Analysis of Lecturers Competency Performance Evaluation using Fuzzy Modeling

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Info Articles	Abstract
_____	_____ In the Indonesian 2005 Law (UU No. 14 Tahun 2005) about Teachers and Lecturers there are four competencies that must be owned by a lecturer in carrying out the duties –the Tridharma– namely pedagogic, personality, professional, and social competence. This research analyzes the evaluation results of lecturer's performance at the Faculty of Science and Mathematics using fuzzy modeling, employing the FIS Mamdani method.. The twelve aspects assessed in the questionnaire are grouped into four competencies with an assessment of 1 (not good), 2 (poor), 3 (good), and 4 (excellent). The average value of each aspect of each competency is used to derive the fuzzy value of each competency. The value of each competence is then used to get the final value of lecturer performance evaluation, to be back-processed into the crisp value which is translated through membership function. Based on the criteria set by the faculty, i.e. "Poor", "Fair", and "Good", the results show that the performance evaluation of all lecturers are "Fair" towards "Good", but when the assessment uses the average value, all lecturer have a "Good" performance except one lecturer who shows "Fair" performance.

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INTRODUCTION

The performance evaluation is not only needed in the business office, but also in the education world to improve the quality of education in a sustainable manner. In improving the quality of education on an ongoing basis, universities conduct assessments, namely accreditation and internal evaluation of universities. Higher education strives to improve the quality including that of the lecturers. To maintain the quality of lecturers, monitoring and evaluation of the performance of lecturers are conducted every year/end of the semester by filling out questionnaires by peers, students, and superiors. With the results of the performance evaluation, lecturers are expected to improve or maintain the good performance that has been achieved.

Many instruments with assessment aspects can be used to evaluate the performance of lecturers. Universitas Kristen Satya Wacana has conducted lecturer performance evaluation using the "Beban Kinerja Dosen" report –performance report based on credit units– as regulated by the Indonesian Ministry of Research and Higher Education / MENRISTEKDIKTI, for lecturers who have been certified. Every lecturer also has to report internally using the "BATA" report to evaluate the real workload every semester. The Quality Assurance unit (PMF) of the Faculty of Science and Mathematics designed a questionnaire to evaluate the performance of lecturers based on competency which refers to the Indonesian Law, "UU Nomor 14 Tahun 2005" concerning Teachers and Lecturers at the faculty level, involving supervisors, peers, administrative staff, and taught students concerned. The lecturers' competencies in question include pedagogic, professional, personality and social competencies. The performance evaluation based on lecturer competence in this paper hereinafter is referred to as lecturer performance evaluation.

The assessment carried out so far has been in accordance with the lecturers' performance competence in general, but has not addressed each of the four lecturer performance competencies. Assessment of each aspect is considered highly subjective. Therefore, the assessment is carried out by the direct supervisor in question, fellow lecturers, supporting staff (administrative/laboratory staff), and students who took the course. The assessment uses a discrete scale of 1, 2, 3, 4, and the average value of the twelve aspects assessed, but this average value has not been able to describe the performance in each competency possessed by each lecturer. Therefore, based on the description above, in this study fuzzy logic will be applied with the Mamdani FIS method to reprocess the evaluation results that have been done at the FSM UKSW. A similar research that has been done is to obtain the value of each competency to determine the prototype of the software (Mahmud 2013). Fuzzy logic is widely applied in various fields, because the concept of fuzzy logic is easy to understand and the mathematical concepts that underlie fuzzy reasoning are fairly simple.

According to Kusumadewi (2004), the fuzzy set is a set that states an object that can be a member of several sets with different membership values (μ). The fuzzy set has two attributes, namely: Linguistics, i.e. naming groups that represent a particular situation using natural language, such as young, middle-aged, and old; Numeric, which is a value or number that indicates the size of a variable, such as 25, 35, 40, 50 and so on.

The fuzzy set attribute is then stated in the membership function. The membership function is represented by a curve that shows the mapping of data input points into membership degrees that have intervals between 0 to 1. Some membership functions can be used, namely: Linear Representation
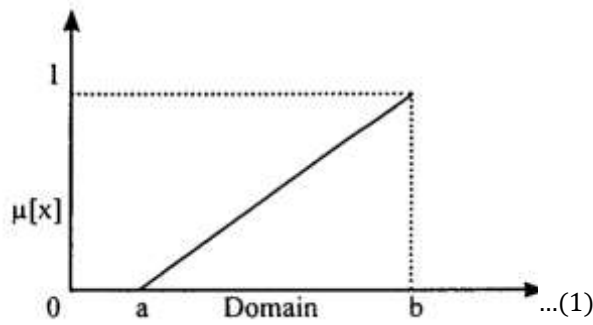
Membership Function:

$$\mu[x] = \begin{cases} 0 & ; \quad x < a \\ \dfrac{x-a}{b-a} & ; \quad a \le x \le b \\ 1 & ; \quad x > b \end{cases} \quad \dots(1)$$
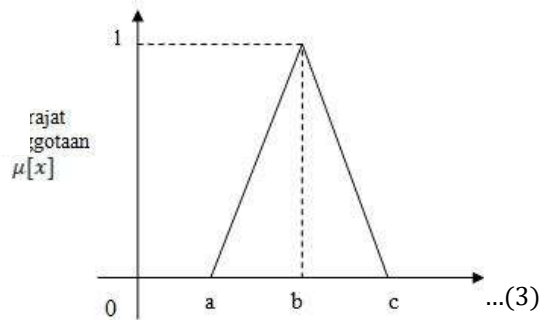
Figure 1. Linear Representation Goes Up
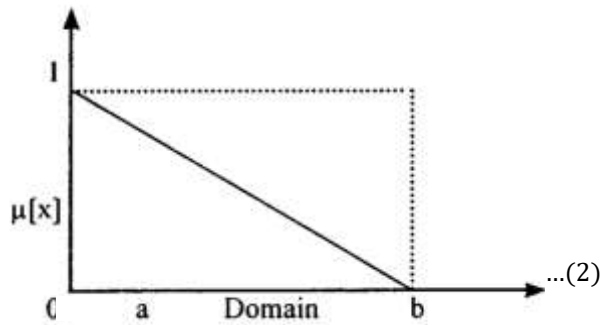
Membership Function:

$$\mu[x] = \begin{cases} \dfrac{b-x}{b-0} & ; \quad 0 \le x \le b \\ 0 & ; \quad x > b \end{cases} \quad \dots(2)$$

Figure 2. Linear Representation Goes Down

- Triangle Curve Representation
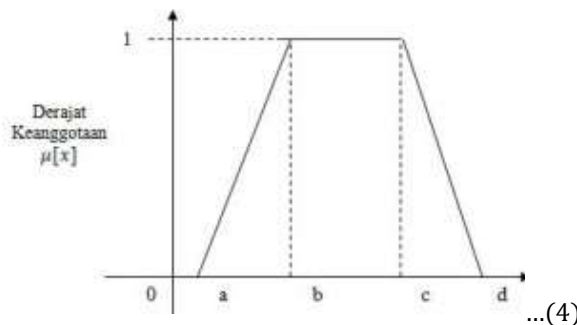
Membership Function:

$$\mu[x] = \begin{cases} 0 & ; \quad x < a \quad atau \quad x > c \\ \dfrac{x-a}{b-a} & ; \quad a \le x \le b \\ \dfrac{c-x}{c-b} & ; \quad b < x \le c \end{cases} \quad \dots(3)$$

Figure 3. Triangle Curve Representation

- Trapezoidal Curve Representation

Membership Function:

$$\mu[x] = \begin{cases} 0 & ; \quad x < a \quad atau \quad x > d \\ \dfrac{x-a}{b-a} & ; \quad a \le x \le b \\ 1 & ; \quad b < x \le c \\ \dfrac{d-x}{d-c} & ; \quad c < x \le d \end{cases} \quad \dots(4)$$

Figure 4. Trapezoidal Curve Representation

Fuzzy logic was first introduced by Prof. Lotfi A. Zadeh in 1965. The basis of fuzzy logic is the theory of fuzzy sets, namely the important role of the degree of membership as a determinant of

the existence of elements in a set. The degree of membership is the main characteristic in reasoning with this fuzzy logic.

Fuzzy logic can be considered as a black box that connects the input space to the output space, as shown in Figure 5.

Figure 5. Input-output mapping illustration.

The black box contains a method or techniques that can be used to process input data into output in the form of good information.

The method used is FIS Mamdani (Max-Min) which was introduced by Ebrahim Mamdani. Fuzzy Inference System (FIS) is a system used for reasoning with similar principles as humans do reasoning with their instincts. According to Kusumadewi (2010), there are several things that leads to the understanding of fuzzy systems, namely fuzzy variables, fuzzy sets, discussion universes, and domains. To get Mamdani's FIS output, 4 stages are needed: Formation of fuzzy sets; Application function implication; The composition of rules; Defuzzification

Based on the description above, the formulation of the problem in this study is "How to analyze the results of lecturer performance evaluation using fuzzy modeling to determine the performance of lecturers?". The purposes of this study are: Obtain the results of the analysis of lecturer performance evaluation using Mamdani's Fuzzy Inference System (FIS) model; Obtain the results of a comparative analysis of the results of the lecturer performance evaluation obtained using fuzzy on average.

METHODS

This research is a research on performance evaluation based on the competence of lecturers at the FSM UKSW Salatiga. The study uses secondary data, namely even semester 2016/2017 data obtained from the "Penjaminan Mutu Fakultas" /Quality Assurance Section, Faculty of Science and Mathematics UKSW. In accordance with "UU Nomor 14 Tahun 2005" concerning Teachers and Lecturers (Chapter 5, Part Five: Guidance and Development, Article 69 paragraph 2) there are four types of lecturer competencies, namely Pedagogic, Professional, Personality, and Social. The twelve aspects assessed in the questionnaire were then grouped into four competencies based on the "Buku Pedoman Sertifikasi Pendidik untuk Dosen Terintegrasi" issued by "Direktorat Jenderal Pendidikan Tinggi, Kementrian Pendidikan Nasional 2011" as follows:

a. Pedagogic Competence
   - Mastery of media and learning technology (Aspect 2).
   - Objectivity in assessing students (Aspect 3).
   - Ability to guide students (Aspect 4).
b. Professional Competence
   - Mastery of their expertise (Aspect 5).
   - Willingness to reflect and discuss learning problems with peers (Aspect 6).
   - Ability to follow developments in science and technology for updating learning (Aspect 7).
c. Personality Competence
   - Communication skills (Aspect 1).
   - Wisdom in decision making (Aspect 8).
   - Being a role model in thoughts and behaviour (Aspect 9).
d. Social Competence

- Ability to express opinions (Aspect 10).
- Ability to accept criticism, suggestions, and opinions of others (Aspect 11).
- Being sociable to colleagues, other employees, and students (Aspect 12).

Calculation of lecturer performance appraisal use an assessment in the form of discrete categorization of an ordinal scale, namely 1 = not good, 2 = poor, 3 = good, and 4 = excellent. To determine the results of the performance evaluation of the lecturers at the FSM UKSW, the questionnaire must be filled by the direct supervisor concerned, 3 fellow lecturers, 3 non-faculty members (administrative staff/laboratory staff) and 5 students who have been taught by the lecturer (regardless of the type of course). This questionnaire was first used in the second semester of the 2016-2017 academic year. Data is processed using the Mamdani FIS method fuzzy system. The tool used is Matlab with fuzzy logic toolbox. The steps taken are:

1. Formation of fuzzy sets (fuzzification)
2. Application implication function: using the implication function Min.
3. The composition of rules: using the Max method.
4. Defuzzification: using the Centroid method.

Data processing that has been done can be implemented in the following scheme:
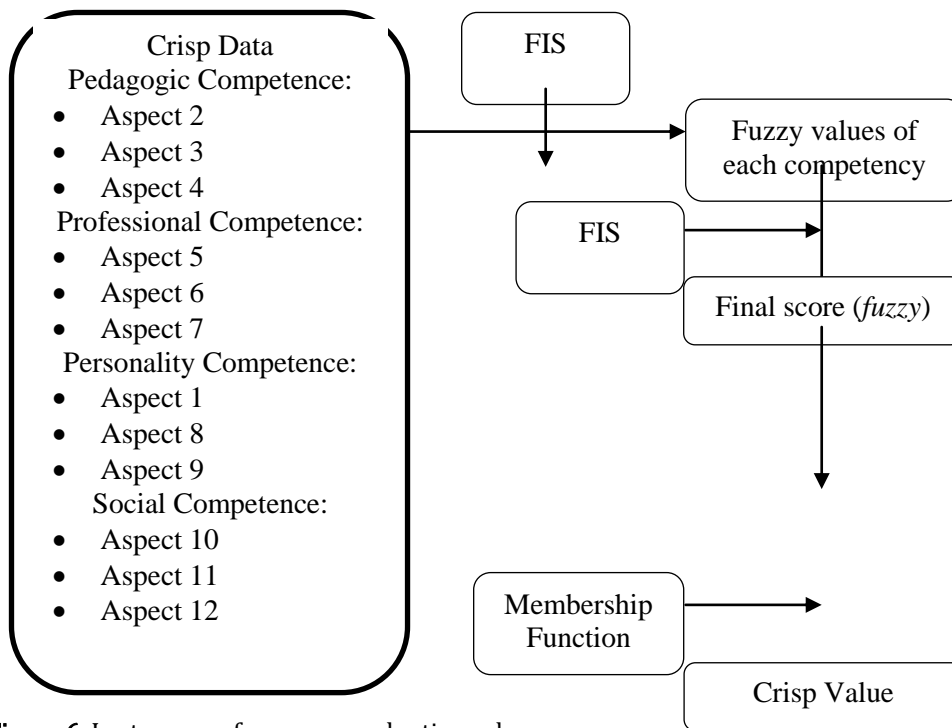

Figure 6. Lecturer performance evaluation scheme.

RESULTS AND DISCUSSION

Identification of variables is carried out to determine the input and output variables and the universe of the discussion needed to calculate and analyze problems.

Table 1. Formation of *Input* and *Output* Variables.

Variable	Fuzzy Set	Discussion Universes	Domain
		Input	
Pedagogic	Not Good	0-4	[0, 2]

Professional	Poor		[1, 3]
Personality	Good		[2, 4]
Social	Excellent		[3, 4]
Output			
Performance Result	Poor	0-4	[0, 2]
	Fair		[1.5, 3.5]
	Good		[2.5, 4]

Next, a membership function is formed describing the input variable which consists of a trapezoidal curve, a triangle, and a linear rise. Whereas the output variable uses the shoulder curve.

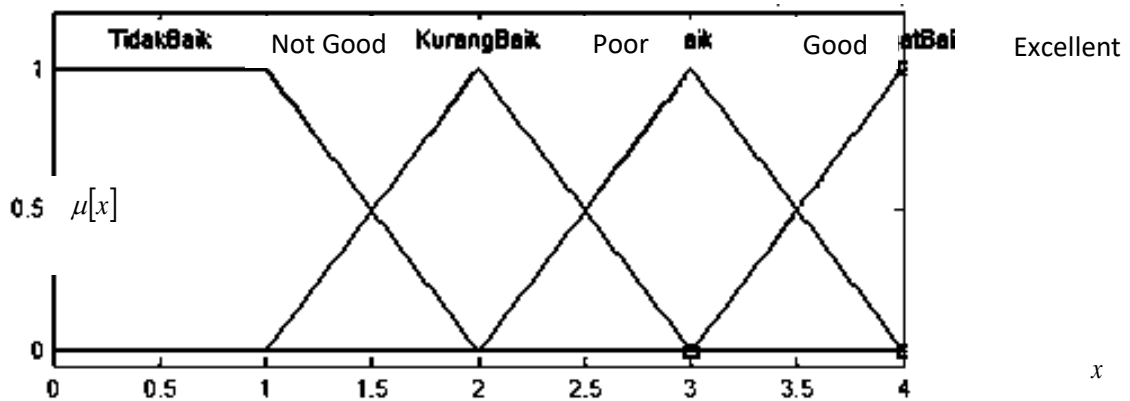   a.   Membership Function for each Pedagogic, Professional, Personality, and Social Input Variable

Figure 6. Fuzzy set for competency input variables.

Based on the formula (4), (3), and (1) the membership function is shown as follows:

$$\mu_{NotGood}[x]=\begin{cases} 1 & ; \quad 0 \le x < 1 \\ \dfrac{2-x}{2-1} & ; \quad 1 \le x < 2 \\ 0 & ; \quad x \ge 2 \end{cases}$$

...(5)

$$\mu_{Poor}[x]=\begin{cases} 0 & ; \quad x \le 1 \quad atau \quad x \ge 3 \\ \dfrac{x-1}{2-1} & ; \quad 1 < x < 2 \\ \dfrac{3-x}{3-2} & ; \quad 2 \le x < 3 \end{cases}$$

...(6)

$$\mu_{Good}[x]=\begin{cases} 0 & ; \quad x \le 2 \quad atau \quad x \ge 4 \\ \dfrac{x-2}{3-2} & ; \quad 2 < x < 3 \\ \dfrac{4-x}{4-3} & ; \quad 3 \le x < 4 \end{cases}$$

...(7)

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$$\mu_{Excellent}[x] = \begin{cases} 0 & ; \quad x \leq 3 \\ \dfrac{x-3}{4-3} & ; \quad 3 < x < 4 \\ 1 & ; \quad x \geq 4 \end{cases}$$

...(8)

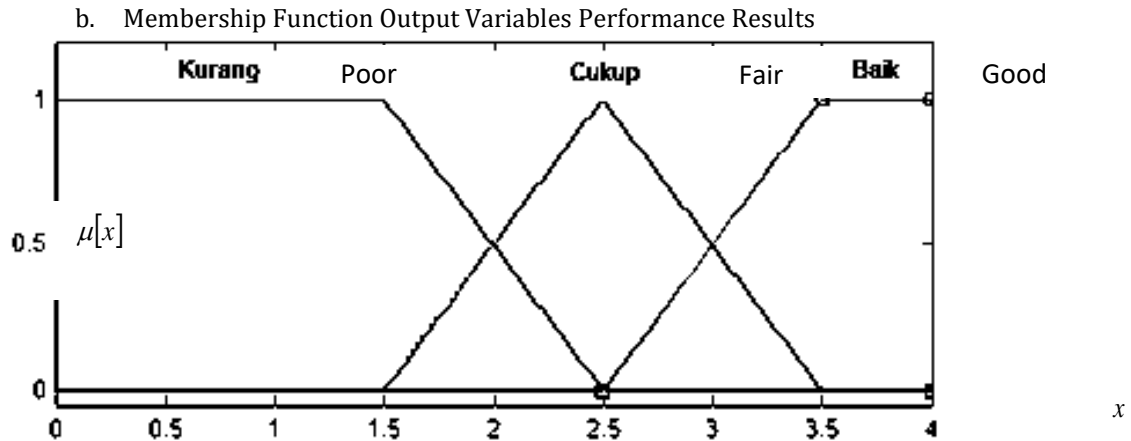b. Membership Function Output Variables Performance Results

Figure 7. The fuzzy set for output variables is Performance Results.

Based on the formula (4) and (3) the membership function is shown as follows:

$$\mu_{Poor}[x] = \begin{cases} 1 & ; \quad 0 \leq x < 1.5 \\ \dfrac{2.5-x}{2.5-1.5} & ; \quad 1.5 \leq x < 2.5 \\ 0 & ; \quad x \geq 2.5 \end{cases} \qquad ...(9)$$

$$\mu_{Fair}[x] = \begin{cases} 0 & ; \quad x \leq 1.5 \quad atau \quad x \geq 3.5 \\ \dfrac{x-1.5}{2.5-1.5} & ; \quad 1.5 < x < 2.5 \\ \dfrac{3.5-x}{3.5-2.5} & ; \quad 2.5 \leq x < 3.5 \end{cases}$$

...(10)

$$\mu_{Good}[x] = \begin{cases} 0 & ; \quad x \leq 2.5 \\ \dfrac{x-2.5}{3.5-2.5} & ; \quad 2.5 < x < 3.5 \\ 1 & ; \quad x \geq 3.5 \end{cases}$$

...(11)

The data processing stage is done by building a fuzzy system using the Mamdani method. The Mamdani method fuzzy system was chosen because this method resembles a human mindset where the implication function between antecedents and consequences are the same in the fuzzy set. In this study, the output obtained is a Performance Result that can be used as an evaluation material. The stages are explained as follows:

Formation of fuzzy sets (fuzzification)

In this stage, crisp values are taken, namely the performance value of lecturers from each aspect of the assessment to determine the degree of membership where the values become members of each fuzzy set that is appropriate and used as input when forming membership functions. Based

$$\mu_{Good}[3.42] = \frac{4 - 3.42}{4 - 3} = \frac{0.58}{1} = 0.58,$$

$$\mu_{Excellent}[3.42] = \frac{3.42 - 3}{4 - 3} = \frac{0.42}{1} = 0.42.$$

Whereas if a lecturer gets a value of 2.88, s/he gets a value that lies between "Fair" and "Good". Stated in a fuzzy set according to the

$$\mu_{Fair}[2.88] = \frac{3.5 - 2.88}{3.5 - 2.5} = \frac{0.62}{1} = 0.62,$$

$$\mu_{Good}[2.88] = \frac{2.88 - 2.5}{3.5 - 2.5} = \frac{0.38}{1} = 0.38.$$

As discussed at the variable identification stage, each aspect assessed is an input variable in a competency which later becomes the output variable of each competency. Furthermore, the

on the membership function, if, for example, a lecturer gets a value of 3.42, it means that the value lies between "Good" and "Excellent". Stated in a fuzzy set in accordance with formulas (7) and (8) the degree of membership can be presented as follows:

formula (10) and (11) the degree of membership can be presented as follows:

value of each competency is used as an input variable to produce output that is the result of lecturer performance evaluation. Table 2 shows input data as well as the value of each competency.

Table 2. Data processed with fuzzy for competency values.

Lecturer	Rated Aspects															
	Pedagogic				Professional				Personality				Social			
	2	3	4	fuzzy	5	6	7	fuzzy	1	8	9	fuzzy	10	11	12	fuzzy
D1	3.42	3.75	3.75	3.26	3.83	3.75	3.50	3.23	3.83	3.58	3.50	3.15	3.83	3.58	3.67	3.21
D2	3.27	3.00	2.91	3.00	3.45	3.10	3.18	3.02	2.91	2.82	2.91	2.88	3.09	2.91	3.00	3.00
D3	3.67	3.42	3.17	3.09	3.17	3.50	3.50	3.13	3.25	3.17	3.25	3.03	3.33	3.50	3.17	3.07
D4	3.67	3.50	3.17	3.13	3.08	3.17	3.67	3.02	3.42	3.09	3.36	3.07	3.45	3.45	3.67	3.10
D5	3.92	3.67	3.67	3.24	3.92	3.58	3.83	3.33	3.75	3.75	3.58	3.26	3.92	3.75	3.92	3.50
D6	2.83	2.83	3.00	2.79	3.50	2.75	3.08	3.01	2.67	2.75	2.50	2.59	2.92	2.50	2.50	2.50
D7	4.00	3.50	3.33	3.13	3.75	3.33	3.75	3.29	3.25	3.42	3.58	3.09	3.58	3.42	3.58	3.17
D8	4.00	3.83	3.58	3.33	3.92	3.58	3.92	3.46	3.58	3.67	3.83	3.21	3.83	3.75	3.42	3.26
D9	3.83	3.75	3.58	3.26	3.83	3.67	3.75	3.29	3.92	3.42	3.83	3.33	3.83	3.67	3.83	3.36
D10	3.75	3.92	3.58	3.26	3.83	3.42	3.42	3.09	3.75	3.42	3.83	3.26	3.50	3.50	3.67	3.13
D11	3.75	3.75	3.67	3.29	3.92	3.83	3.75	3.38	3.75	3.67	3.67	3.24	3.67	3.67	3.92	3.24
D12	3.42	3.67	3.67	3.21	3.58	3.33	3.17	3.06	3.67	3.50	3.33	3.13	3.42	3.17	3.42	3.09
D13	3.00	3.42	3.75	3.09	3.50	3.58	2.83	3.13	3.42	3.42	3.42	3.09	3.42	3.58	3.75	3.17
D14	3.58	3.50	3.67	3.15	3.67	3.36	3.67	3.23	3.50	3.17	3.17	3.02	3.36	3.33	3.92	3.07
D15	3.42	3.42	3.17	3.09	3.67	3.17	3.50	3.13	2.92	3.25	3.08	3.01	3.08	2.92	2.67	2.88
D16	3.42	2.58	2.67	2.62	3.33	2.83	3.42	3.06	3.00	3.00	2.75	3.00	2.83	2.75	3.08	2.78
D17	3.67	3.33	3.25	3.06	3.67	3.25	3.58	3.17	3.00	3.00	2.67	3.00	3.17	3.25	3.42	3.04
D18	3.50	3.08	3.17	3.02	3.58	3.00	3.67	3.17	3.33	3.08	2.92	3.01	3.25	3.08	3.50	3.04
D19	3.58	3.58	3.67	3.17	3.83	3.58	3.42	3.17	3.50	3.42	3.50	3.13	3.42	3.67	3.67	3.21
D20	3.92	3.42	3.50	3.13	3.83	3.25	3.42	3.09	3.58	3.58	3.42	3.17	3.50	3.50	3.75	3.13
D21	3.75	3.58	3.67	3.21	3.58	3.58	3.67	3.17	3.67	3.75	3.92	3.29	3.75	3.75	3.83	3.31
D22	3.25	3.42	3.50	3.10	3.83	3.42	3.08	3.09	3.58	3.42	3.42	3.09	3.67	3.08	3.50	3.13

D23	3.75	3.92	3.75	3.31	3.67	3.67	3.75	3.24	3.92	3.75	3.75	3.31	3.67	3.75	3.92	3.29
D24	3.50	3.67	3.67	3.18	3.58	3.58	3.67	3.17	3.58	3.58	3.67	3.17	3.58	3.67	3.50	3.15

a. Application implication function

In this study, the implication function used is Min because this function will cut the output of the fuzzy set.

b. The Composition of Rules

The composition of the rules in this study uses the Maximum method. The first stage is to obtain the value of each competency; there are 64 composition rules. Following are examples of some composition rules used.

IF ("Aspect 2" is "NOT GOOD") and ("Aspect 3" is "NOT GOOD") and ("Aspect 4" is "NOT GOOD") THEN ("Pedagogic" is "NOT GOOD"),

IF ("Aspect 2" is "NOT GOOD") and ("Aspect 3" is "NOT GOOD") and ("Aspect 4" is "POOR") THEN ("Pedagogic" is "NOT GOOD"),

IF ("Aspect 2" is "NOT GOOD") and ("Aspect 3" is "NOT GOOD") and ("Aspect 4" is "GOOD") THEN ("Pedagogic" is "POOR"),

⋮

IF ("Aspect 2" is "EXCELLENT") and ("Aspect 3" is "EXCELLENT") and ("Aspect 4" is "EXCELLENT") THEN ("Pedagogic" is "EXCELLENT"),

Whereas in the next stage, 259 composition rules are employed to obtain performance results. Following are extracts of some composition rules that are used.

IF ("Pedagogic" is "POOR") and ("Personality" is "POOR") and ("Professional" is "POOR") and ("Social" is "GOOD") THEN ("Rating Result" is "POOR"),

IF ("Pedagogic" is "POOR") and ("Personality" is "POOR") and ("Professional" is "POOR") and ("Social" is "EXCELLENT") THEN ("Rating Result" is "FAIR"),

IF ("Pedagogic" is "POOR") and ("Personality" is "POOR") and ("Professional" is "FAIR") and ("Social" is "FAIR") THEN ("Rating Result" is "FAIR"),

⋮

IF ("Pedagogic" is "FAIR") and ("Personality" is "POOR") and ("Professional" is "POOR") and ("Social" is "POOR") THEN ("Rating Result" is "POOR").

All rules were made having considered the results between antecedents and consequence. For example, if a lecturer gets a minimum score of GOOD on pedagogic and professional competencies and gets a minimum score of FAIR on social competence and personality, then the lecturer will get a GOOD assessment.

c. Defuzzification

To determine the crisp output, a defuzzification method is used that matches the Mamdani FIS. The crisp output obtained is a score of the performance assessment results. In this study, the Centroid (Composite Moment) method is used.

Furthermore, testing and simulation are carried out to calculate the score of the performance assessment of lecturers by using fuzzy logic. Simulation was carried out using the Matlab software along with fuzzy logic toolbox which consists of two stages, namely:

1. Stage 1 is to get the value of each competency, based on each aspect assessed in the questionnaire. In this stage, the 64 rules were used. The following are the figures that show the work in stage 1.
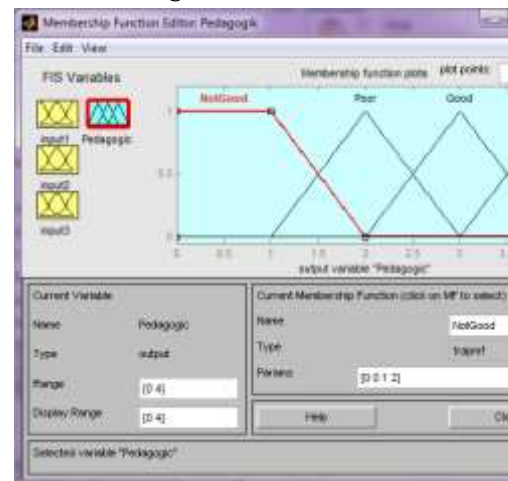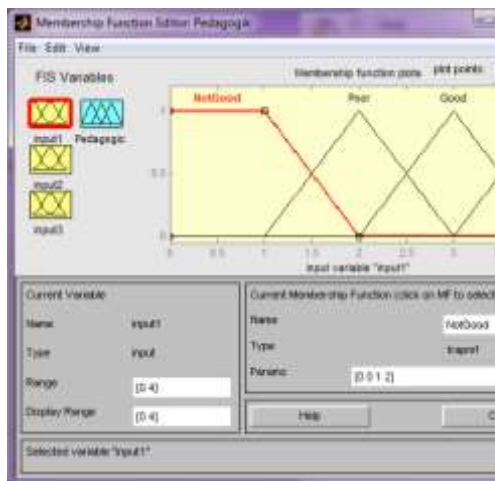

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Figure 8. FIS editor membership functions input variable aspects of the assessment.

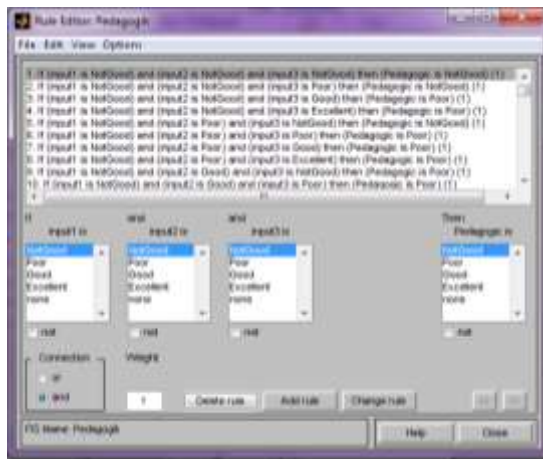**Figure 9.** FIS editor membership function output variable competency.

Figure 10. Rule editor for R1-R64.

To test whether the rules is in accordance with the objectives to be achieved, the value of each aspect in Table 2 were entered to get the competency value. Examples of results of competency output variables (Pedagogic, Professional, Personality, and Social) for L2 are presented in the following figure:
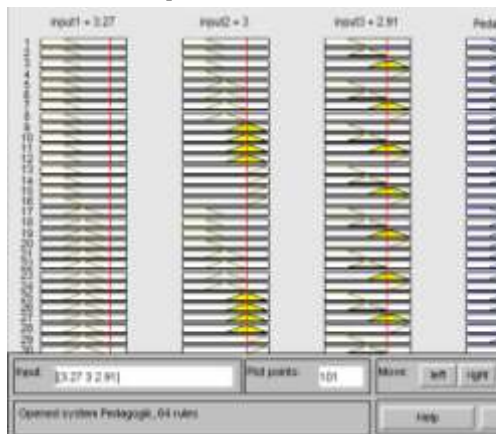

Figure 11. Examples of output from Pedagogic Competencies.
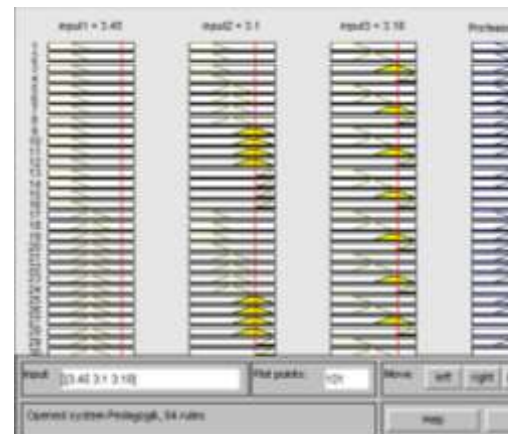
Figure 12. Examples of output from Personality Competencies.
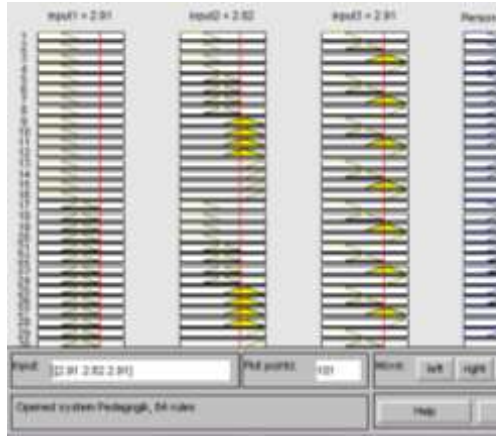
Figure 13. Examples of output from Professional Competencies.
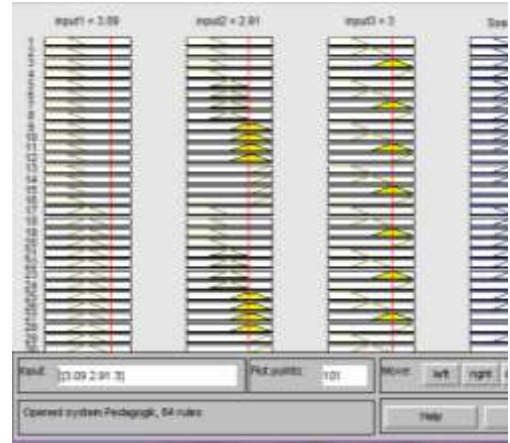

Figure 14. Examples of output from Social Competencies.

2. Stage 2 is to get the results of the lecturer performance assessment, based on the value of each competency from the previous stage. In this stage, 259 rules were used. The following are the figures that show the work in stage 2.
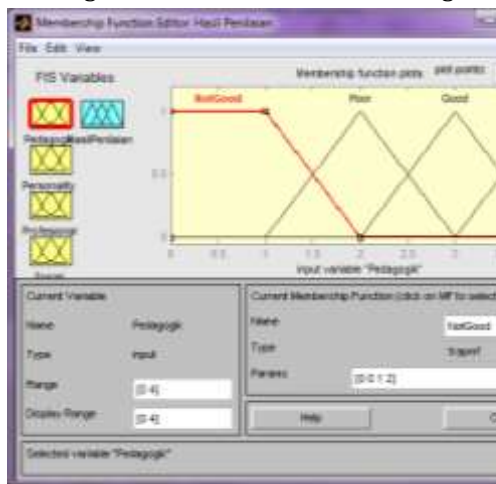

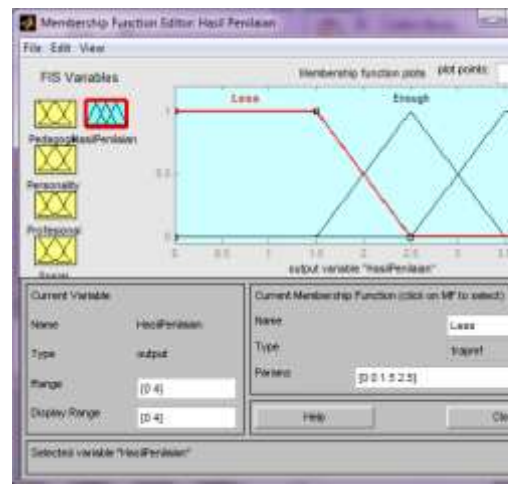**Figure 15.** FIS editor membership function competency input variable.

Figure 16. FIS editor membership function output variable Performance Results.

Figure 17. Rule editor for R1-R259.

To test whether the rules are in accordance with the objectives to be achieved, the value of each competency was entered in Table 3 to get the results of the lecturers' performance. Examples of the results of the lecturer performance output variable for L2 are presented in Figure 18.
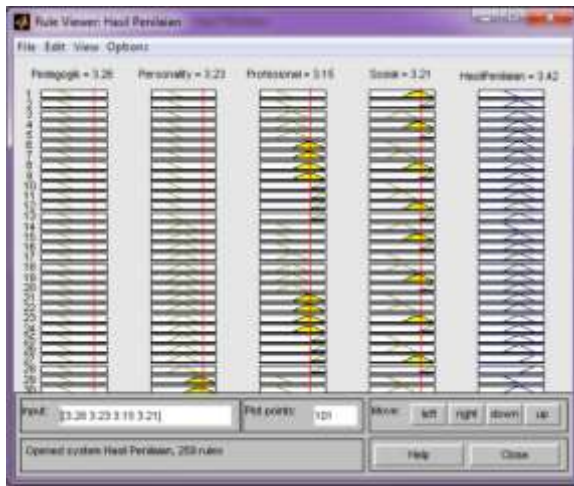

Figure 18. Examples of outputs of lecturer performance.

Based on the testing and simulation, data analysis was done by comparing the scores of the results of the lecturers' performance evaluation which were calculated on average and using fuzzy logic. The simulation resulted in the calculation of the output of Lecturer Performance Results as presented in Table 3.

Table 3. Data from assessment processing based on FIS and average assessment results.

Lecturers	Competency				Rating Result (*fuzzy*)	Rating Result (average)
	Pedagogic *fuzzy*	Professional *fuzzy*	Personality *fuzzy*	Social *fuzzy*		
D1	3.26	3.23	3.15	3.21	3.42	3.66
D2	3.00	3.02	2.88	3.00	3.45	3.05
D3	3.09	3.13	3.03	3.07	3.45	3.46
D4	3.13	3.02	3.07	3.10	3.45	3.45
D5	3.24	3.33	3.26	3.50	3.38	3.84
D6	2.79	3.01	2.59	2.50	3.06	2.99
D7	3.13	3.29	3.09	3.17	3.42	3.70
D8	3.33	3.46	3.21	3.26	3.39	3.83
D9	3.26	3.29	3.33	3.36	3.41	3.82
D10	3.26	3.09	3.26	3.13	3.42	3.74
D11	3.29	3.38	3.24	3.24	3.40	3.84
D12	3.21	3.06	3.13	3.09	3.43	3.59
D13	3.09	3.13	3.09	3.17	3.44	3.47
D14	3.15	3.23	3.02	3.07	3.43	3.59
D15	3.09	3.13	3.01	2.88	3.45	3.41
D16	2.62	3.06	3.00	2.78	3.40	3.22
D17	3.06	3.17	3.00	3.04	3.44	3.34
D18	3.02	3.17	3.01	3.04	3.44	3.45
D19	3.17	3.17	3.13	3.21	3.43	3.62

D20	3.13	3.09	3.17	3.13	3.44	3.68
D21	3.21	3.17	3.29	3.31	3.42	3.77
D22	3.10	3.09	3.09	3.13	3.45	3.62
D23	3.31	3.24	3.31	3.29	3.42	3.82
D24	3.18	3.17	3.17	3.15	3.44	3.74

The main focus of the data analysis is the fuzzy evaluation results and the results of the assessment using average. Before comparing the two assessment results, each assessment is first examined. The lecturer performance appraisal scale on the average value of lecturer performance set by the "Penjaminan Mutu Fakultas" is 0 to 4 with the following details:

- "Poor", for the score of between 0 to 2.
- "Fair", for the score of between 2 to 3.
- "Good", for the score of between 3 to 4.

Based on the assessment results using the average (Table 3), all lecturers has a performance title of "Good". However, D6 has the title "Enough" because it gets a value of 2.99 which is on a scale of 2-3. Calculated using the average, the final result

shows as if D5 and D11 are lecturers who perform the most "Good" because they have a value of 3.84 but, in fact, other lecturers who have grades between 3-4 also have a "Good" performance. The results of the average assessment appears as such that it may be interpreted as the sequence of lecturers who get the highest value to the lowest.

This study using fuzzy modeling is expected to eliminate the assumption of the lecturer sequence from the highest value to the lowest, or vice versa. With fuzzy logic and modeling that has been created, results of evaluations using fuzzy should be observed in Table 3. By observing Figure 7 and equation (9) - (11), if one of the lecturer values is taken, namely D6 with a value of 3.06 and substituted into equation (9) - (11), it yields:

$$\mu_{Poor}[3.06] = 0$$

$$\mu_{Fair}[3.06] = \frac{3.5 - 3.06}{3.5 - 2.5} = \frac{0.44}{1} = 0.44 \qquad \mu_{Good}[3.06] = \frac{3.06 - 2.5}{3.5 - 2.5} = \frac{0.56}{1} = 0.56$$
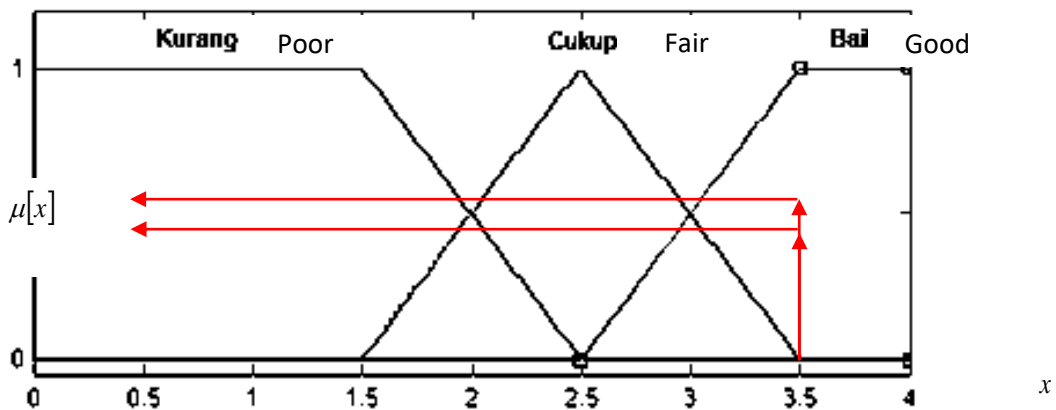

Figure 19. D6 performance results.

Figure 19 explains that D6 has performance results between "Fair" and "Good". The calculation results from D6 are obtained and, it can be interpreted that D6 has a performance that is more than "Fair", closing to "Good" performance.

As it can be seen in Table 3 and Figure 7, D2 with a value of 3.45 is in two fuzzy sets, namely "Fair" and "Good". To find out which predicate is appropriate, it is first substituted into equation (9) - (11) as follows:
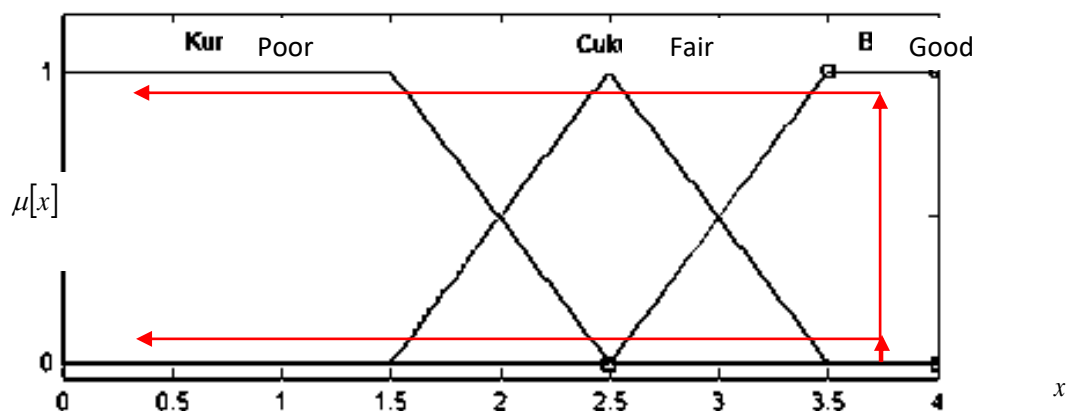
$$\mu_{Poor}[3.45] = 0$$

$$\mu_{Fair}[3.45] = \frac{3.5 - 3.45}{3.5 - 2.5} = \frac{0.05}{1} = 0.05 \qquad \mu_{Good}[3.45] = \frac{3.45 - 2.5}{3.5 - 2.5} = \frac{0.95}{1} = 0.95$$

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Figure 20. D2 performance results.

The calculation results from D2 are $\mu_{Fair}[3.45] = 0.05$ and $\mu_{Good}[3.45] = 0.95$ can be interpreted that D2 has a performance more than "Fair" closing to "Good" performance, and also shown in Figure 20. If D2 has a value greater than or equal to 3.50, then the lecturer has a "Good" performance with a membership degree of value 1. Simple fuzzy modeling in this study cannot be ordered from the highest value to the lowest value because the output will return to the very fuzzy set.

D2 and D6 both show performance that moves away from "Fair" and approaching "Good" performance with their respective membership degrees. However, when compared with D2, D6 must further increase the value of each competency to achieve "Good" performance, so that the membership level can be one or close to one.

CONCLUSION

From the results of the research and discussion in this study, it can be concluded that by using FIS Mamdani, each lecturer shows a performance evaluation that is more than "Fair" and approaches the "Good" performance based on the criteria set by the faculty. If the average value is used, all lecturers have a "Good" performance, except for one lecturer who shows "Fair" performance. Fuzzy modeling can thus be used as a comparison in processing lecturer performance evaluation results which are calculated using the average value. To improve or maintain the predicate of lecturers' performance evaluation, each lecturer can look at the values of each competency that is still lacking.

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