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# *APPLICATION OF FUZZY MAMDANI LOGIC IN DETERMINING TEACHER PERFORMANCE TO THE LEARNING SYSTEM AT PUBLIC HIGH SCHOOL 6 BENGKULU MIDDLE*

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***ABSTRACT***
*Nowadays, the process of assessing teacher performance at State High School 6 Bengkulu Middle is still manually, namely by filling in the scores on each criterion consisting of 14 competencies, then the values are added together to get the final result of the teacher performance assessment. However, this takes quite a long time, besides that the assessment of teacher performance is only by looking at teachers who are active in various fields in the school. The application of teacher performance in State High School 6 Bengkulu Middle can help provide the results of teacher performance assessment of the learning system in schools through a fuzzy Mamdani logic approach. The application of teacher performance to the learning system at State High School 6 Bengkulu Middle was created using the Visual Basic .Net programming language and SQL Server 2008r2 Database. Based on the black box testing that has been carried out, it was found that the functionality of the teacher performance application to the learning system at State High School 6 Bengkulu Middle went well as expected and was able to analyze teacher assessment data through the Fuzzy Mamdani Method to determine teacher performance against the learning system in schools.*

***Keywords:*** *Fuzzy Mamdani Logic, Teacher Performance, State High School 6 Bengkulu Middle*

## 1. Introduction

The rapid development of information and communication technology makes us aware of the importance of information (Chen & Sivakumar, 2021). Information media and telecommunications are media that can be used in the process of information transactions. In everyday life, information technology is very useful, with information it will help us to make a decision more precisely based on the data obtained in the form of information (Szymkowiak et al., 2021; Hamzah et al., 2022).

In the learning process, teachers are required to manage so that the learning process can run well. In order for the functions and duties attached to the functional position of the teacher to be carried out in accordance with applicable rules, an assessment of teacher performance is needed. Performance appraisal is a method or tool used to record and assess the achievement of the implementation of activities carried out based on goals, objectives and strategies, so that the progress of the organization can be known. Teacher performance proves the success rate of a teacher in delivering learning materials to students. Teacher performance appraisals usually take place over a period of time once a year (Bone et al., 2021; Lohman, 2021).

High School 6 Bengkulu Middle is one of the high schools in Bengkulu City. So far, the process of assessing teacher performance in schools is still manually, namely by filling in the scores on each criterion consisting of 14 competencies, then the values are added together to get the final result of the teacher performance assessment. However, this takes quite a long time, besides that the assessment of teacher performance is only by looking at teachers who are active in various fields in the school (Mito et al., 2021).

Therefore, in this study, system development was carried out by making applications in determining teacher performance of the learning system at High School 6 Bengkulu Middle through a computerized-based mathematical approach to Fuzzy Mamdani Logic (Ningrum et al., 2021; Mavani et al., 2021; Ashiedu, 2022).

Fuzzy logic is one of the components that make up Soft Computing. The basis of fuzzy logic is fuzzy set theory. In fuzzy set theory, the role of the degree of membership as a determinant of the presence of elements in a set is very important (Serrano-Guerrero et al., 2021).

Fuzzy logic was first introduced by Zadeh in 1965. The basis of fuzzy logic is fuzzy set theory. In fuzzy set theory, the role of the degree of membership or the value of membership as a determinant of the presence of elements in a set is very important. In the crisp set, the membership value is only two possibilities, namely 0 and 1, while in the fuzzy set, the membership value is located in the range of 0 to 1 (Rasulova, & Salieva, 2021; Thakkar, et al., 2021).

Fuzzy logic is used to map an insert variable into the process and will generate output using the IF-THEN rule. The use of fuzzy logic can be developed as an expert system, because it can produce output as if it were an expert. In addition, fuzzy logic can store the knowledge of experts stored in the knowledge base and can predict future events (Sharma et al., 2021).

Teacher performance is the ability of a teacher to carry out learning tasks at school and is responsible for students under his guidance by improving student learning achievement. Therefore, teacher performance can be interpreted as a condition that shows the ability of a teacher to carry out his duties at school (Chen et al., 2022; Dumitrescu et al., 2021).

Visual Studio 2010 (Microsoft Visual Basic .Net) is a tool for developing and building applications that move on top of the .Net Framework system, using the basic language. Using this tool, programmers can build windows form applications, ASP.Net-based web applications and also command-line applications. The Visual Basic .Net language itself adheres to the object-oriented programming language paradigm which can be seen as an evolution of previous versions of Microsoft Visual Basic implemented on top of the .Net Framework.

## 2. Research Methodology

The research method used by the author is the Waterfall method. The waterfall method is often called the classic life cycle, which describes a systematic and sequential approach to software development, starting with the specification of user needs and then continuing through the stages of planning, modeling, construction, and system delivery to customers/users (deployment), which ends with support for the complete software produced. The stages of the waterfall method can be seen in figure 1 (Alsagaby & Alharbi, 2021).

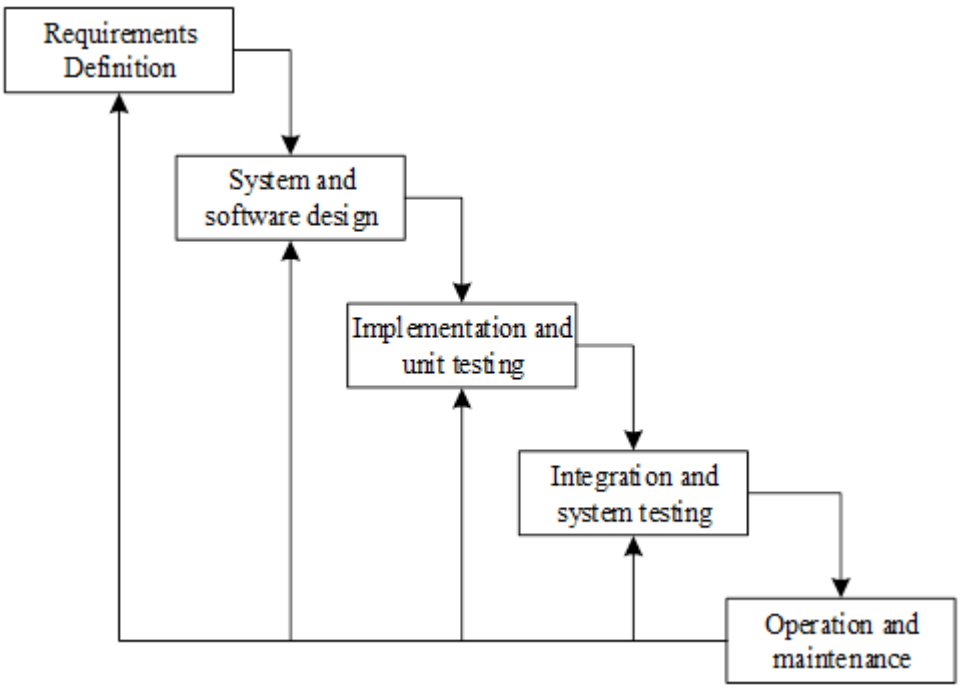



Fig. 1 Stages of the Waterfall Method

Mamdani's Fuzzy Logic Method

The Mamdani method is often also known by the name of Max-Min Method. Using Min on the implication function and Max on the composition of the Interfunctional implications. There are 4 stages to get the output, including

- ✓ Formation of fuzzy sets

  In the Mamdani method, both input variables and output variables are divided into one or more sets.
- ✓ Function app Implications

  In the Mamdani method, the implication function used is Min
- ✓ Composition of rules

  There are 3 methods used in inference of fuzzy systems, namely:
  1). Max Method (maximum)
  2). Additive Method (Sum)
  3). Probabilistic OR Method (Probor)
- ✓ Affirmation (Defuzyy)

  The input of the defuzzy process is a fuzzy set obtained from the composition of fuzzy rules. In contrast, the resulting output is a number in the domain of the fuzzy set. If given a fuzzy set in a certain range, it must be able to take a certain crisp value as output. in this study using the Centroid method.

3. Knowledge Acquisition

$$\mu_{Bad}(z) = \begin{cases} 1 & x \leq 0 \\ \frac{25-x}{25-0} & 0 \leq x \leq 25 \\ 0 & x \geq 25 \end{cases}$$

$$\mu_{Not\ Good\ Enough}(z) = \begin{cases} 0 & x \leq 25\ or\ x \geq 50 \\ \frac{x-0}{25-0} & 0 \leq x \leq 25 \\ \frac{50-x}{50-25} & 25 \leq x \leq 50 \end{cases}$$

$$\mu_{Good\ Enough}(z) = \begin{cases} 0 & x \leq 25\ or\ x \geq 75 \\ \frac{x-25}{50-25} & 25 \leq x \leq 50 \\ \frac{75-x}{75-50} & 50 \leq x \leq 75 \end{cases}$$

$$\mu_{Good}(z) = \begin{cases} 0 & x \leq 50\ or\ x \geq 100 \\ \frac{x-50}{75-50} & 50 \leq x \leq 75 \\ \frac{100-x}{100-75} & 75 \leq x \leq 100 \end{cases}$$

$$\mu_{Excellent}(z) = \begin{cases} 0 & x \leq 75 \\ \frac{x-75}{100-75} & 75 \leq x \leq 100 \\ 100 & x \geq 100 \end{cases}$$

Sample data on the performance assessment of teacher Eka Septi Kusmeriyati, S.Pd where the scores obtained in the 14 competencies are as shown in Table 1.

Table 1 - Data of Competencies

| Membership Degree Value |
|---|

| Competency Code | Value | Excellent | Good | Good Enough | Not Good Enough | Bad |
|---|---|---|---|---|---|---|
| K1 | 75 | 0 | $\frac{75-50}{75-50} = 1$ | 0 | 0 | 0 |
| K2 | 75 | 0 | $\frac{75-50}{75-50} = 1$ | 0 | 0 | 0 |
| K3 | 75 | 0 | $\frac{75-50}{75-50} = 1$ | 0 | 0 | 0 |
| K4 | 77 | $\frac{77-75}{100-75} = 0{,}08$ | $\frac{100-77}{100-75} = 0{,}92$ | 0 | 0 | 0 |
| K5 | 71 | 0 | $\frac{71-50}{75-50} = 0{,}84$ | $\frac{75-71}{75-50} = 0{,}16$ | 0 | 0 |
| K6 | 75 | 0 | $\frac{75-50}{75-50} = 1$ | 0 | 0 | 0 |
| K7 | 70 | 0 | $\frac{70-50}{75-50} = 0{,}8$ | $\frac{75-70}{75-50} = 0{,}2$ | 0 | 0 |
| K8 | 70 | 0 | $\frac{70-50}{75-50} = 0{,}8$ | $\frac{75-70}{75-50} = 0{,}2$ | 0 | 0 |
| K9 | 70 | 0 | $\frac{70-50}{75-50} = 0{,}8$ | $\frac{75-70}{75-50} = 0{,}2$ | 0 | 0 |
| K10 | 75 | 0 | $\frac{75-50}{75-50} = 1$ | 0 | 0 | 0 |
| K11 | 67 | 0 | $\frac{67-50}{75-50} = 0{,}68$ | $\frac{75-67}{75-50} = 0{,}22$ | 0 | 0 |
| K12 | 67 | 0 | $\frac{67-50}{75-50} = 0{,}68$ | $\frac{75-67}{75-50} = 0{,}22$ | 0 | 0 |
| K13 | 67 | 0 | $\frac{67-50}{75-50} = 0{,}68$ | $\frac{75-67}{75-50} = 0{,}22$ | 0 | 0 |
| K14 | 75 | 0 | $\frac{75-50}{75-50} = 1$ | 0 | 0 | 0 |

R01 $\alpha_1$ = min {0; 0 ; 0; 0,08; 0; 0; 0; 0; 0; 0; 0; 0; 0; 0} = 0
See the set of excellent teacher performance
(z-75)/100) = 0
Z – 75 = 0 x 100
Z – 75 = 0
$Z_1$ = 75 + 0 = 75

R02 $\alpha_2$ = min {1; 1; 1; 0,92; 0,84; 1; 0,8; 0,8; 0,8; 1; 0,68; 0,68; 0,68; 1} = 0,68
View good teacher performance set
(z-50)/100) = 0,68
Z – 50 = 0,68 x 100
Z – 50 = 68
$Z_2$ = 50 + 68 = 118

R06 $\alpha_2$ = min {1; 1; 1; 0,08; 0,84; 1; 0,8; 0,8; 0,8; 1; 0,68; 0,68; 0,68; 1} = 0,08
View good teacher performance set
(z-50)/100) = 0,08
Z – 50 = 0,08 x 100
Z – 50 = 8
$Z_2$ = 50 + 8 = 58

R15 $\alpha_3$ = min {0; 0; 0; 0; 0,16; 0; 0,2; 0,2; 0,2; 0; 0,22; 0,22; 0,22;0} = 0
See the set of teacher performance Good Enough
(z-25)/75) = 0
Z – 25 = 0 x 75
Z – 25 = 0
$Z_3$ = 25 + 0 = 25

R30 $\alpha_4$ = min {0; 0; 0; 0; 0; 0; 0; 0; 0; 0; 0; 0; 0; 0; 0} = 0
See the set of teacher performance Good Enough
(z-0)/50) = 0
Z – 0 = 0 x 50
Z – 0 = 0
$Z_4$ = 0 + 0 = 0

R45 $\alpha_5$ = min {0; 0; 0; 0; 0; 0; 0; 0; 0; 0; 0; 0; 0; 0; 0} = 0
See the set of teacher performance is Not Good
(z-0)/25) = 0
Z – 0 = 0 x 25
Z – 0 = 0
$Z_4$ = 0 + 0 = 0

The last step is to carry out affirmation (defuzzyfication), where in this study defuzzyfication using the Centroid Method, so that crisp values are obtained:

$$z^* = \frac{\sum_{j=1}^{n} z_j \mu(z_j)}{\sum_{j=1}^{n} \mu(z_j)}$$

$$z^* = \frac{0 * 75 + 0{,}68 * 118 + 0{,}08 * 58 + 0 * 25 + 0 * 0 + 0 * 0}{0 + 0{,}68 + 0{,}08 + 0 + 0 + 0}$$

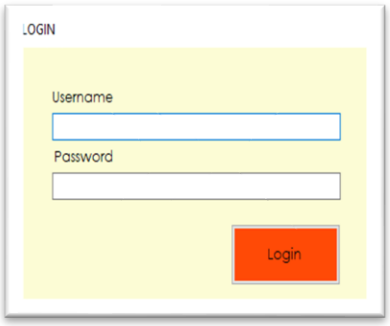
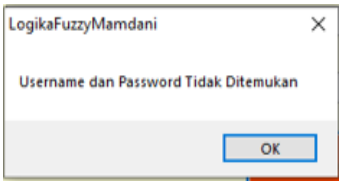
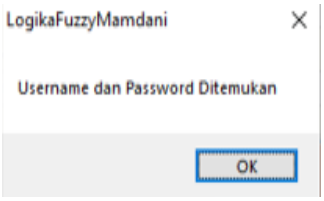
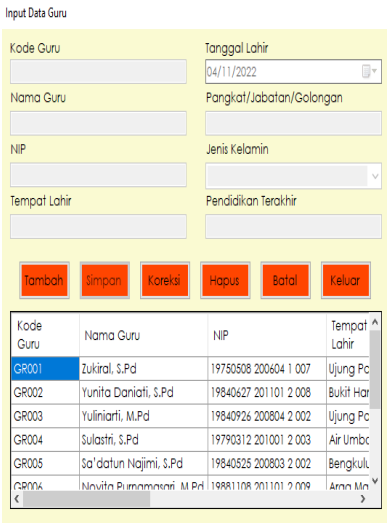
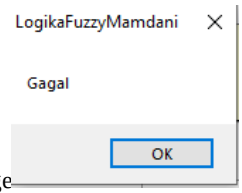
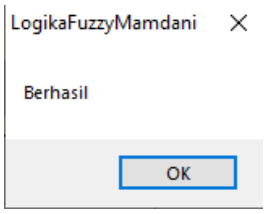
$$z = \frac{84{,}88}{0{,}76} = 111{,}68 \quad (Excellent)$$

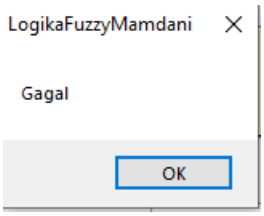
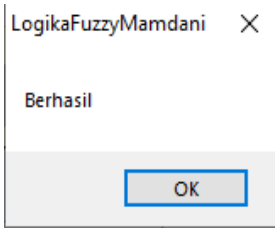
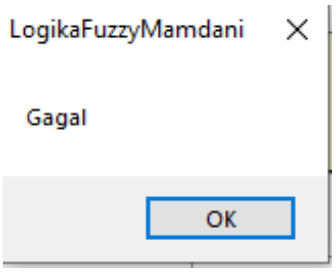
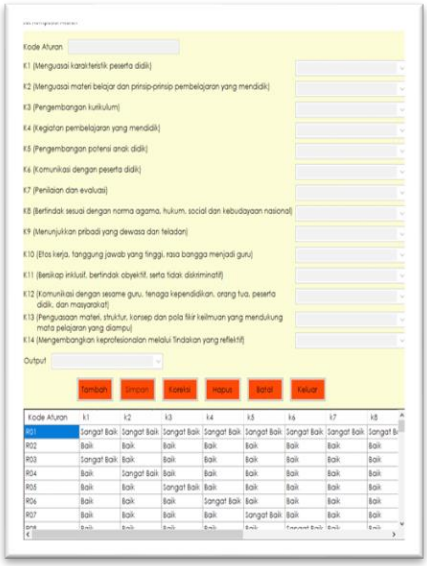
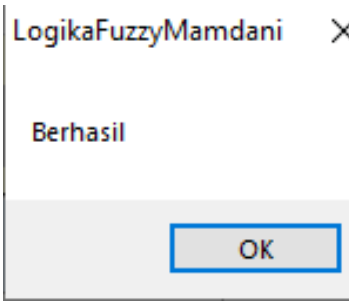
## 4. Results and Discussions

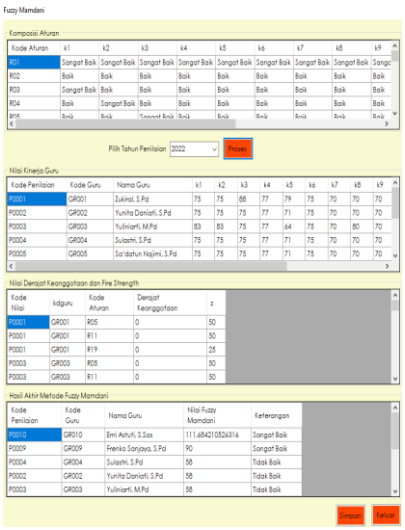
Blackbox testing is one of the software testing methods that focuses on functionality, especially on the input and output of teacher performance applications to the learning system at High School 6 Bengkulu Middle. The results of the black box testing that has been carried out on the application of teacher performance to the learning system at High School 6 Bengkulu Middle, are shown in table 1.

Table 1 - Test Results

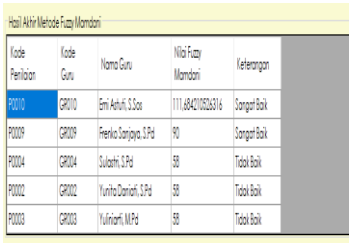
| No. | Tested Form | Test Scenario | Test result | Conclusion |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| 1 | Login Form<br>  | Entering the wrong username or password | The system denies access to the login by displaying an error message<br>  | As expected |
| | | Enter the correct username and password | The system receives such login access by displaying a successful message<br>  | As expected |
| 2 | Teacher Data Input Form<br>  | Store existing teacher data in a database | The system denies access to store such data by displaying an error message<br>  | As expected |
| | | Store teacher data that doesn't already exist in the database | The system receives access to save that data and displays a successful message<br>  | As expected |
| 3 | Teacher Performance Data Input Form | Store existing teacher assessment data in a database | The system denies access to store such data by displaying an error | As expected |

| | | | | |
|---|---|---|---|---|
| | |  | message   | |
| | | Stores teacher assessment data that is not already in the database | The system receives access to save that data and displays a successful message   | As expected |
| 4 | Rule Composition Data Input Form | Store existing rule composition data in a database | The system denies access to store such data by displaying an error message   | As expected |
| |  | Store rule composition data that doesn't already exist in the database | The system receives access to save that data and displays a successful message   | As expected |
| 5 | Fuzzy Tsukamoto Method Form | Conducting the Fuzzy Mamdani method process on teacher assessment data based on the | The system successfully displays the final results of the mamdani fuzzy for each teacher and provides information on the results of the teacher performance | As expected |



selected assessment assessment year.



Based on the black box testing that has been carried out, it was found that the functionality of the teacher performance application to the learning system at High School 6 Bengkulu Middle went well as expected and was able to analyze teacher assessment data through the Fuzzy Mamdani Method to determine teacher performance of the learning system in schools.

## 5. Conclusions

Based on the results of the discussion and testing that has been carried out, it can be concluded that: The application of teacher performance at High School 6 Bengkulu Middle can help provide the results of teacher performance assessment of the learning system in schools through a fuzzy Mamdani logic approach. The application of teacher performance to the learning system at High School 6 Bengkulu Middle was made using the Visual Basic .Net programming language and SQL Server 2008r2 Database. Based on the black box testing that has been carried out, it was found that the functionality of the teacher performance application to the learning system at High School 6 Bengkulu Middle went well as expected and was able to analyze teacher assessment data through the Fuzzy Mamdani Method to determine teacher performance of the learning system in schools.

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