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Implementation of Fuzzy Inference System with Sugeno Method for Marketing Performance Assessment

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Abstract: The Witel Business Service Division is a division that is responsible for the operational sector of PT Telkom Telekomunikasi Indonesia. One of the operational areas in the Witel division is customer service. The task of contacting customer needs in the ICT field as well as the disruption that the customer is experiencing is the task of the marketing department. The marketing department visits or prospects to customers through visits, calls, emails, to each predetermined customer data. If the customer agrees with what marketing offers, a memorandum of understanding is made. Furthermore, marketing will report its activities to the manager. Manager has one of his duties to evaluate marketing performance. There are several parameters / criteria for evaluating marketing performance based on reports received. In this study, to assess marketing performance using the Fuzzy Inference System (FIS) Sugeno method, namely the process of making a mapping system from the input given to the output using fuzzy logic. Fuzzy variables are obtained from the criteria for Existing Customer Management, Acquisition of Subscription Contracts and PBC is Acquisition of Billing Complete which is then used as fuzzy input. The results of this study resulted in the Sugeno method of Fuzzy Interference System which can be applied at the calculation stage of the marketing performance assessment, where the value of each input variable is subject to fuzzification first. Furthermore, inference is made to the rules used and ends with the defuzzification stage in the form of calculating the score using the weighted average method. With the average weight value is in the range 41-89, and is in the good category in general, although there is a low value.

Keywords: Fuzzy Inference System (FIS), Fuzzy Logic, Sugeno Method

I. INTRODUCTION

In a company, there is performance monitoring, where monitoring is one of the things that can affect the implementation of each work that has been determined by the company[1]. Performance is performance or performance. Performance is the success of a person or group of people in carrying out their duties and responsibilities as well as the ability to achieve predetermined goals and standards. The importance and competitive advantage of performance measurement systems are proven today to ensure survival in world class competition.

Measuring the performance of employees in a company is very important for the evaluation and planning of the company in the future[2]. Performance appraisal is something that cannot be separated from the company in an effort to increase work productivity. Therefore, the success or failure of the company in achieving the goals that have been determined, one of which is very dependent on performance appraisal.

Marketing performance is an important element of company performance in general because the performance of a company can be seen from its marketing performance so far. Marketing performance is influenced by the effectiveness of the company's growth or profitability.

Fuzzy Inference System (FIS) is the process of making a mapping system from the given input to the output using fuzzy logic[3]. Mapping then provides the basis from which decisions can be made, or patterns can be found[4]. Fuzzy inference systems have been properly implemented in many fields such as automatic control, data classification, decision analysis, expert systems, and computer vision[5].

In research, the employee performance appraisal system uses the Tsukamoto Fuzzy Inference System. The parameters used to limit the fuzzy membership function based on expert opinion are responsibility, discipline and deduction factors[6][7]. System accuracy is calculated by comparing the system output with expert judgment. The test results show that the system built produces an accuracy of 84%. while research uses fuzzy logic to measure the performance of

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the E-learning center system at a university with the variable criteria used are student, professor, educational center, relation, research, timing, continuous improvement and substructure from the results obtained, the attitude of the master towards the most important course in measuring performance.

Fuzzy inference systems can be used as a method as a solution to solving various problems in various fields by first determining the criteria which will then be used as variables. So that fuzzy can be used to assess marketing performance.

II. RESEARCH METHOD

The initial stage of this research is data collection to apply the FIS method in assessing Marketing performance through direct observation of PT. Telekomunikasi Indonesia, the Business Service Division of Witel Bekasi, then interviewing managers and marketing to get what is needed for this research.

data analysis as a preliminary analysis Before calculating using the fuzzy inference system, it is necessary to determine the range of criteria value data that will be used as marketing performance assessment data.

Fuzzy Logic for marketing performance assessment with the following stages :

A. Determine Fuzzy Variable
Fuzzy variables are variables to be applied in a fuzzy system

B. Determine Fuzzy Sets
To determine an association that has a certain degree, each member has a degree of membership which is determined by a certain membership function

C. Determine the Fuzzy Membership Function
The membership function is a curve that shows the mapping of data input points into their membership values which have an interval of 0 to 1. One way that can be used to obtain membership values is to use the function approach.

Fuzzy Inference System is a system for performing calculations based on the concept of fuzzy set theory, fuzzy rules, and fuzzy logic concepts. Fuzzy Inference System (FIS) is a computational framework based on fuzzy set theory, IF - THEN form rules, and fuzzy reasoning. Sugeno fuzzy inference system method is also called TSK fuzzy inference system method introduced by Takagi dan Sugeno.

The output of the fuzzy inference system requires 4 stages :

1. Fuzzyfication Stage is the process of transforming observational data into fuzzy sets
2. Establishment of basic fuzzy data rules is the basic fuzzy rules define the relationship between the membership function and the form of the membership function results. In the Sugeno method the output (consequent) of the system is not a fuzzy set but is a constant or linear equation. According to the TSK (Takagi Sugeno Kang) method consists of two orders, are :

- Zero orde Sugeno fuzzy model is the zero orde Sugeno fuzzy form is : IF (X_1 is A_1)(X_2 is A_2)(X_3 is A_3)(X_N is A_N) THEN z=k. **(1)** Where A_i is the fuzzy set to i as the antecedent and k is the consequent strict constant.
- the first orde Sugeno fuzzy form is : *IF (X_1 is A_1)(X_2 is A_2)(X_3 is A_3) (X_N is A_N) THEN* $z=p_1*x_1+\ldots+p_n*x_n+q$. **(2)** Where: A_i is the ith fuzzy set as the antecedent, Pi is the ith strict constant and q is the consequent constant.

3. Composition of Rules
If the system consists of several rules, then inference is obtained from the collection and correlation between the rules, namely calculating the results.

$$\sum_{r=1}^{R} \propto_r . z_r \qquad \textbf{(3)}$$

explanation :
R= number of rules
α_r = fire strength ke-r
z_r output to the antecedent of the r.

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4. Establishment of basic fuzzy data rules This process outputs a crisp number. Defuzification is done by finding the average value is :

$$Z = \frac{\sum_r^R 1 \propto_r . Z_r}{\sum_r^R 1 \propto_r}$$

III. RESULTS AND DISCUSSION

Based on the data obtained, Then the criteria value range from 3 criteria, namely Existing Customer Management (ECM), Acquisition of a Subscription Contract (ASC), Obtaining Complete Billing (OCB). Based on the data obtained, the marketing performance appraisal score displayed, as shown in table 1.

TABLE I PERFORMANCE APPRAISAL CRITERIA
VALUE RANGE

Criteria Value	Range Of Values
ECM (Existing Customer Management)	0-100
ASC (Acquisition of a Subscription Contract)	0-100
OCB (Obtaining Complete Billing)	0-100

After defining the value range data, Employee data are used as input values for each criteria. Shown in table 2.

Table 2. Employee Data

Variable Input	Nilai Input
ECM	70
ASC	65
OCB	82

A. Determining the Fuzzy Logic Set

Fuzzy sets in this research using three liguistic values are a little, medium, a lot. The formation of this fuzzy set is adjusted to the marketing input data. Fuzzy set data and linguistic value data are shown in Table 3.

Table 3. Fuzzy sets

Input of Variable	Linguistic value
ECM	Little
	Medium
	A lot
ASC	Little
	Medium
	A lot
OCB	Little
	Medium
	A lot

B. Process Fuzzyfication

The following is a fuzzy set membership function with input criteria :

- Fuzzy Set ECM (Existing Customer Management) shown in figure 1.

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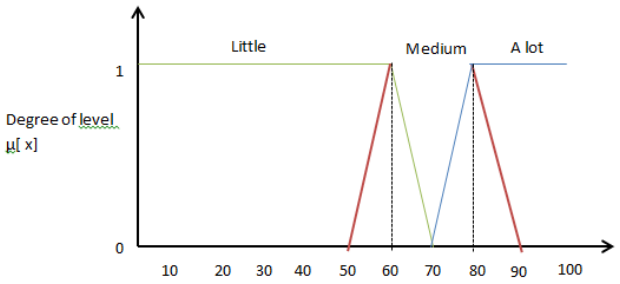

Figure 1. Fuzzy Set PPE

The degree of membership function of the PPE variable defined below with a little degrees of membership :

$$\propto_{little\ degree[x]=} \begin{cases} 1; x \leq 50 \\ \dfrac{60-x}{60-50}; 50 \leq x \leq 60 \\ 0; \quad x \geq 70 \end{cases}$$

With medium of membership degrees :

$$\propto_{medium\ degree[x]=} \begin{cases} 0; x \leq 0 \\ \frac{x-50}{60-50}; 50 \leq x \geq 60 \\ 1; 60 \leq x80 \\ 0; \qquad x \geq 90 \end{cases}$$

With a lot of membership degrees :

$$\propto_{a\ lot\ degree=} \begin{cases} 0; x \leq 70 \\ \dfrac{x-80}{90-80}; 80 \leq x \leq 90 \\ 1; \quad x \geq 90 \end{cases}$$

- Fuzzy Set ASC (Acquisition of a Subscription Contract)

The function of the degree of membership of the ASC variable is as shown in Figure 2

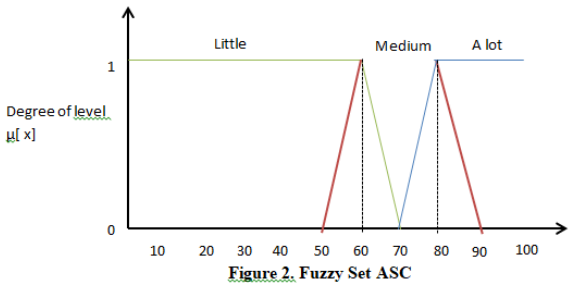

Figure 2. Fuzzy Set ASC

The degree of membership function of the ASC variable is defined as below :
with a little degree of membership

$$\propto_{little\ degree[x]=} \begin{cases} 1; x \leq 50 \\ \dfrac{60-x}{60-50}; 50 \leq x \leq 60 \\ 0; \quad x \geq 70 \end{cases}$$

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Withmedium degree of membership

$$\propto_{medium\ degree[x]=} \begin{cases} 0; x \le 0 \\ \dfrac{x-50}{60-50}; \ 50 \le x \ge 60 \\ 1; 60 \le x80 \\ 0; \quad x \ge 90 \end{cases}$$

With a lot degree of membership

$$\propto_{a\ lot[x]=} \begin{cases} 0; x \le 70 \\ \dfrac{x-80}{90-80}; 80 \le x \ \le 90 \\ 1; \ x \ge 90 \end{cases}$$

- Fuzzy set OCB (Obtaining Complete Billing)

The function of the degree of membership of the ASC variable is as shown in Figure 3.

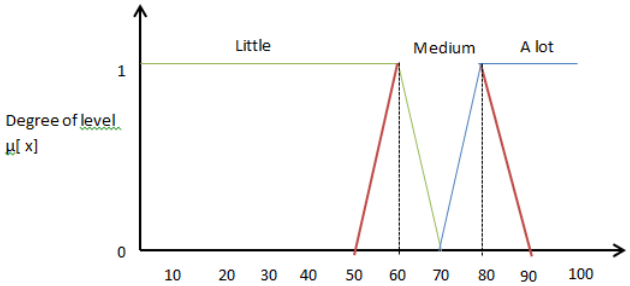

Figure 3. Fuzzy Set OCB

The degree of membership function of the ASC variable is defined as below :
with a little degree of membership

$$\propto_{little\ degree[x]=} \begin{cases} 1; x \le 50 \\ \dfrac{60-x}{60-50}; 50 \le x \ \le 60 \\ 0; \ x \ge 70 \end{cases}$$

with medium degree of membership

$$\propto_{medium\ degree[x]=} \begin{cases} 0; \mathrm{x} \le 0 \\ \dfrac{\mathrm{x}-50}{60-50}; \ 50 \le \mathrm{x} \ge 60 \\ 1; 60 \le \mathrm{x}80 \\ 0; \quad \mathrm{x} \ge 90 \end{cases}$$

with a lot degree of membership

$$\propto_{a\ lot[x]=} \begin{cases} 0; \mathrm{x} \le 70 \\ \dfrac{\mathrm{x}-80}{90-80}; 80 \le \mathrm{x} \ \le 90 \\ 1; \ \mathrm{x} \ge 90 \end{cases}$$

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IV. CONCLUSION

The conclusions clearly indicate the results obtained, the advantages and disadvantages, and the possibility of further development. Conclusions can be in the form of paragraphs, but can also take the form of bullet points by using numbering or bullets.

The results obtained show that after applying the fuzzy interference system Sugeno method shows that the predicate results are sufficient for marketing performance in the Bekasi wittel division.

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