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Implementation of Mamdani Fuzzy Method in Employee Promotion System

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Abstract. Nowadays, employees are big assets to an institution. Every employee has a different educational background, degree, work skill, attitude and ethic that affect the performance. An institution including government institution implements a promotion system in order to improve the performance of the employees. Pangandaran Tourism, Industry, Trade, and SME Department is one of government agency that implements a promotion system to discover employees who deserve to get promotion. However, there are some practical deficiencies in the promotion system, one of which is the subjectivity issue. This work proposed a classification model that could minimize the subjectivity issue in employee promotion system. This paper reported a classification employee based on their eligibility for promotion. The degree of membership was decided using Mamdani Fuzzy based on determinant factors of the performance of employees. In the evaluation phase, this model had an accuracy of 91.4%. It goes to show that this model may minimize the subjectivity issue in the promotion system, especially at Pangandaran Tourism, Industry, Trade, and SME Department.

1. Introduction

Subjectivity is one of main problems in the process of employee promotion. It is very possible that someone in charge of the promotion process to give an employee a promotion just because the employee in question is a relative or close to him personally. This can negatively affect the organization since such promotion practice may position the wrong man in the wrong place. A good promotion process should be done openly to avoid a possible conflict of interest [1][2].

Mamdani Fuzzy is a method easy to be implemented and has been widely used in various fields like decision support systems, artificial intelligence, and so on[3][4]. This method is quite effective in doing classification. In addition, this method is also equipped with a rule-based generation that can be optimized to increase the speed up and accuracy of the results [5]. In previous works, this method produced good results, especially in health systems, financial management, and staffing [6][7][8][9].

This time, this method was implemented in an employee promotion system at Pangandaran Tourism, Industry, Trade, SME Department in order to minimize the subjectivity in the process of employee promotion.

2. Employee assessment analysis

Fuzzy logic is one of the constituent components of soft computing. The basis for fuzzy logic is the fuzzy set theory. In the fuzzy set theory, the role of the degree of membership as a determinant of elements in a set is critical since it becomes the main characteristic in the fuzzy logic reasoning [10][11].

Fuzzy logic offers several advantages such as being easy to understand and being able to be adjusted to certain needs. It is also tolerant towards fairly homogeneous data. It can implement the experiences of experts directly without having to go through the training process[10][12][13][14].

Assessors assess employees based on common sub-criteria agreed upon in the organization. The scoring system uses a 0 to 100 scale. Using Mamdani Fuzzy logic, the average score of each criterion will be the determinant variable of employee eligibility to get promotion. The criteria and sub criteria is outlined in Table 1. The first step is establishing the degree of membership. Figure 1 illustrates the degree of membership for variables average ability and average work completion.

Table 1. Assessment Criteria [7]

	Criteria	Sub criteria	Description
1.	Ability	Job Knowledge	Job description an individual needs to know so as to achieve a satisfactory achievement
		Dependability	The ability to perform well under minimum supervision
		Performance Under Pressure	The ability to remain calm under pressure and in a crisis situation
		Interpersonal Relationship	The ability to work collaboratively
		Creativity	The ability to generate new ideas
2.	Loyalty	Quantity of Work	The amount of work an individual can do within a working day
		Attendance	Having good attendance records
		Accuracy	Offering accurate performance
		Housekeeping	Cleanliness and order in the work area
		Courtesy	Being polite to others

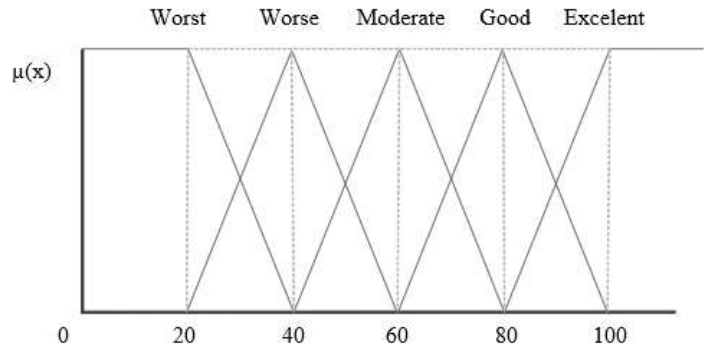

Figure 1. The Membership Function of a Fuzzy Set

In this work, a non-zero membership degree will be entered into the scoring rules used to determine the outcome. The average work completion and the average ability will be accumulated to obtain the scoring rules. The scoring rules are sorted from the best to the worst, from 5, 4, 3, 2, to 1 to represent **excellent, good, moderate, worse,** and **worst**. The weight of each fuzzy set of the two variables are added, halved, and rounded up if the result is greater than 3 and rounded down if the result is smaller than 3. The formula to do this calculation is:

$$Nilai = \frac{A + B}{2} \quad (1)$$

Note:
A= The weight of the fuzzy set for average ability
B= The weight of the fuzzy set for average work completion

Table 2. Scoring Rules

Average Ability	Average Work Completion				
	Excellent	**Good**	**Moderate**	**Worse**	**Worst**
Excellent	E	E	G	G	M
Good	E	G	G	M	W
Moderate	G	G	M	W	W
Worse	G	M	W	W	Wst
Worst	M	W	W	Wst	Wst

Based on the highest degree of membership in each fuzzy set, the scores of the following grades are:

- E = Excellent = 100
- G = Good = 80
- M = Moderate = 60
- W = Worse = 40
- Wst = Worst = 20

The value used in the defuzzification process is obtained through two stages. The first step is combining the degree of membership of the average ability variable (μA) and that of the average work completion variable (μB). The second step is determining the degree of membership to be used in the defuzzification process. The technique used in defuzzification is the center of average defuzzifier. The final results will be grouped using the following range:

- The total score greater than or equal to 75 is declared **eligible** for promotion.
- The total score lesser than 75 is declared ineligible for promotion.

3. The implementation of Mamdani Fuzzy

3.1. Defining variable of fuzzy

Table 3. Data Personal Assessment

Variable	
Linguistic	**Numeric**
Average ability score	73
Average loyalty score	81

Table 3 shows that an employee has an average ability score of 73 and an average loyalty score of 81. These scores will be computed using the following formulae:

μAbility Moderate [73] $$\frac{x-60}{20} = \frac{73-60}{20} = 0{,}65 \quad (2)$$

μAbility Good [73] $$\frac{80-x}{20} = \frac{80-73}{20} = 0{,}35 \quad (3)$$

μLoyalty Good [81] $$\frac{x-80}{20} = \frac{81-80}{20} = 0{,}05 \quad (4)$$

μLoyalty Excellent [81] $$\frac{100-x}{20} = \frac{100-81}{20} = 0{,}95 \quad (5)$$

3.2. Implication Function

[R1] IF (Ability=Moderate) AND (Loyalty=Good) THEN (6)

MIN (0.65; 0.05) = 0.05

[R2] IF (Ability=Moderate) AND (loyalty=Excellent) THEN (7)

MIN (0.65; 0.95) = 0.65

[R3] IF (Ability=Good) AND (loyalty=Good) THEN (8)

MIN (0.35; 0.05) = 0.05

[R4] IF (Ability=Good) AND (loyalty=Excellent) THEN (9)

MIN (0.35; 0.95) = 0.35

3.3. Rule composition

Figure 2 explains R1 aggregation of (6). Figure 3 explains R1 aggregation of (7). Figure 4 explains R1 aggregation of (8). Figure 5 explains R1 aggregation of (9).

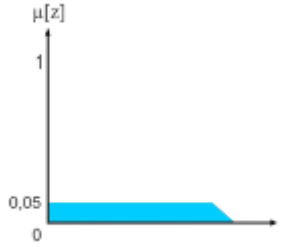

Figure 2. R1 Aggregation

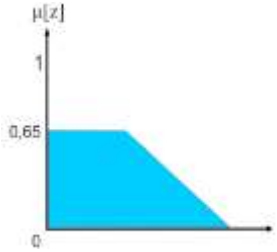

Figure 3. R2 Aggregation

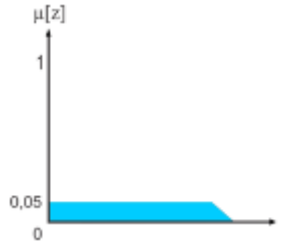

Figure 4. R3 Aggregation

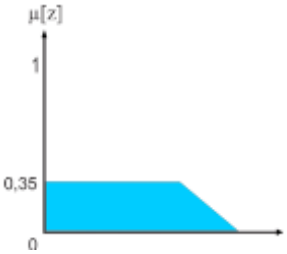

Figure 5. R4 Aggregation

3.4. Defuzzification

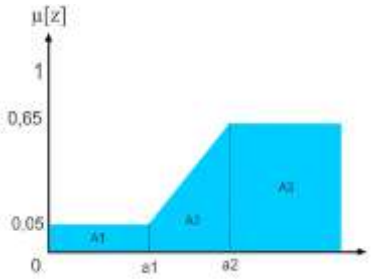

Figure 6. Defuzzification

$$= \frac{0{,}05 * 100 + 0{,}65 * 80}{0{,}05 + 0{,}65}$$

$$= \frac{57}{0{,}7}$$

$$= 81{,}43 \approx \mathbf{81}$$

The employee is **eligible** for promotion

4. Results

In this work, we found that the proposed model had an accuracy of 91.4% in 35 testing data. Under normal conditions, this model can process an average dataset for 1.24 seconds.

5. Conclusion

In terms of accuracy and performance, we conclude that the Mamdani Fuzzy method has a good performance in determining employee promotion. Further works need to be adjusted and employee assessment criteria need to be added in accordance the job fields. The accuracy of 91.4% is sufficient but needs to be verified by comparing this model with other methods such as Sugeno and Tsukamoto [15][16].

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