



Analysis of Customer Satisfaction with Marketing Services Using Fuzzy Logic

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Abstract

In sales companies, the acquisition of turnover every month is very influential on the assessment of sales quality. The problem faced by the company is a decrease in turnover, this may be caused by the performance of marketing services, therefore the purpose of this study is to evaluate the service performance of the marketing team at Jayaindo Abadi Makmur. To improve customer satisfaction, the team should consider components such as reliability, responsiveness, assurance, and empathy. To get the results, mamdani fuzzy logic is used with the stages of fuzzy set, implication function, rule composition, and affirmation (defuzzy). The results showed that customer satisfaction with manual calculations amounted to 84.12, while the results with mamdani fuzzy logic using matlab software amounted to 81.3. The company's customer satisfaction is classified as very satisfied. Sales quality shows a decrease in turnover several times, but this is not caused by the marketing team. Recommendations for improvements that can be made include improving product management, pricing policies, and overcoming market competition. The data presented shows that the company's ability to manage products, pricing policies, and the competitive market atmosphere can contribute to higher levels of customer satisfaction.

Keywords: Customer Satisfaction, Marketing Services, Fuzzy Logic, Mamdani, Matlab

1. INTRODUCTION

Business strategy is needed in developing a business with various supporting factors that can improve business and minimize failure in business. The number of competitors in business makes companies have their own way of handling current business competition by modifying business services following the current times. Lifestyle and culture that can reflect the product or brand is done through experiential marketing [1]. Marketing is more associated with the process of delivering products or services to potential customers [2].



Marketing has an important role to attract customers to buy company products with marketing techniques to understand the needs, wants and demands of customers [3]. Marketing services as the main spear connecting customers with companies [4].

Customer demands will provide important information in the business that can be used to build marketing methods that satisfy customers [5], one of which is to develop business at the company Jayaindo Abadi Makmur. One of the companies that offers various types of packaging products includes duct tape products, strapping bands, bubble packs, PE foam. As a sales service provider, maintaining customer loyalty can drive sales, so as to increase customer satisfaction continues to increase. The relationship between satisfaction and loyalty is almost intuitive [6].

Figure 1 A measure of how well the level of service is able to meet customer expectations, with a good level of service provided resulting in a high level of customer satisfaction, thus sales turnover will continue to increase [7].

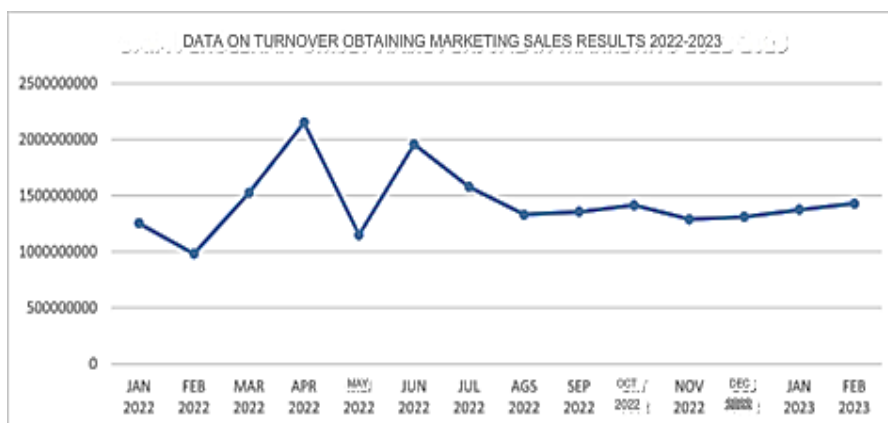


Figure 1. Research Design Marketing Turnover 2022-2023

The problem of obtaining marketing sales turnover for the Jayaindo Abadi Makmur company in 2022 to 2023 experienced instability in turnover generated from the company's marketing team with a total of 10 marketing employees, it is necessary to analyze the level of customer satisfaction to determine customer satisfaction in assessing sales quality.

Internal factors (factors controlled by parts of the company), such as the company's ability to manage the products to be marketed, the pricing and promotion policies set by the company, and the intermediary selection policies used, are divided into two categories that affect the size of the bill. National and global economic and business developments, government policies in the

economic, trade, and monetary fields, and the level of market competition are examples of external variables (factors that cannot be influenced by the company) [8]. Today, it is believed that providing high-quality services to customers is the key to success in business competition [9].

Fuzzy logic techniques are incorporated into the proposed measurement and analysis system as a solution to this problem to reduce the incidence of this uncertainty in the decision-making and analysis process based on consumer actions towards the products offered by the company. The reason for using fuzzy logic is because the concept of fuzzy logic is easy to understand, adaptable, tolerant of data, and able to model very complicated nonlinear functions, without having to go through a training process to build on the experience of experts directly, can work with conventional techniques, using everyday natural language [10].

Based on the above problems, this research was conducted. The fuzzy logic method with the mamdani inference method is the best method for understanding the relationship between the variables studied and producing a customer satisfaction model. The results of calculations using the fuzzy mamdani method with the average value of each variable of reliability of 8.22, responsiveness of 8.1, assurance of 7.92, and empathy of 7.83 obtained the results of customer satisfaction with manual calculations of 84.12 and the results of fuzzy mamdani logic calculations using fuzzy inference mamdani logic systems using matlab software obtained results of 81.3. It can be concluded that the level of customer satisfaction of the company Jayaindo Abadi Makmur is classified into a very satisfied group.

2. METHODS

In this study, to produce a level of customer satisfaction, several stages were carried out such as analyzing needs, managing data, fuzzy inference systems, testing data with matlab applications to apply fuzzy logic workflow methodology with the mamdani inference method according to Sri Kusumadewi. The stages of research carried out to obtain the output results of the mamdani inference method are the formation of fuzzy sets, application of implication functions, rule composition, affirmation (defuzzy) as shown in Figure 2 [11].

2.1 Requirement Analysis

Sampling is carried out from a population, the sample taken represents data from the population using the slovin formula sampling technique to determine the minimum number of samples from a population that meets certain criteria until it meets the quota according to the slovin formula calculation [12]. The number of samples in this study that will be used is 100 respondent data used.

Data collection was carried out in this study by conducting a questionnaire to obtain information directly [13] with customers of the Jayaindo Abadi Makmur company on the object of research, namely assessing based on the quality of marketing services for 3 months which was carried out in December 2022 to February 2023. The next procedure is data selection, which is carried out after the data collection process. The data used is data selected based on the needs of this study.

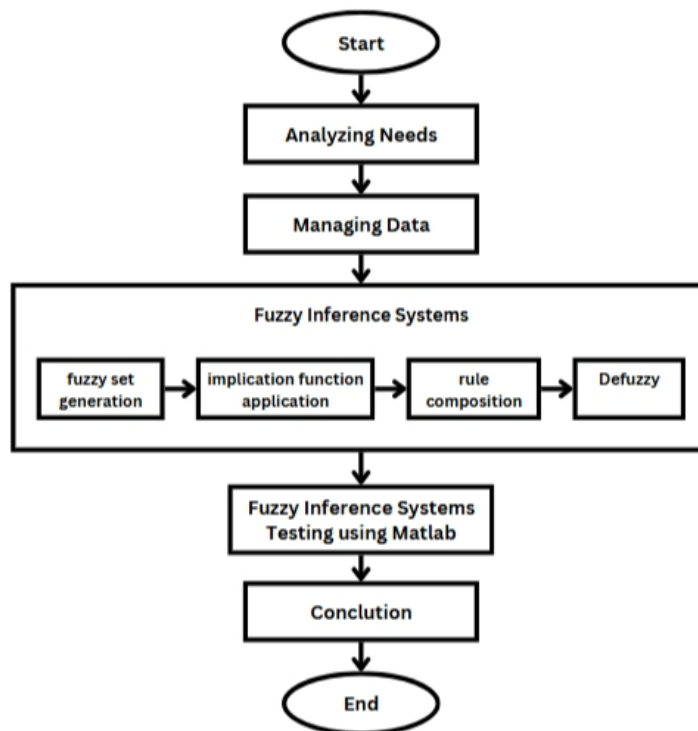


Figure 2. Research Design

The marketing performance questionnaire is a global or comprehensive assessment of the entire marketing unit of the company Jayaindo Abadi Prosperous questions submitted to consumers. The list of questions contains matters relating to the performance of services related to the marketing performance of the company Jayaindo Abadi Prosper. The level of service satisfaction cannot be assessed only based on the company's point of view but must also be seen from the point of view of customer assessment [14]. The attributes in the questionnaire are grouped into four variables to measure the performance of marketing services in the company Jayaindo Abadi Prosper in the form of reliability, responsiveness, assurance, empathy. The data collected in this

study are questionnaire data that has been filled in by customers who have made product purchase transactions at the company Jayaindo Abadi Makmur.

2.2 Manage Data

Managing data begins with testing data quality using validity and reliability tests. From the results of the validity test calculation, the test criteria are $r_{hitung} \geq r_{tabel}$, the data is declared valid and vice versa if the test value $r_{hitung} \leq r_{tabel}$, the data is declared invalid [15]. From the reliability data, the test criteria are if the Cronbach's Alpha value is more than or equal to 0.7, the attribute can be said to be reliable [16]. And the results of the calculation of the validity test and reliability test can be concluded that the questionnaire data results are used.

2.3. Fuzzy Inference System

Fuzzy was introduced by Prof. Lotfi A. Zadeh from the University of California in his paper "fuzzy set" in 1965. In his paper explains the basic ideas of fuzzy sets including inclusion, union, intersection, complement, relation and convercity [17]. With the integration of fuzzy with information systems and process engineering, it will create control systems and decision-making systems that are more sophisticated and flexible than conventional systems [18]. Fuzzy logic is also called biased logic [19] which is considered a black box that connects the input space to the output space.

At this stage it is necessary to form a fuzzy set [11] to determine the input variables and output variables [20] in this study for input variables using variables sourced from identical consumer criteria that provide satisfaction to customers, divided into 4 categories, namely reliability, responsiveness, assurance, and empathy. And for the output variable of this study, namely customer satisfaction. The determination of linguistic fuzzy sets in this study for input variables is less, enough, good and for output variables is very satisfied, satisfied and dissatisfied [21].

The process used in the mamdani fuzzy inference system at the implication function stage is to take the minimum value. Select the rules to be used in this study; if the system consists of a series of rules, correlation and rule compilation will be used to draw conclusions. The maximum rule composition approach is used in this study to obtain the maximum value of each rule. The fuzzy area is then modified by applying the rule composition data to the output using the OR (union) operator. The fuzzy set indicating the contribution of each proposition is then incorporated into the resulting output. If the implication process uses the MIN approach, the MAX approach is used for rule construction. The names of these composition techniques are MAX-MIN, MIN-MAX or MAMDANI [22].

In the selected assertion method using centroid. By calculating the moments for each region. The last step is to determine the center point after calculating the size of the area of each region.

2.4 Testing data with matlab application

At this stage the researcher will test the data from the results of the analysis that has been done previously using the matlab application from the calculation results and the matlab application system has the same results or not in determining the level of customer satisfaction of the company with the Mamdani inference method [23]. Graphical user interface is one of the Graphical User Interfaces (GUI) devices [24]. Users can easily learn data, develop algorithms, and build various graphical tools thanks to the open architecture of the GUI [25].

3. RESULTS AND DISCUSSION

To get the results of calculations with fuzzy logic, several stages are carried out, namely, the process of forming fuzzy sets, application of implication functions, rule composition, affirmation (defuzzy).

3.1 Fuzzy Set

At this stage it is necessary to form a fuzzy collection to determine the input variables and output variables in this study for input variables using variables sourced from identical consumer criteria that provide satisfaction to customers, divided into 4 categories, namely reliability, responsiveness, assurance, and empathy. And for the output variable of this study, namely customer satisfaction. The determination of the linguistic fuzzy set in this study for input variables is less, enough, good and for output variables is very satisfied, satisfied and dissatisfied.

Table 1. Fuzzy Set

| Function | Variable | Fuzzy Set | Range | Client |
|----------|----------------|-----------|--------|--------|
| Input | Reliability | Less | | [0-4] |
| | | Enough | [0-10] | [2-8] |
| | | Good | | [6-10] |
| | Responsiveness | Less | | [0-4] |
| | | Enough | [0-10] | [2-8] |
| | | Good | | [6-10] |
| | Assurance | Less | | [0-4] |
| | | Enough | [0-10] | [2-8] |
| | | Good | | [6-10] |
| | Empathy | Less | | [0-4] |
| | | Enough | [0-10] | [2-8] |
| | | Good | | [6-10] |

| Function | Variable | Fuzzy Set | Range | Client |
|----------|--------------|-----------------|---------|----------|
| Output | Satisfaction | Not Satisfield | [0-100] | [0-40] |
| | | Satisfield | | [20-80] |
| | | Very Satisfield | | [60-100] |
| | | Satisfield | | |

Identify the membership function for each variable based on the variables and domain of the fuzzy set that has been assembled and then calculate the value or degree of membership based on the identified membership function. Based on information collected from the average value of completing customer surveys for the Jayaindo Abadi Makmur company, the fuzzy set and membership functions are reliability of 8.22, responsiveness of 8.1, assurance of 7.92, and empathy of 7.83. There are 4 fuzzy input variables that are modeled, namely:

- a. Reliability; consists of 3 fuzzy sets, namely: Less, Enough, and Good.

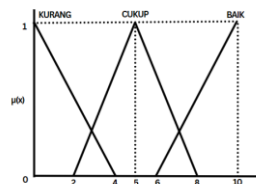


Figure 3. Reliability Membership Function Curve

The membership function for the reliability variable is formulated as follows:

$$\mu_{rel}Less = \begin{cases} \frac{4-x}{4-0}; & 0 \leq x \leq 4 \\ 0; & x \geq 4 \end{cases}$$

$$\mu_{rel}Enough = \begin{cases} 0; & x \leq 2 \text{ atau } x \geq 8 \\ \frac{x-2}{5-2}; & 2 \leq x \leq 5 \\ \frac{8-x}{8-5}; & 5 \leq x \leq 8 \end{cases}$$

$$\mu_{rel}Good = \begin{cases} 0; & x \leq 6 \\ \frac{x-6}{10-6}; & 6 \leq x \leq 10 \\ 1; & x \geq 10 \end{cases}$$

The reliability variable of customer satisfaction data with a value of 8.22 is obtained as follows:

$$\mu_{rel}Less(8,22) = 0$$

$$\mu_{rel}Enough(8,22) = 0$$

$$\mu_{rel}Good(8,22) = \frac{8,22 - 6}{10 - 6} = \frac{2,22}{4} = 0,55$$

- b. Responsiveness; consists of 3 fuzzy sets, namely: Less, Enough, and Good.

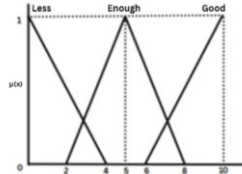


Figure 4. Responsiveness Membership Function Curve

The membership function on the responsiveness variable is formulated as follows:

$$\mu_{res}Less = \begin{cases} \frac{4-x}{4-0}; & 0 \leq x \leq 4 \\ 0; & x \geq 4 \end{cases}$$

$$\mu_{res}Enough = \begin{cases} 0; & x \leq 2 \text{ atau } x \geq 8 \\ \frac{x-2}{5-2}; & 2 \leq x \leq 5 \\ \frac{8-x}{8-5}; & 5 \leq x \leq 8 \end{cases}$$

$$\mu_{res}Good = \begin{cases} 0; & x \leq 6 \\ \frac{x-6}{10-6}; & 6 \leq x \leq 10 \\ 1; & x \geq 10 \end{cases}$$

Variable responsiveness of customer satisfaction data with a value of 8.1, the following membership degrees are obtained:

$$\mu_{res}Less(8,1) = 0$$

$$\mu_{res}Enough(8,1) = 0$$

$$\mu_{res}Good(8,1) = \frac{8,1 - 6}{10 - 6} = \frac{2,1}{4} = 0,53$$

- c. Assurance; consists of 3 fuzzy sets, namely: Less, Enough, and Good.

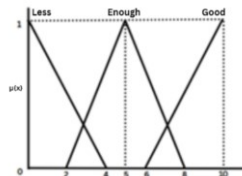


Figure 5. Assurance Membership Function Curve

The membership function for the assurance variable is formulated as follows.

$$\mu_{Asr}Less = \begin{cases} \frac{4-x}{4-0}; 0 \leq x \leq 4 \\ 0; x \geq 4 \end{cases}$$

$$\mu_{Asr}Enough = \begin{cases} 0; x \leq 2 \text{ atau } x \geq 8 \\ \frac{x-2}{5-2}; 2 \leq x \leq 5 \\ \frac{8-x}{8-5}; 5 \leq x \leq 8 \end{cases}$$

$$\mu_{Asr}Good = \begin{cases} 0; x \leq 6 \\ \frac{x-6}{10-6}; 6 \leq x \leq 10 \\ 1; x \geq 10 \end{cases}$$

The assurance variable of customer satisfaction data with a value of 7.92, the following membership degrees are obtained:

$$\mu_{asr}Less(7,92) = 0$$

$$\mu_{asr}Enough(7,92) = \frac{8-7,92}{8-5} = \frac{0,08}{3} = 0,03$$

$$\mu_{asr}Good(7,92) = \frac{7,92-6}{10-6} = \frac{1,92}{4} = 0,48$$

- d. Empathy; consists of 3 fuzzy sets, namely: Less, Enough, and Good.

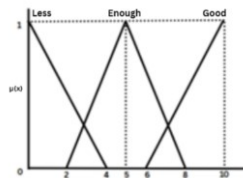


Figure 6. Empathy Membership Function Curve

The membership function for the empathy variable is formulated as follows:

$$\mu_{Emp}Less = \begin{cases} \frac{4-x}{4-0}; 0 \leq x \leq 4 \\ 0; x \geq 4 \end{cases}$$

$$\mu_{Emp}Enough = \begin{cases} 0; x \leq 2 \text{ atau } x \geq 8 \\ \frac{x-2}{5-2}; 2 \leq x \leq 5 \\ \frac{8-x}{8-5}; 5 \leq x \leq 8 \end{cases}$$

$$\mu_{Emp}Good = \begin{cases} 0; x \leq 6 \\ \frac{x-6}{10-6}; 6 \leq x \leq 10 \\ 1; x \geq 10 \end{cases}$$

Variable Empathy of customer satisfaction data with a value of 7.83, then the following membership degrees are obtained:

$$\begin{aligned} \mu_{emp}Less(7,83) &= 0 \\ \mu_{emp}Enough(7,83) &= \frac{8-7,83}{8-5} = \frac{0,17}{3} = 0,06 \\ \mu_{emp}Good(7,83) &= \frac{7,83-6}{10-6} = \frac{1,83}{4} = 0,46 \end{aligned}$$

There are fuzzy output variables that are modeled, namely:

- Satisfaction; consists of 3 fuzzy sets, namely: Not Satisfied, Satisfied, and Very Satisfied.

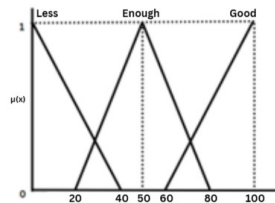


Figure 7. Satisfaction Membership Function Curve

The membership function on the satisfaction variable is formulated as follows:

$$\begin{aligned} \mu_{Sat}Not\ Satisfied &= \begin{cases} \frac{40-x}{40-0}; 0 \leq x \leq 40 \\ 0; x \geq 40 \end{cases} \\ \mu_{Sat}Satisfied &= \begin{cases} 0; x \leq 20 \text{ atau } x \geq 80 \\ \frac{x-20}{50-20}; 20 \leq x \leq 50 \\ \frac{80-x}{80-50}; 50 \leq x \leq 80 \end{cases} \\ \mu_{Sat}Very\ Satisfied &= \begin{cases} 0; x \leq 60 \\ \frac{x-60}{10-60}; 60 \leq x \leq 100 \\ 1; x \geq 100 \end{cases} \end{aligned}$$

The next step is to create fuzzy logic rules after the membership function of each variable is determined. Based on the existing data there are 81 rules.

3.2 Implication Function Application

The process used in the mamdani fuzzy inference system at the implication function stage is to take the minimum value. To find the alpha predicate results for each rule.

Based on the results of the implication calculation, the largest predicate of each fuzzy set is taken, as follows:

[R1] IF reliability is LESS and responsiveness is LESS and assurance is LESS and empathy is LESS THEN satisfaction is NOT SATISFIELD

$$\alpha - predikat_1 = \min(0; 0; 0; 0) = 0$$

[R81] IF reliability is ENOUGH and responsiveness is ENOUGH and assurance is ENOUGH and empathy is ENOUGH THEN satisfaction is SATISFIELD

$$\alpha - predikat_{81} = \min(0; 0; 0,03; 0,06) = 0$$

[R10] IF reliability is GOOD and responsiveness is GOOD and assurance is GOOD and empathy is GOOD THEN satisfaction IS VERY SATISFIELD

$$\alpha - predikat_{10} = \min(0,55; 0,53; 0,48; 0,46) = 0,46$$

3.3 Rule Composition

Based on the results of the application of the implication function of each rule, the Max (Maximum) method is used to perform the composition between all rules, so that the result area (domain) is obtained.

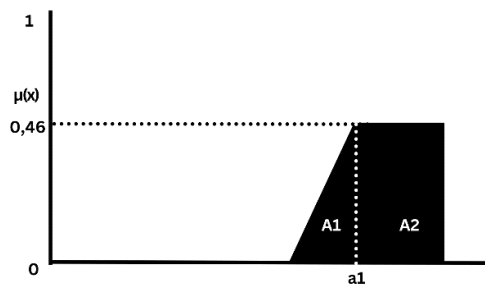


Figure 8. Rule Composition Curve

In the figure, we divide the result area into 2 parts, namely A1, and A2. Then find the value of a_1

$$\frac{a_1 - 60}{(100 - 60)} = 0,46 \rightarrow a_1 = 78,4$$

Thus, the membership function for this composition result is

$$\mu[z] = \begin{cases} 0; z \leq 60 \text{ atau } z \geq 100 \\ \frac{z - 60}{40}; 60 \leq z \leq 78,4 \\ 0,46; 78,4 \leq z \leq 100 \end{cases}$$

3.4 Defuzzification

The method of affirmation is centroid, then calculate the moment of each region

$$\begin{aligned} M1 &= \int_{60}^{78,4} \frac{z - 60}{40} z \, dz \\ &= \frac{1}{40} \int_{60}^{78,4} z^2 - 60z \, dz = 305,83 \\ M2 &= \int_{78,4}^{100} 0,46 z \, dz = 0,46 \left[\frac{z^2}{2} \right]_{80}^{100} = 886,29 \end{aligned}$$

Next, calculate the area of each region:

$$\begin{aligned} A1 &= \int_{60}^{78,4} \frac{z - 60}{40} \, dz = \frac{1}{40} \int_{60}^{78,4} z - 60 \, dz = 4,23 \\ A2 &= \int_{78,4}^{100} 0,46 \, dz = [0,46z]_{78,4}^{100} = 9,94 \end{aligned}$$

Calculating the center point of the calculation that has been obtained

$$z = \frac{0 + 305,83 + 886,29}{0 + 4,23 + 9,94} = \frac{1192,12}{14,17} = 84,12$$

3.5 Testing Data with Matlab Application

The initial appearance of the interface of the matlab application in Figure 9 for the mamdani fuzzy editor system, the first step is to enter each variable. required

where in this study the input variables are reability, responsiveness, empathy, assurance and for the output variable is satisfaction. satisfaction.

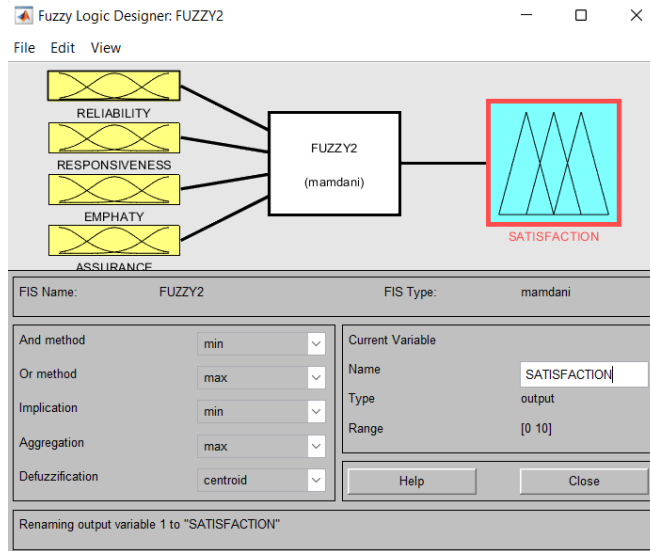


Figure 9. Rule Composition Curve

Rule formation in Figure 10 by entering all the rules into the rule editor and selecting connection. Shows the matlab application interface for all variables to set the graph model by entering the range and entering the domain of each fuzzy set.

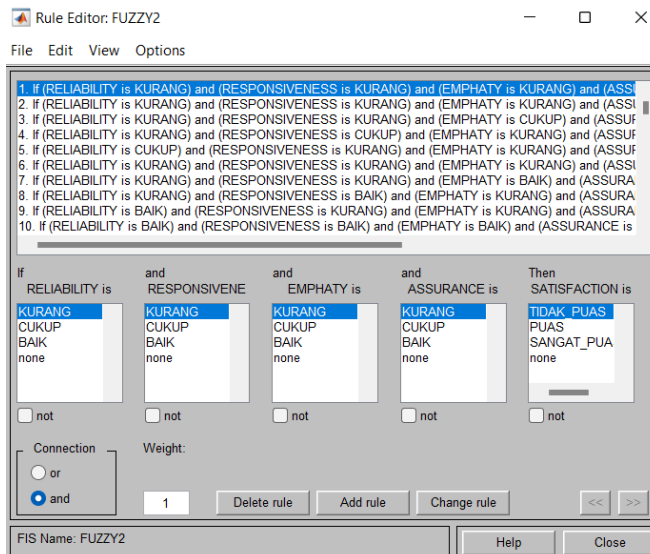


Figure 10. Mamdani Fuzzy Rule Formation

Mamdani Fuzzy Toolbox Testing Data testing on the fuzzy mamdani toolbox in Figure 11 where entering each value into each variable so that obtaining the final result in the form of satisfaction value.

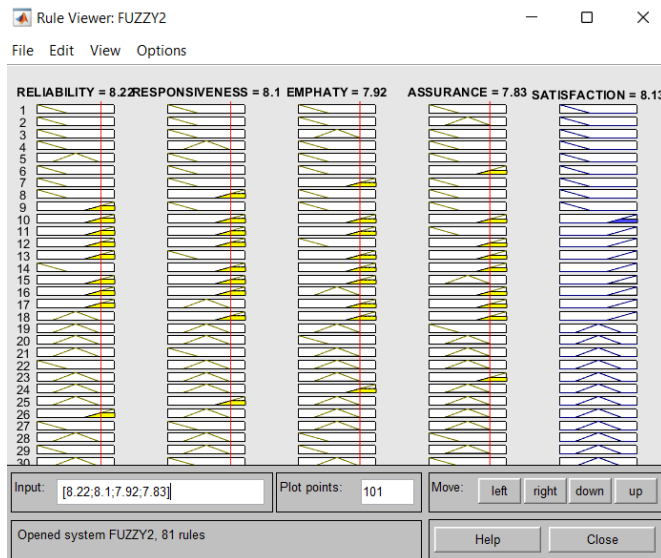


Figure 11. Testing the Mamdani Fuzzy Toolbox

3.6 Discussion

Based on the results of the calculations that have been obtained, the results of the fuzzy logic mamdani inference method as an analysis of the company's customer satisfaction level can be used to determine the level of customer satisfaction. Where in the calculation of the level of customer satisfaction in the company with manual calculations, the result is 84.12 and the results of the calculation of fuzzy logic mamdani using fuzzy inference mamdani logic system using matlab software obtained a result of 81.3 shows a comparison that is not too far away and is still in the same group of variables. It can be concluded that the level of customer satisfaction of the company Jayaindo Abadi Makmur is classified into a very satisfied group. The distribution of questionnaires was carried out from December 2022 to February 2023 where the conditions on the marketing sales turnover graph showed an increase so that there was a match between the calculation analysis and the turnover graph showing the level of customer satisfaction was very satisfied. This research uses a fuzzy logic approach as an analysis of the level of customer satisfaction with the company based on aspects of global marketing performance in assessing sales quality. The first stage determines the appropriate minimum sample size used for questionnaire data using the slovin data collection technique, and from the results of the calculation the researcher determines that 100

questionnaire answer data can be used in this study and uses a sampling technique with the quota sampling method. The data used in this study were obtained from the results of the questionnaire answers.

4. CONCLUSION

Implementation in matlab software in determining the level of customer satisfaction of the company Jayaindo Abadi Makmur by inputting fuzzy variables, fuzzy sets, and forming curves to get membership values. Then enter the rules that have been determined into the fuzzy inference system editor mamdani and finally test the data with the fuzzy mamdani toolbox by entering the input value on each fuzzy variable. Based on the results of the calculations that have been obtained, the results of the fuzzy logic mamdani inference method as an analysis of the company's customer satisfaction level can be used to determine the level of customer satisfaction. Where in the calculation of the level of customer satisfaction in the company with manual calculations, the result is 84.12 and the results of the calculation of mamdani fuzzy logic using the fuzzy inference mamdani logic system using matlab software obtained a result of 81.3 shows a comparison that is not too far away and is still in one group of variables. It can be concluded that the level of customer satisfaction of the company Jayaindo Abadi Makmur is classified as a very satisfied group. Recommendations for improvements that can be developed further are from the company's ability to manage products to be marketed, price policy, and the atmosphere of market competition.

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