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Level of student satisfaction on lecturer performance with fuzzy inference system (FIS) tsukamoto method

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Abstract. To improve the quality of students in higher education is inseparable from how the performance of lecturers in the teaching-learning process. The quality of lecturers greatly influences how the quality of graduates will be. Qualified lecturers can be seen from the lecturers' performance in delivering learning material, assessment, discipline, behaviour and appearance. Lecturer performance evaluation can be assessed by students and assessors by study programs through questionnaires in which there are several aspects of assessment. The data processing of the questionnaire will use the Tsukamoto fuzzy method. The Mamdani method is often also known as the average method. In this method, there are 4 the stage for obtaining output, namely the formation of fuzzy sets, application function implications, rule composition and defuzzification. With the fuzzy mamdani method, information will be generated in the form of output of the success level of the teaching lecturer.

1. Introduction

Teaching is one of the activities of lecturers who are directly related to students. Teaching and learning activities in higher education not only provide material, but also foster a creative, innovative, proactive, and developing student potential as well as forming thinking patterns for students. Healthy and effective organizations and management and supported by professional lecturers strongly support the quality of the teaching and learning process, the quality of graduates and the quality of Tri Dharma services to stakeholders [1]. So that it can increase the value of the university's accreditation. Fuzzy systems have closeness to human reasoning so that the solutions obtained are easy to implement and understand. By utilizing fuzzy systems, it can be used as an evaluation of the perceptions of complaints of each consumer to measure the level of customer satisfaction [2]. In Tsukamoto's fuzzy system, each rule takes the form of a causal implication in which each rule is represented in a fuzzy set with monotonous membership. The application of the Tsukamoto method can determine the results of the level of student satisfaction based on the performance of the lecturer.

2. Theory

Fuzzy logic was first introduced by Lotfi A. Zadeh. Fuzzy logic is a logic that has obscurity/correctness between right and wrong or between 0 and 1 [3]. Fuzzy logic was born in line with imprecise natural phenomenon, which is reviewed from people's perspectives in which no condition or statement is exactly right or wrong. Prof. Lotfi A. Zadeh suggests that the concept of true or false in Boolean logic cannot represent uncertain statements between



the statements of true or false similar to the real world. To represent the uncertainty values between the true or false, Prof. Lotfi A. Zadeh suggests that fuzzy set is a class of objects with a united series of membership grades. A set is characterised by functions, which gives each object a membership grade from 0 to 1. Ideas of inclusion, union, intersection, complement, relations and convexity are given to the set; and various properties of these ideas, in the context of fuzzy set, are constructed. Particularly, a hypothesis of convex fuzzy sets is proved without dashed fuzzy sets.

2.1. Fuzzy set

Fuzzy set has two attributes [4], as follows:

- a. Linguistics is a naming of a group which stands for a particular condition with natural language, such as: very less, less and fair.
- b. Numeric is a value (number) indicating a size of variables, such as: 45, 46, or 59b. Zero (0), which means that an item does not belong to a set.

2.2. Membership function

Membership function is a curve showing a point mapping points of inputting data into membership values (often called membership grades), whose interval is between 0 and 1. One method applied to obtain the membership grades is the function approach. There are several functions that can be used, namely: Linear Representation, Triangle Curve Representation and Shoulder-Shaped Curve Representation.

2.3. Fuzzy-Rule Based Systems

Linguistic variable is a numerical interval with linguistic values, which is defined by its membership functions. The fuzzy-rule based system consists of three main components: fuzzification, inference and defuzzification.

- a. Fuzzification is a value mapping process of crisp-inputs coming from the system (non-fuzzy scales) controlled into a fuzzy set along with its membership functions. The fuzzyset is fuzzy inputs being processed in the next fuzzical process. To change crisp inputs into fuzzy inputs requires determining membership functions for each crisp input, then a fuzzification process will take crisp inputs and compare them with the existing membership functions to generate values of fuzzy inputs [6].
- b. Inference is a proceeded relationship between values of crisp input and values of crisp output, which are expected by particular rules. These rules will determine the system's response towards various conditions of setting points and disruptions in the system. The used rules are IF-THEN.
- c. Defuzzification is a stage where min values ($\alpha_1, \alpha_2 \dots \alpha_n$) are defined, then finding the value of z_1 (approximate values), calculating crisp values, and outputs. The stage is illustrated below.

$$Z^* = \frac{Z_1 * \text{pred1} + Z_2 * \text{pred2} + Z_3 * \text{pred3} \dots Z_n * \text{predn}}{\text{pred1} + \text{pred2} + \text{pred3} \dots \text{predn}}$$

2.4. Fuzzy Inference System (Method Tsukamoto)

In Tsukamoto method, each consequence of the IF-Then rules must be represented by a fuzzy set with monotonous membership function. Consequently, the interference outputs of

each rule are crisply presented in line with α -predicate (fire strength). The end result is obtained by a weighted average.

When the process of evaluation in inference in the tsukamoto method is carried out using the MIN implication function to get the α -predicate value of each rule ($\alpha_1, \alpha_2, \alpha_3, \dots, \alpha_n$). Each α -predicate value is used to calculate the results of explicit inference (crisp) of each rule ($z_1, z_2, z_3, \dots, z_n$). For the defuzzification process in the Tsukamoto method use the average method with the following formula:

$$Z = \frac{\sum \alpha_i \cdot z_i}{\sum \alpha_i}$$

The final results are obtained using weighted averages.

Broadly speaking, the block diagram of the Tsukamoto method fuzzy inference system is as shown below.

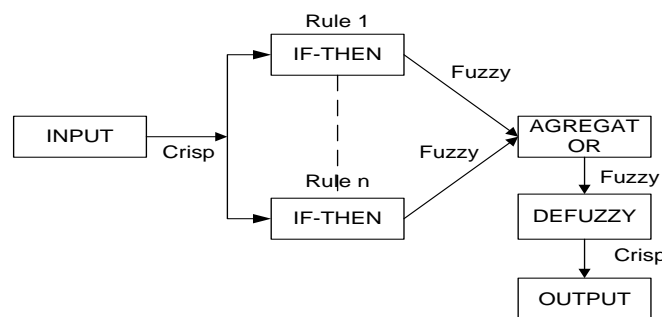


Figure 1. Block diagram of Fuzzy Tsukamoto inference system

3. Research Method

The research methodology uses Fuzzy Tsukamoto logic inference technique to conduct an analysis of the level of student satisfaction with the Lecturer, in this case the author carries out several stages as follows:

- a. Data Collection
Sources of data from this study were taken directly from STIKOM Medan
- b. Data Initialization
The collected data is identified and classified according to the group. In addition, it also determines the validity of the data and variables that will be used. In the data initialization stage, a fuzzy variable interval is made as the basis for fuzzification formation.
- c. Fuzzification process
The results of the data initialization will then be clarified, each fuzzy variable in the input data will be divided into five fuzzy sets, which are very satisfied, satisfied, satisfied and dissatisfied. All fuzzy sets for each fuzzy variable in the input data are represented by using the same membership function, namely the shape of the curve of the shoulder.
- d. Making Fuzzy Tsukamoto Rules
The results of data fuzzyfication then the data is processed using predetermined fuzzy Tsukamoto to produce the basic rules of the fuzzy inference model.
- e. Fuzzy Inference Process.
From the rule that has been generated, the fuzzy inference process is performed using Tsukamoto's fuzzy inference, to get a fuzzy value then the fuzzy value will be deflused.

f. Defuzzification

The results of the inferensifuzzy Tsukamoto method are fuzzy numbers (blurred) then it is returned to the firm number (crisp) by doing defuzzification, and produces output in the form of the level of student satisfaction towards the lecturers of the Tsukamoto model.

4. Result and Discussion

The results of the research taken from the questionnaire given to active students in the STIKOM Medan Information System Study Program. For testing the research, the number of respondents was 100 active students, then processed using Microsoft Excel to tabulate respondents' answers and look for the total score given by each respondent, to get the lowest score and the highest score used to determine the interval value of the fuzzy function. As explained in the previous chapter, that this study will determine the value of student satisfaction towards lecturers measured from 5 (five variables) namely teaching readiness, teaching material, teaching discipline, teaching evaluation and lecturer personality which is then symbolized by X1, X2, X3, X4 and X5.

The following table 1 shows that the results of the study used 100 sample input data with the results of each percentage of student satisfaction towards the lecturer.

Table 1. Criteria of Input and Output Variable

Function	Variable	Set	Universe	Domain
Input	X1,X2,X3,X4,X5	Not satisfied	[0 100]	[0 20 40]
		Quite satisfied	[0 100]	[20 40 60]
		Satisfied	[0 100]	[40 60 80]
		Very satisfied	[0 100]	[60 80 100]
Output	Student Satisfaction	Not satisfied	[0 100]	[0 20 40]
		Quite satisfied	[0 100]	[20 40 60]
		Satisfied	[0 100]	[40 60 80]
		Very satisfied	[0 100]	[60 80 100]

Table 2. Results of the Manual Questionnaire

Number of Samples	Variable	Variable Value (%)				The Highest Score
		Very satisfied	Satisfied	Quite satisfied	Not satisfied	
100	X ₁	15	56	28	2	56 (Satisfied)
	X ₂	11	56	31	2	56 (Satisfied)
	X ₃	14	59	25	2	59 (Satisfied)
	X ₄	15	52	23	1	52 (Satisfied)
	X ₅	20	53	23	4	53 (Satisfied)

Table 3. Fuzzy Rules

Rule		X1	X2	X3	X4	X5	Score	
R1	IF	Satisfied	Satisfied	Satisfied	Satisfied	Satisfied	THEN	Satisfied
R2	IF	Satisfied	Satisfied	Satisfied	Satisfied	Very satisfied	THEN	Very satisfied
R3	IF	Satisfied	Satisfied	Satisfied	Satisfied	Very satisfied	THEN	Satisfied
...
R20	IF	Very satisfied	Very satisfied	Very satisfied	Satisfied	Very satisfied	THEN	Very satisfied

Based on the data that has been obtained from the average value of filling in student questionnaires namely 75 teaching readiness, 73 teaching material, 75 teaching discipline, 74 teaching evaluation, and lecturer personality 75.

After inputting the questionnaire results data to the results of the Tsukamoto inference using Excel then the results are then compared. In table 4, it follows that this comparison uses 100 sample input data with the results of each percentage of student satisfaction towards lecturers.

Table 4. Research Comparative Analysis

Number of Samples	Variable Value (%)					Avarage (Manually)	Tsukamoto
	X ₁	X ₂	X ₃	X ₄	X ₅		
100	56	56	59	52	53	55,2 (Satisfied)	67.60 (Satisfied)

Some of the respondents, 56% said they were satisfied with the performance of the lecturers' results on the teaching readiness variable and teaching material, 59% satisfied with the teaching discipline. 52% were satisfied with the teaching evaluation variable and 53% were satisfied with the personality of the lecturer and on average 55.2% of students were satisfied with the lecturer. While the results obtained for the level of lecturer satisfaction with the Tsukamoto method, a 67.60% assessment was obtained with satisfaction levels satisfied.

5. Conclusion

The measurement of student satisfaction uses fuzzy logic with dynamic values so that it always gets a value of less satisfaction and very good satisfaction, even though the set is not obtained. Fuzzy models with membership values using the shoulder curve function are intended to get the best value from the less and the worst value from the bad or find the best value from the good and the lowest value from the good.

Providing recommendations to other universities in charge of academics to test the truth of the rule approach possessed by the ability of lecturers to refer to competency-based curricula

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