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Fuzzy Mamdani Model for Assessing the Level of Service Satisfaction for Requirements of Social Welfare Services at the "Prof. Dr. Soeharso" Integrated Center in Surakarta

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Abstract-Service quality is one of the competitive advantages, because good service is one of the basic factors that can affect the comfort level of service recipients. Public services by the government apparatus today are still often found to be weak, so that they cannot meet the quality expected by the community. This study is intended to see how much service satisfaction is, and the effect of service levels on satisfaction levels based on Mamdani Model Fuzzy Inference System Logic. There are three input variables used namely clarity of information, ability of officers and availability of facilities and infrastructure to produce service satisfaction output. Based on the stages using Mamdani Model Fuzzy Inference System Logic starting from the formation of fuzzy sets, application of the implementation function, composition of the rules until the confirmation process (defuzzyfication), it can be proved the correlation between input variables so that it can determine the output of service satisfaction. The results of this study are expected to be used by the agency, as a support system for the decision on the results of the assessment given by the community for perceived services. The future development of this research will be re-tested by adding more variables and an interface will be created to facilitate the processing of the results of the quality assessment of public complaints services.
Keywords: Service, Fuzzy Mamdani, Fuzzy Logic

I. INTRODUCTION

Social welfare services are efforts made by the government and other social institutions to meet the basic needs of economically and socially disadvantaged people. This service includes various programs and activities aimed at improving the quality of life and social welfare of individuals and families. However, to achieve this goal, it is important for those who need social welfare services to pay attention to the satisfaction of the people they serve.

Good service quality in an agency is a basic factor that can influence the level of comfort. In controlling service quality in the future, service quality is needed to prevent poor service quality from occurring from the start [1].

The aim of this research is to find out the weaknesses or shortcomings of each element in providing services, as well as see how much service satisfaction there is and the influence of service levels on satisfaction levels based on the Fuzzy Inference System Model Mamdani Logic.

II. RESEARCH METHODS

Research conducted by [1] with the title Fuzzy Mamdani Model for Assessing the Level of Satisfaction with Public Complaint Services uses system design starting from the formation of Fuzzy sets, application of implication functions (formation of Fuzzy rules), composition of Fuzzy rules, and confirmation (defuzzification) [2]. The research results show service satisfaction if the value of clarity of information is 80, clarity of requirements is 78, ability of officers is 80 and availability of infrastructure is 81. Solving this case will take samples using the tenth rule, meaning that service satisfaction is quite satisfactory. The output obtained is that the service satisfaction results are worth 318.137 and are at the Satisfactory membership level[3].

A fuzzy system is a system built based on rules (knowledge) in the form of a collection of IF - THEN (IF - THEN) rules. The reasons for using fuzzy logic are: the concept of fuzzy logic is easy to understand, very flexible, has tolerance for inaccurate data, is able to model very complex nonlinear data, can build and apply the experiences of experts directly without having to go through the process. training, can cooperate with conventional control techniques in natural language[4].

The process in the Mamdani Fuzzy Inference System Model is implemented in three stages[5]:

1) Fuzzyfication stage, namely the process of mapping Crisp (numerical) values into fuzzy sets and determining the degree of membership in the fuzzy set.

2) The inference stage, includes two parts, namely implication and composition, where the process gets the output from the IF – THEN rule, then combines all the IF – THEN rule output into a single fuzzy set.
3) Deffuzyfication stage, namely changing the fuzzy set output to crisp values.

There are three variables used in this research, namely the input is clarity of information, the ability of officers and the availability of facilities and infrastructure, while the output is service satisfaction.

III. RESULT AND ANALYSIS

In the process of determining the level of satisfaction with PPKS services at the Integrated Center "Prof. Dr. Soeharso" in Surakarta will use three input variables and one output variable [6]. In the process of generating values from output variables, three stages are required, namely the formation of fuzzy sets (Fuzzification), the inference stage to the confirmation process (defuzzification).

1. Formation of Fuzzy Sets (Fuzzification)

The fuzzification process functions to change inputs whose truth values are definite (crisp input) into fuzzy input form. There are three input variables and one output variable used in this research, namely input clarity of information, officer ability and availability of facilities and infrastructure, while the output is service satisfaction. The details can be seen in table 1 below:

Table 1. Fuzzy Input and Output Variables

Fungsi	Variable Name	Universe of Conversations
Fuzzy input variables	Clarity of Information	[0-10]
	Officer Abilities	[0-10]
	Availability of Facilities and Infrastructure	[0-10]
Fuzzy output variables	Service Satisfaction	[0-70]

Next, the degree of membership will be determined for each variable using the triangular curve and shoulder curve, which can be seen in table 2 below:

Table 2. Fuzzy Input and Output Variables

Variable Name	Fuzzy Sets	Domain	Membership Functions	Parameter
Kejelasan Informasi (Variabel Input)	Unclear	[0-4]	Left Shoulder	(0;2;4)
	Quite clear	[2-6]	Right Shoulder	(2;4;6)
	Clear	[4-10]	Right Shoulder	(4;6;10)
Officer Abilities (Input Variables)	Incompetent	[0-4]	Right Shoulder	(0;2;4)
	Competent Enough	[2-6]	Triangle	(2;4;6)
	Competent	[4-10]	Right Shoulder	(4;6;10)
Availability of Facilities and Infrastructure (Input Variables)	Inadequate	[0-4]	Left Shoulder	(0;2;4)
	Adequate	[2-6]	Triangle	(2;4;6)
	Adequate	[4-10]	Right Shoulder	(4;6;10)
Service Satisfaction (Output Variable)	Not satisfied	[0-30]	Left Shoulder	(0;20;30)
	Quite satisfied	[20-50]	Triangle	(20;30;50)
	Satisfied	[30-70]	Right Shoulder	(30;50;70)

The following is a graph representing the degree of membership of the fuzzy set of service satisfaction assessments[7]:

a. Graph of Degree of Membership of Input Variable Information Clarity

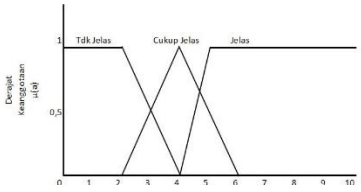

Figure.1 Graph of Membership Degrees of Information Clarity Input Variables

The fuzzy membership function for the Information Clarity variable is formulated as follows:

$$\mu \text{ Unclear} = \begin{cases} 1; & x \le 2 \\ \dfrac{(2-x)}{(4-2)}; 2 \le & x \le 4 \\ 0; & x \ge 4 \end{cases}$$

μ Quite clear =

$$\begin{cases} 0; & x \le 2 \; dan \; x \ge 6 \\ \dfrac{(x-2)}{(4-2)}; & 2 \le x \le 6 \\ \dfrac{(6-x)}{(6-4)}; & 4 \le x \le 6 \end{cases}$$

μ Clear =

$$\begin{cases} 0; & \\ \dfrac{(x-4)}{(6-4)}; 4 \le & x \le 4 \\ & x \le 6 \\ 1; & x \ge 6 \end{cases}$$

b. Chart of Membership Degrees of Officer Ability Input Variables

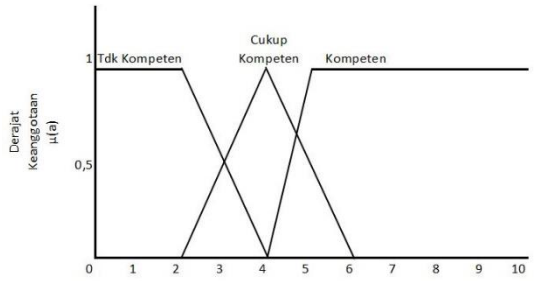

Figure 2. Graph of Membership Degrees of Officer Ability Input Variables

The fuzzy membership function for the Officer Ability variable is formulated as follows:

μ Incompetent =

$$\begin{cases} 1; & \\ \dfrac{(2-x)}{(4-2)}; 2 \le & x \le 2 \\ & x \le 4 \\ 0; & x \ge 4 \end{cases}$$

μ Competent enough =

$$\begin{cases} 0; & x \le 2 \; dan \; x \ge 6 \\ \dfrac{(x-2)}{(4-2)}; & 2 \le x \le 6 \\ \dfrac{(6-x)}{(6-4)}; & 4 \le x \le 6 \end{cases}$$

μ Competent =

$$\begin{cases} 0; & \\ \dfrac{(x-4)}{(6-4)}; 4 \le & x \le 4 \\ & x \le 6 \\ 1; & x \ge 6 \end{cases}$$

c. Graph of Degree of Membership Input Variable Availability of Facilities and Infrastructure

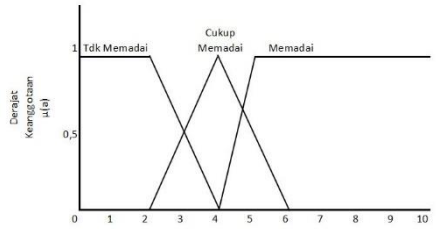

Figure 3. Graph of Membership Degrees for Input Variables Availability of Facilities and Infrastructure

The fuzzy membership function for the Availability of Facilities and Infrastructure variable is formulated as follows:

μ Inadequate =

$$\begin{cases} 1; & \\ \dfrac{(2-x)}{(4-2)}; 2 \le & x \le 2 \\ & x \le 4 \\ 0; & x \ge 4 \end{cases}$$

μ Adequate =

$$\begin{cases} 0; & x \le 2 \; dan \; x \ge 6 \\ \dfrac{(x-2)}{(4-2)}; & 2 \le x \le 6 \\ \dfrac{(6-x)}{(6-4)}; & 4 \le x \le 6 \end{cases}$$

μ Adequate =

$$\begin{cases} 0; & \\ \dfrac{(x-4)}{(6-4)}; 4 \le & x \le 4 \\ & x \le 6 \\ 1; & x \ge 6 \end{cases}$$

a. Graphical Representation of Membership Degrees for Service Satisfaction Output Variables

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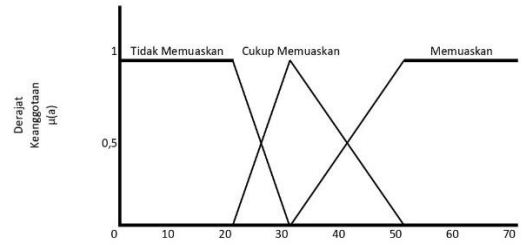

Figure 3. Graph of Membership Degrees for Service Satisfaction Input Variables

The fuzzy membership function for the Service Satisfaction variable is formulated as follows:

μ Not satisfactory =

$$\begin{cases} 1; & x \leq 20 \\ \dfrac{(20-x)}{(30-20)}; & 20 \leq x \leq 30 \\ 0; & x \geq 30 \end{cases}$$

μ Good enough =

$$\begin{cases} 0; & x \leq 20 \; dan \; x \geq 50 \\ \dfrac{(x-30)}{(30-20)}; & 20 \leq x \leq 50 \\ \dfrac{(50-x)}{(50-30)}; & 30 \leq x \leq 50 \end{cases}$$

μ Satisfying =

$$\begin{cases} 0; & x \leq 30 \\ \dfrac{(x-30)}{(50-30)}; & 30 \leq x \leq 50 \\ 1; & x \geq 50 \end{cases}$$

1. Implication Function

After forming variables in the fuzzy set, rules are formed that are in accordance with the research carried out[8]. The rules in question are:

[R1] If the clarity of the information is not clear and the ability of the officers is not competent and the availability of facilities and infrastructure is inadequate then service satisfaction is not satisfied[9].

[R2] If the clarity of the information is not clear and the ability of the officers is not competent and the availability of facilities and infrastructure is adequate then service satisfaction is not satisfied

[R3] If the clarity of the information is not clear and the ability of the officers is not competent and the availability of facilities and infrastructure is adequate then service satisfaction is not satisfied[10].

[R4] If the clarity of the information is not clear and the officer's ability is competent enough and the availability of facilities and infrastructure is inadequate then service satisfaction is not satisfied[11].

[R5] If the clarity of the information is not clear and the ability of the officers is quite competent and the availability of facilities and infrastructure is sufficient then service satisfaction is quite satisfactory[12].

[R6] If the clarity of the information is not clear and the ability of the officers is quite competent and the availability of facilities and infrastructure is adequate then service satisfaction is quite satisfactory[13].

[R7] If the clarity of the information is not clear and the ability of the officers is competent and the availability of facilities and infrastructure is inadequate then service satisfaction is not satisfied[14].

[R8] If the clarity of the information is not clear and the ability of the officers is competent and the availability of facilities and infrastructure is adequate then service satisfaction is quite satisfactory[15].

[R9] If the clarity of the information is not clear and the ability of the officers is competent and the availability of facilities and infrastructure is adequate then service satisfaction is satisfied

[R10] If the clarity of the information is clear enough and the ability of the officers is not competent and the availability of facilities and infrastructure is inadequate then service satisfaction is not satisfied

[R11] If the clarity of the information is clear enough and the ability of the officers is not competent and the availability of facilities and infrastructure is sufficient then service satisfaction is quite satisfactory

[R12] If the clarity of the information is clear enough and the ability of the officers is not competent and the availability of facilities and infrastructure is adequate then service satisfaction is quite satisfactory

[R13] If the clarity of the information is clear enough and the officers' abilities are competent enough and the availability of facilities and infrastructure

is inadequate then service satisfaction is quite satisfactory

[R14] If the clarity of the information is clear enough and the ability of the officers is quite competent and the availability of facilities and infrastructure is sufficient then service satisfaction is quite satisfactory.

[R15] If the clarity of the information is clear enough and the officer's ability is competent enough and the availability of facilities and infrastructure is adequate then service satisfaction is quite satisfactory.

[R16] If the clarity of the information is clear enough and the ability of the officers is competent and the availability of facilities and infrastructure is inadequate then service satisfaction is quite satisfactory

[R17] If the clarity of the information is clear enough and the ability of the officers is competent and the availability of facilities and infrastructure is sufficient then service satisfaction is quite satisfactory

[R18] If the clarity of the information is clear enough and the ability of the officers is competent and the availability of facilities and infrastructure is adequate then service satisfaction is satisfied

[R19] If the clarity of the information is clear and the ability of the officers is not competent and the availability of facilities and infrastructure is inadequate then service satisfaction is not satisfied[16].

[R20] If the clarity of the information is clear and the ability of the officers is not competent and the availability of facilities and infrastructure is adequate then service satisfaction is quite satisfactory

[R21] If the clarity of the information is clear and the ability of the officers is not competent and the availability of facilities and infrastructure is adequate then service satisfaction is satisfied

[R22] If the clarity of the information is clear and the officers' abilities are competent enough and the availability of facilities and infrastructure is inadequate then service satisfaction is quite satisfactory[17].

[R23] If the clarity of the information is clear and the ability of the officers is quite competent and the availability of facilities and infrastructure is sufficient then service satisfaction is quite satisfactory.

[R24] If the clarity of the information is clear and the officer's ability is competent enough and the availability of facilities and infrastructure is adequate then service satisfaction is satisfied

[R25] If the clarity of the information is clear and the ability of the officers is competent and the availability of facilities and infrastructure is inadequate then service satisfaction is satisfied

[R26] If the clarity of the information is clear and the ability of the officers is competent and the availability of facilities and infrastructure is sufficient then service satisfaction is satisfied

[R27] If the clarity of the information is clear and the ability of the officers is competent and the availability of facilities and infrastructure is adequate then service satisfaction is satisfied[18].

2. Defuzzyfikasi

Defuzzification was carried out with the help of MATLAB R2022a fuzzy toolbox software. In Figure 4 you can see the results obtained using MATLAB R2022a.

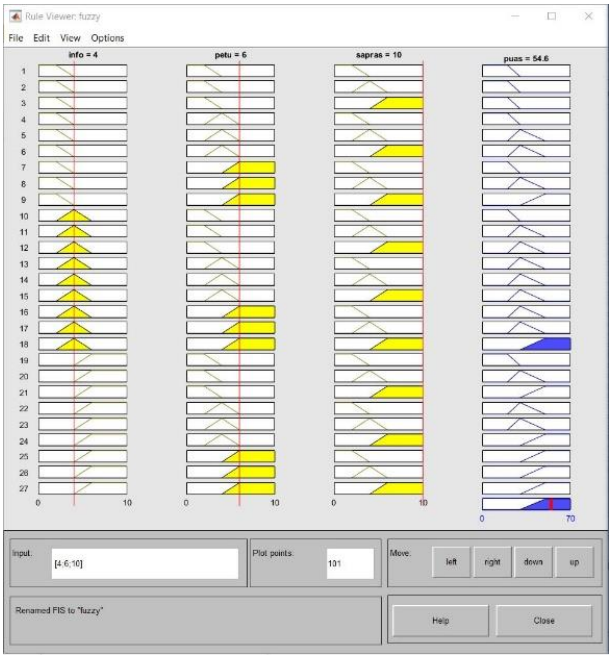

Figure 4. Results of satisfaction levels using the Matlab fuzzy toolbox

The results of the affirmation are as follows:

a. Input, including:

1. Information Clarity, obtained a real number of 4, which is membership of the Information Clarity domain of the clear set.

2. Officer Ability, obtained a real number of 6, which is membership in the Officer Ability domain of the Competent set.

3. Availability of Facilities and Infrastructure, obtained a real number of 10, which is membership in the

Availability of Facilities and Infrastructure domain of the adequate set[19].
b. The satisfaction level output obtained is a real number of 54.6, which is membership of the satisfaction level domain of the satisfied set, which means that the satisfaction level variable is said to be satisfied, namely 54.6. Based on the results obtained using fuzzy mamdani calculations with Matlab R2022a, it can be seen that the results indicate community satisfaction with a value of 54.6 being declared satisfied[20].

IV. CONCLUSION

Using the mamdani method to assess the level of service satisfaction for Social Welfare Service Recipients at Integrated Centers "Prof. Dr. Soeharso" in Surakarta through three processes starting from the Formation of Fuzzy Sets (Fuzzification), Application of Implication Functions and Defuzzification[21]. The results show that using the Mamdani fuzzy model can show the rules of connection between input variables, namely clarity of information, ability of officers and availability of facilities and infrastructure so as to produce output values for service satisfaction. This research has proven the correlation of these variables in determining the results of service satisfaction for Social Welfare Service Recipients[22]. In the future, the development of this research will be tested again by adding more input variables and an interface will be created to facilitate the processing of service quality assessment results for Social Welfare Service Recipients[23][24][25][26].

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