} \mu[x_5] &= \text{Very satisfactory} \\ \mu(93) &= \begin{cases} 0; & x_5 \leq 80 \\ \frac{x_5-80}{90-80}; & 80 \leq x_5 \leq 90 \\ 1; & x_5 \geq 90 \end{cases} \\ &= 1 \end{aligned} \quad (26)$$

the membership function of the organizer's criterion is formulated,

$$\begin{aligned} \mu[x_6] &= \text{Not satisfactory} \\ \mu(85) &= \begin{cases} 1; & x_6 \leq 50 \\ \frac{60-x_6}{60-50}; & 50 \leq x_6 \leq 60 \\ 0; & x_6 \geq 60 \end{cases} \\ &= 0 \end{aligned} \quad (27)$$

$$\begin{aligned} \mu[x_6] &= \text{Unsatisfactory} \\ \mu(85) &= \begin{cases} \frac{(x_6-50)}{60-50}; & 50 \leq x_6 \leq 60 \\ \frac{70-x_6}{70-60}; & 60 \leq x_6 \leq 70 \\ 0; & x_6 \geq 70 \end{cases} \\ &= 0 \end{aligned} \quad (28)$$

$$\begin{aligned} \mu[x_6] &= \text{Quite satisfactory} \\ \mu(85) &= \begin{cases} \frac{(x_6-60)}{70-60}; & 60 \leq x_6 \leq 70 \\ \frac{80-x_6}{80-70}; & 70 \leq x_6 \leq 80 \\ 0; & x_6 \geq 80 \end{cases} \\ &= 0 \end{aligned} \quad (29)$$

$$\begin{aligned} \mu[x_6] &= \text{Satisfactory} \\ \mu(85) &= \begin{cases} \frac{(x_6-70)}{80-70}; & 70 \leq x_6 \leq 80 \\ \frac{90-x_6}{90-80}; & 80 \leq x_6 \leq 90 \\ 0; & x_6 \geq 90 \end{cases} \\ &= 0.5 \end{aligned} \quad (30)$$

$$\begin{aligned} \mu[x_6] &= \text{Very satisfactory} \\ \mu(85) &= \begin{cases} 0; & x_6 \leq 80 \\ \frac{x_6-80}{90-80}; & 80 \leq x_6 \leq 90 \\ 1; & x_6 \geq 90 \end{cases} \\ &= 0.5 \end{aligned} \quad (31)$$

2.4. Inferences

The set value (μ) for each variable is entered in the predetermined fuzzy rule to find the z value. In this study, there are two fuzzy rules that match the set value of each variable from the existing thirteen thousand rules, namely,

[R13099] If (X1 very satisfactory) AND (X2 very satisfactory) AND (X3 very satisfactory) AND (X4 very satisfactory) AND (X5 very satisfactory) AND (X6 satisfactory) THEN (Y very good) (32)

[R13100] If (X1 very satisfactory) AND (X2 very satisfactory) AND (X3 very satisfactory) AND (X4 very satisfactory) AND (X5 very satisfactory) AND (X6 very satisfactory) THEN (Y very good) (33)

based on the rule according to the set value, then the value α - predicate of each rule is calculated with the Min implication function, α _ predicate1 = $\min [\mu x1(\text{Very Satisfactory}) \cap \mu x2(\text{Very Satisfactory}) \cap \mu x3(\text{Very Satisfactory}) \cap \mu x4(\text{Very Satisfactory}) \cap \mu x5(\text{Very Satisfactory}) \cap \mu x6(\text{Satisfactory})]$,
 $= \min(1, 1, 1, 1, 1, 0.5) = 0,5$ $z_i = 92.5$ (34)

α _ predicate2 = $\min [\mu x1(\text{Very Satisfactory}) \cap \mu x2(\text{Very Satisfactory}) \cap \mu x3(\text{Very Satisfactory}) \cap \mu x4(\text{Very Satisfactory}) \cap \mu x5(\text{Very Satisfactory}) \cap \mu x6(\text{Very Satisfactory})]$

$$= \min(1, 1, 1, 1, 1, 0.5) = 0,5 \quad z_i = 92.5 \quad (35)$$

2.5. Defuzzification

Furthermore, the process of converting the output from the inference system into a crisp form uses the membership function to become a value. The defuzzification method used is the average method with the following equation,

$$z = \frac{\sum a_i \cdot z_i}{\sum a_i} \tag{36}$$

after carrying out the system inference process, the rule according to the set value in each variable is calculated the z value with the average formula,

$$\begin{aligned} z &= ((0.5 \times 92.5) + (0.5 \times 92.5)) / (0.5 + 0.5) \\ z &= (46.25 + 46.25) / 1 = 92.50 \end{aligned} \tag{37}$$

3. RESULTS AND DISCUSSION

3.1. Implementation of decision support system with fuzzy method

Based on the fuzzification process on the training assessment data, sets are formed for each criterion in each civil servants training class. In civil servant training class II, for the coach, lecturer, preacher, mentor, and examiner criteria are very satisfying sets with weight equal to 1.0 for each, while for the organizer criterion consists of two sets, namely satisfactory with weight equal to 0.5 and very satisfying set with weight equal to 0.5. Furthermore, in civil servant training class III it is obtained that for coach, lecturer, preacher, mentor, and examiner criteria are very satisfying sets with weight equal to 1.0, while for the the organizer criterion consist of two sets, namely satisfactory with weight equal to 0.2 and very satisfying with weight equal to 0.8. Based on the results, it can be concluded that the quality of the training for civil servant class III is more satisfying than the civil servant class II. Those result indicated by the weight values on the organizer set as shown in Figures 3(a) and 3(b).

The terms used to express the set in Figure 3(a) and Figure 4(b) are TM (Not satisfactory), KM (Unsatisfactory), CM (Quite Satisfactory), M (Satisfactory), SM (Very Satisfactory). After fuzzification, the inference process is then carried out to determine the output value. Based on the results of the system inference, the rules for each class are obtained as presented in Table 3 and Table 4. These rules are formed according to the fuzzy set values.

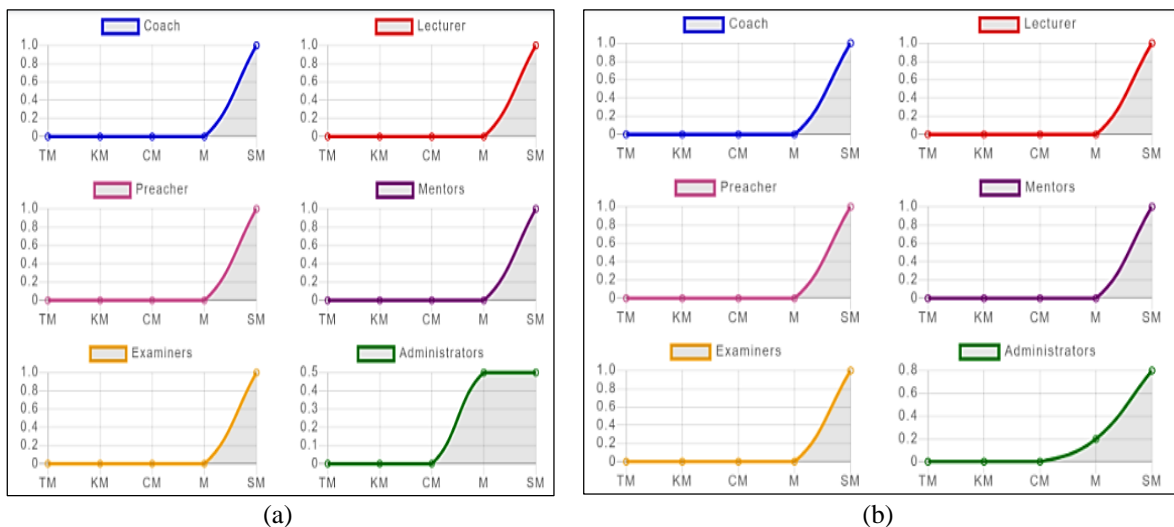


Figure 3. (a) Fuzzification group II, (b) Fuzzification group III

Table 3. Rules of civil servant training class II

Rule	X1	μ_{X1}	X2	μ_{X2}	X3	μ_{X3}	X4	μ_{X4}	X5	μ_{X5}	X6	μ_{X6}	Decision	Alpha	Z(i)	Alpha*Z(i)
R1309	Very satisfactory	1	Very satisfactory	1	Very satisfactory	1	Very satisfactory	1	Very satisfactory	1	Satisfactory	0.5	Very Good	0.5	92.5	46.25
R1310	Very satisfactory	1	Very satisfactory	1	Very satisfactory	1	Very satisfactory	1	Very satisfactory	1	Satisfactory	0.5	Very Good	0.5	92.5	46.25

Table 4. rules of civil servant training class III

Rule	X1	μ_{X1}	X2	μ_{X2}	X3	μ_{X3}	X4	μ_{X4}	X5	μ_{X5}	X6	μ_{X6}	Decision	Alpha	Z(i)	Alpha*Z(i)
R1309	Very satisfactory	1	Very satisfactory	1	Very satisfactory	1	Very satisfactory	1	Very satisfactory	1	Satisfactory	0.2	Very Good	0.2	88	17.6
R1310	Very satisfactory	1	Very satisfactory	1	Very satisfactory	1	Very satisfactory	1	Very satisfactory	1	Very satisfactory	0.8	Very Good	0.8	97	77.6

Based on the inference results, the output value for civil servant training class II is 92.50 which states that the quality of the training is very good. While, for the civil servant training class III, the output value is 95.20 which states that the quality of the training is also very good. Figure 4(a) and Figure 4(b) figure out the quality of the training for each class.

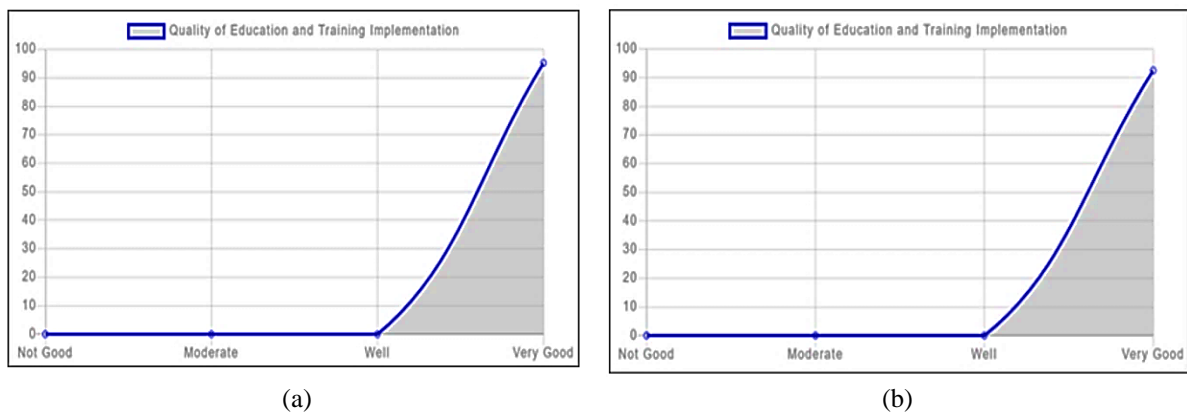


Figure 4. (a) Class II training output value, (b) Class III training output value

3.2. Fuzzy method output testing

Furthermore, testing is carried out to determine the level of output accuracy of the fuzzy method. Testing was conducted by comparing the results of conventional calculation decisions with the results of system decisions. The results of decisions based on conventional calculations are made by finding the mean value of each criterion. Tests are carried out using data based on the training class category. The results of the fuzzy method output test are presented in Table 5.

Table 5 shows that the conventional calculation output value at the civil servant training class II is 91.17 (very good decision) and the civil servant training class III training is 93.50 (very good decision). While the output value produced by the proposes decision support system for civil servant training class II is 92.50 (very good decision) and the civil servant training class III is 95.20 (very good decision). Even though it produces a different average output value, the decisions are the same for both approach, which is very good. Based on the test results shown in Table 5, level of accuracy of each results of the fuzzy analysis method then calculated using the following formula,

$$Accuracy = \frac{\text{the correct amount of data}}{\text{the total amount of data}} \times 100 \tag{38}$$

$$\text{Accuracy} = \frac{2}{2} \times 100 = 100\% \quad (39)$$

Table 5. Fuzzy method output testing

Type of training	Input						Output		Decision		Difference	Percentage of Error%
	Coach	Lecturer	Preachers	Mentors	Examiners	Organizer	Conventional	System	Conventional	System		
Civil Servant Class II training	92	92	93	92	93	85	91,17	92,50	Very Good	Very Good	1,33	1,33%
Civil Servant Class III training	95	94	95	94	95	88	93,50	95,20	Very Good	Very Good	1,70	1,70%

After calculating the level of accuracy, it is obtained that the accuracy of the decision output of the fuzzy method is 100%. While the accuracy rate of the output value is 98.49%. Level of accuracy of the output value is obtained from a reduction of 100% with an average error percentage value of 1.52%.

4. CONCLUSION

Three order criteria were obtained based on the criteria test using the fuzzy method, namely: 1) the highest order are examiner and preacher criteria; 2) the second order are coach, lecture, and mentor criteria; and 3) the lowest order is organizer criterion. In both the civil servant training class II and III, the coach, lecturer, preacher, mentor, and examiner criteria participants are very satisfying. While for the organizer criterion, 50% participants are Satisfactory and 50% are Very Satisfactory in the civil servant training class II. And, for organizer criterion in the civil servant training class III 20% participants are Satisfactory and 80% are Very Satisfactory. Moreover, the result shows that overall quality of the civil servant training class III is better than the civil servant training class II as indicated by the organizer criterion which shows different levels of satisfaction. However, the overall quality of the training is very good. Based on the testing results, the accuracy rate is 100%. Thus the fuzzy method can be used to assess the quality of the training appropriately. However, further research is needed to find out how far the quality of the training influences the participant's success.

ACKNOWLEDGEMENTS

We would like to thanks to School of Management Informatics and Computer Bina Bangsa as a sponsor for the first and second authors, as well as to School of Management Informatics and Computer Handayani for facilities provided to conduct this research. Special thanks also to the Human Resources Development Agency of Southeast Sulawesi Province for welcoming us to collect data for this research.

REFERENCES

- [1] Government Regulation of the Republic of Indonesia, "Civil Service Management," no. 023819, 2020, [Online]. Available: <https://peraturan.bpk.go.id/Home/Details/134462/pp-no-17-tahun-2020>
- [2] State Administration of the Republic of Indonesia, "Regulation of the State Administration of the Republic of Indonesia Number 12 of 2018 concerning Basic Training of Candidates for Civil Servants," *Inst. Adm. Republic of Indonesia.*, 2018, [Online]. Available: <https://infoasn.id/wp-content/uploads/2019/01/Peraturan-LAN-Nomor-12-Tahun-2018-Tentang-Pelatihan-Dasar-CPNS.pdf>
- [3] A. Grohmann and S. Kauffeld, "Evaluating training programs: Development and correlates of the Questionnaire for Professional Training Evaluation," *Int. J. Train. Dev.*, vol. 17, no. 2, pp. 135-155, 2013, doi: 10.1111/ijtd.12005.
- [4] D. T. L. Shek and Y. L. Y. Chak, "Evaluation of the Training Program of the Project P.A.T.H.S.: Findings based on the perspective of the participants from different cohorts," *Sci. World J.*, vol. 2012, 2012, doi: 10.1100/2012/687198.
- [5] R. R. Alsyabany, "The evaluation of effectiveness on education and training program," *J. Educ. Learn. Stud.*, vol. 2, no. 1, p. 56, 2019, doi: 10.32698/0662.
- [6] S. Farjad, "The Evaluation Effectiveness of Training Courses in University by Kirkpatrick Model (Case Study: Islamshahr University)," *Procedia - Soc. Behav. Sci.*, vol. 46, pp. 2837-2841, 2012, doi: 10.1016/j.sbspro.2012.05.573.
- [7] A. Al-Janabi, E. A. Al-Zubaidi, and R. H. A. Al Sagheer, "Dependable estimations for education quality using fuzzy logic based strategy a case study (University of Kufa)," *Indonesian Journal of Electrical Engineering and Computer Science (IJECS)*, vol. 17, no. 1, pp. 472-480, 2019, doi: 10.11591/ijeecs.v17.i1.pp472-480.

- [8] S. Wibowo, H. Deng, and W. Xu, "Evaluation of Cloud Services: A Fuzzy Multi-Criteria Group Decision Making Method," *Algorithms*, vol. 9, no. 4, p. 84, 2016, doi: 10.3390/a9040084.
- [9] A. Buriboev, H. K. Kang, M. C. Ko, R. Oh, A. Abduvaitov, and H. S. Jeon, "Application of fuzzy logic for problems of evaluating states of a computing system," *Appl. Sci.*, vol. 9, no. 15, 2019, doi: 10.3390/app9153021.
- [10] C. N. Wang, C. Y. Yang, and H. C. Cheng, "A Fuzzy Multicriteria Decision-Making (MCDM) Model for Sustainable Supplier Evaluation and Selection Based on Triple Bottom Line Approaches in the Garment Industry," *Processes*, vol. 7, no. 7, pp. 1-13, 2019, doi: 10.3390/pr7070400.
- [11] G. Petrović, J. Mihajlović, Ž. Čojbašić, M. Madić, and D. Marinković, "Comparison of Three Fuzzy MCDM Methods for Solving the Supplier Selection Problem," *Facta Univ. Ser. Mech. Eng.*, vol. 17, no. 3, pp. 455-469, 2019, doi: 10.22190/FUME190420039P.
- [12] S. Ismaeel, A. Al-Khazraji, and K. Al-delimi, "Fuzzy Information Modeling in a Database System," *IAES International Journal of Artificial Intelligence (IJAI)*, vol. 6, no. 1, p. 1, 2017, doi: 10.11591/ijai.v6.i1.pp1-7.
- [13] E. Rahmanita, V. T. Widyaningrum, Y. Kustiyahningsih, and J. Purnama, "Model Multi Criteria Decision Making with Fuzzy ANP Method for Performance Measurement Small Medium Enterprise (SME)," *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 336, no. 1, 2018, doi: 10.1088/1757-899X/336/1/012023.
- [14] S. Ozdogan, A. Yildizbasi, and B. D. Rouyendegh, "Performance evaluation of municipal services with fuzzy multi-criteria decision making approaches: a case study from Turkey," *SN Appl. Sci.*, vol. 2, no. 6, 2020, doi: 10.1007/s42452-020-2843-8.
- [15] S. M. Nobari, V. Yousefi, E. Mehrabanfar, A. H. Jahanikia, and A. M. Khadivi, "Development of a complementary fuzzy decision support system for employees' performance evaluation," *Econ. Res. Istraz.*, vol. 32, no. 1, pp. 492-509, 2019, doi: 10.1080/1331677X.2018.1556106.
- [16] O. Tale Arogundade, B. Ojokoh, M. G. Asogbon, B. S. Adeniyi, and O. W. Samuel, "Fuzzy driven decision support system for enhanced employee performance appraisal," *Int. J. Hum. Cap. Inf. Technol. Prof.*, vol. 11, no. 1, pp. 17-30, 2020, doi: 10.4018/IJHCITP.2020010102.
- [17] A. Kharola, S. Kunwar, G. B. Choudhury, A. Kharola, S. Kunwar, and G. B. Choudhury, "Students Performance Evaluation: A fuzzy logic reasoning approach," *PM World J.*, vol. IV, no. IX, pp. 1-11, 2015, [Online]. Available: www.pmworldlibrary.net
- [18] Z. Yildiz and A. F. Baba, "Evaluation of student performance in laboratory applications using fuzzy decision support system model," *IEEE Glob. Eng. Educ. Conf. EDUCON*, no. April, 2014, pp. 1023-1027, doi: 10.1109/EDUCON.2014.6826230.
- [19] R. Wardoyo and W. D. Yuniarti, "Analysis of Fuzzy Logic Modification for Student Assessment in e-Learning," *IJID (International J. Informatics Dev.)*, vol. 9, no. 1, p. 29, 2020, doi: 10.14421/ijid.2020.09105.
- [20] N. Amelia, A. G. Abdullah, and Y. Mulyadi, "Meta-analysis of student performance assessment using fuzzy logic," *Indones. J. Sci. Technol.*, vol. 4, no. 1, pp. 74-88, 2019, doi: 10.17509/ijost.v4i1.15804.
- [21] V. Zaporozhko, V. Shardakov, and D. Parfenov, "Fuzzy model for evaluating the results of online learning," *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 734, no. 1, 2020, doi: 10.1088/1757-899X/734/1/012150.
- [22] M. S. Sulaiman, A. A. Tamizi, M. R. Shamsudin, and A. Azmi, "Course recommendation system using fuzzy logic approach," *Indonesian Journal of Electrical Engineering and Computer Science (IJECS)*, vol. 17, no. 1, pp. 365-371, 2019, doi: 10.11591/ijeecs.v17.i1.pp365-371.
- [23] S. R. Havins, "Decision Support Systems for Managing Innovation through Project Selection in Public Sector R&D Environments," *IEEE Eng. Manag. Rev.*, vol. 48, no. 4, pp. 28-31, 2020, doi: 10.1109/EMR.2020.3007748.
- [24] A. Setyono and S. N. Aeni, "Development of decision support system for ordering goods using fuzzy Tsukamoto," *International Journal of Electrical and Computer Engineering (IJECE)*, vol. 8, no. 2, pp. 1182-1193, 2018, doi: 10.11591/ijece.v8i2.pp1182-1193.
- [25] Q. Kotimah, W. Firdaus Mahmudy, and V. Nur Wijyaningrum, "Optimization of fuzzy Tsukamoto membership function using genetic algorithm to determine the river water," *International Journal of Electrical and Computer Engineering (IJECE)*, vol. 7, no. 5, pp. 2838-2846, 2017, doi: 10.11591/ijece.v7i5.pp2838-2846.
- [26] S. Rizvi, J. Mitchell, A. Razaque, M. R. Rizvi, and I. Williams, "A fuzzy inference system (FIS) to evaluate the security readiness of cloud service providers," *J. Cloud Comput.*, vol. 9, no. 1, 2020, doi: 10.1186/s13677-020-00192-9.
- [27] State Administration Agency and the Financial and Development Supervisory Agency of the Republic of Indonesia (2000:12), "Accountability dan Good Governance," *Modul Sos. Sist. Performance Accountability of Government Agencies*, p. 2, 2000.