JUSIKOM PRIMA (Jurnal Sistem Informasi dan Ilmu Komputer Prima)
Vol. 7 No. 1, August 2023 E-ISSN : 2580-2879

FUZZY LOGIC FOR OPTIMIZING ROOM SALES: SUGENO METHOD AND MAPE EVALUATION

Dadan Suhamdani*[*1], Daniel Christian[2], Frans Aditya Bangun[3], Ahmad Rifai[4], Evta Indra[5]
[1,2,,3,4,5]Universitas Prima Indonesia
Jl.Sampul No.3, Sei Putih Bar., Kec. Medan Petisah, Medan City, North Sumatra 20118
Email : suhamdhani@gmail.com*

ABSTRACT- The Indonesian hospitality industry has increased over the past decades and is one of the most critical sectors of the national economy. The focus is on determining the number of rooms sold using the Sugeno method's fuzzy logic. This study optimizes room sales by developing a fuzzy logic-based system that can effectively determine the number of rooms sold considering availability, best available rates, and revenue target. The Sugeno method is a fuzzy inference system that determines the relationship between input variables (room availability, best available rate, revenue target) and output variables (number of rooms sold). Modeled using linguistic variables and fuzzy rules, the Sugeno method can provide a quantitative output based on specified input conditions. The mean absolute percentage error (MAPE) is used as a performance measure to evaluate the proposed fuzzy logic model's accuracy. Target data 175,000,000 to 245,000,000, BAR standard room 225,000 to 335,000, BAR superior room 285,000 to 425,000, available standard room 68 rooms/day, superior room 10 rooms/day, model accuracy measurement result is 1,80% very accurate interpreted. As such, the proposed system is helpful for decision-making related to optimizing room sales in the hospitality industry.

KEYWORDS: Decision Support System, Fuzzy Logic, Optimizing, MAPE, Sugeno Method.

1. INTRODUCTION

The hospitality industry in Indonesia has overgrown over the past few decades, along with more substantial economic growth and an increase in the number of tourists visiting Indonesia every year. The hotel industry is one of the most critical sectors in contributing to the national economy. Judging from the direct gross domestic product (TDGDP) of tourism, the tourism sector contributes around 4.6-4.9 percent to Indonesia's GDP [1]. However, currently, the Indonesian Hotel and Restaurant Association (PHRI) recorded nearly 40,000 hotel room cancellations with a total loss value of IDR 1 trillion [2], [3] caused by the Covid-19 pandemic where many activities are now carried out on Work From Home (WFH) basis [4]. With the COVID-19 pandemic, it has had an impact on the closure of around 1,642 hotels [5]. In this context, fuzzy logic has been identified as a method that can be used to deal with uncertainty and ambiguity in decision-making as a reference for creating marketing strategies.

Some previous studies have been conducted in this domain. Research by [5] to find out the proper steps to save the hotel industry during the COVID-19 pandemic in Indonesia so that the business wheels of the hotel industry can continue to provide economic stability for the people in Indonesia. To help one of the hotel industries in Gili Trawangan, Gili Amor Boutique Resort [6] uses the Fuzzy Tsukamoto method to help determine hotel rental prices. The tuning process's importance in determining the fuzzy set's parameter value is described [7] to find the best deal. Research [8] explained that using hyper-parameter tuning can make a difference by creating more accurate predictions and having better exactness esteem. A study conducted by [9] concluded the fuzzy Sugeno method has a good accuracy value.

Although some studies use fuzzy logic, they use different methods and have yet to pay attention to room availability and income targets. Therefore, this study aims to fill the gap by applying the Sugeno method in fuzzy logic to optimize room sales based on room availability, the best available rate, and the desired revenue target. The main objective of this study is to develop a fuzzy logic model that can provide optimal recommendations for room sales by considering relevant factors and measuring their accuracy using MAPE as an evaluation indicator.

2. RESEARCH METHODS

2.1 Framework

This research started with data collection, implementation of Sugeno's fuzzy logic method, results, and evaluation. The tools used in this study were Microsoft Office 2019 applications, MATLAB R2017b applications, and VHP as sources to obtain room sales datasets. More details about the framework can be seen in the figure 1.

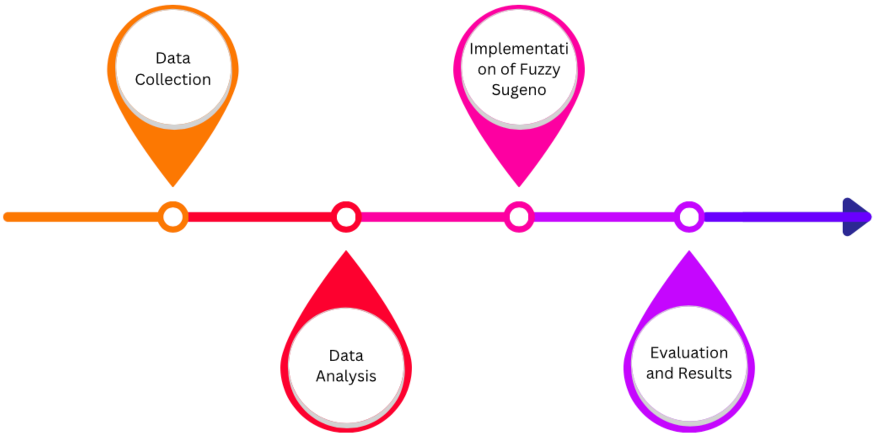


Figure 1. Framework

2.2 Data Collection

Data collection techniques or methods are carried out by taking data from the VHP (Visual Hotel Program) application used at Wisma HM Joni Medan. VHP is an application developed by PT. Sindata. The required data is taken from a server owned by PT. Sindata through a desktop application-based VHP application. The data needed is room production data from Wisma HM Joni Medan. As for Wisma HM Joni's tariff structure data for 2023, budget and sales targets are obtained directly from Wisma HM Joni Medan's management.

The research dataset consists of the 2023 target, level structure, and available room data. Researchers clean the data so that the datasets needed for the study can be obtained.

Table 1. Target Wisma HM Joni 2023

Month	Target
January	175.000.000
February	170.000.000
March	185.000.000
April	200.000.00
May	230.000.000
June	210.000.000
July	185.000.000
August	195.000.000
September	180.000.000

Month	Target
October	187.000.000
November	195.800.000
December	245.000.000

From the table above, it can be seen the data on the 2023 target has been determined by the company's management, and the target must be achieved so that profits can be obtained. The highest target in December 2023 is 245,000,000, and the lowest mark in February 2023 is 170,000,000.

Table 2. Rate structure Wisma HM Joni

BAR	Room Type	
	Standard	Superior
BAR Weekday	225.000 – 275.000	285.000 – 350.000
BAR Weekend	250.000 – 335.000	325.000 – 425.000

The table above shows information about the rate of each room type that has been determined for each market segment. For a rate that is run dynamically for each month under the provisions of the rate structure. The lowest room rate is the standard room rate type, and the highest is the room rate type.

Table 3. Room Available Wisma HM Joni

Room Type	No Of Room
Standard Single	64
Standard Twin	4
Superior Single	7
Superior Twin	3

In the table above, you can find the number of rooms available for each room type. The highest number of rooms is standard single rooms, and the lowest number of rooms is superior twin rooms. Room availability in one month is obtained from the number of rooms multiplied by 30 days each month..

2.3 Fuzzy Logic

Fuzzy logic is part of an artificial intelligence system that emulates the ability of humans to think in the form of algorithms that are then run by machines [10]. Fuzzy logic is a proper way to map an input space into an output space [11]. Prof. Lotfi A. Zadeh introduced fuzzy logic in 1965 [12] as an alternative to binary logic (yes/no or true/false) used in most computing systems. Variables in fuzzy logic can have values that are not only limited to Boolean values (true/false) but can have vague or uncertain values, and this concept is applied to the rules of logic to produce vague or uncertain conclusions. The basis of fuzzy logic is fuzzy set theory [13]. In fuzzy set theory, the role of membership degrees as determinants of the existence of elements in a set is vital [13].

In principle, a fuzzy set is an expansion of a crisp set, that is, a set that divides a group of individuals into two categories, namely members and non-members [14]. There are three kinds of fuzzy methods: Tsukamoto, Mamdani, and Sugeno [15]. All three ways have their advantages and disadvantages [15]. Fuzzy Tsukamoto represents each rule using fuzzy sets with monotonous membership functions [15].

2.4 Sugeno Method

The Fuzzy Sugeno model was proposed by Takagi, Sugeno, and Kang [16]. The fuzzy inference system of the Sugeno method has a characteristic. That is, the consequent is not a fuzzy set but is a linear equation with variables according to the input variables [16], [17]. The Sugeno method is one approach in fuzzy logic used to infer or draw conclusions from fuzzy rules that have been made. The Takagi-Sugeno method is an undefined inference method for governments represented in the form (IF-THEN) where the system's output is not a fuzzy set but rather a constant or linear equation [18]. The Sugeno model uses the singleton membership function, a membership function whose membership level is 1 on one new value and 0 on another [19]. The typical fuzzy rule in the Sugeno fuzzy model is formed IF x is A AND y is B THEN z = f(x, y), where A and B are fuzzy sets in antecedents and z = f(x, y) corporate functions as a consequence [18].

There are 2 fuzzy models of the Sugeno method, namely the Sugeno Zero-Order and the First Order Sugeno fuzzy model. If f(x, y) is a first-order polynomial, the resulting FIS is the first-order Sugeno fuzzy model. If f is constant, a zero-order Sugeno fuzzy model is generated. The fuzzy inference system using the Sugeno method has the characteristic that the consequent is not a fuzzy set but is a linear equation with variables according to input variables [17]. In general, the zero-order Sugeno fuzzy model has the following equation (1):

$$\text{IF } (X_1 \text{ is } A_1) o (X_2 \text{ is } A_2) o (X_3 \text{ is } A_3) o \ldots (X_n \text{ is } A_n) \text{ THEN } Z = k \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(1)}$$

A_n is the nth fuzzy set as an antecedent, and k is a constant as a consequent. While the first-order Sugeno fuzzy model generally has the following equation (2):

$$\text{IF } (X_1 \text{ is } A_1) o (X_2 \text{ is } A_2) o \ldots (X_n \text{ is } A_n) \text{ THEN } z = P_1 * X_1 + \cdots + P_n * X_n + q \ldots\ldots\ldots\text{(2)}$$

A_n is the nth fuzzy set, as an antecedent is an nth constant, and $P_n q$ is a constant in the consequent. In fuzzy logic, the Sugeno method has the following stages:

1. Identify input and output variables
   Input variables are input for fuzzy inference systems that are both linguistic and numerical. At the same time, the output variable is a variable used as the output of the fuzzy inference system.
2. Fuzzification
   The formation of a fuzzy set (fuzzification) is to convert an input value into an unclear set form by using a membership function that shows how much an input value enters into a fuzzy set.
3. Determination/formation of fuzzy rules
   The rule setting is based on data analysis of the limits of each fuzzy set on each variable. Rule assignments have an arrangement of IF–THEN rules describing the relationship between input and output variables. Each practice consists of one or more conditions and one conclusion. Requirements are expressed as fuzzy sets on input variables, while findings are described in the form of linear functions on output variables. The rules that have been formed are combined to produce more accurate conclusions. Fuzzy rules are composed using fuzzy operators such as MIN, MAX, or AVG.
4. Defuzzification
   Defuzzification is converting the result of fuzzy inference into an unequivocal or definite value. Defuzzification can be done using the weighted average method technique, centroid method, or mean of the maximum way.

2.5 MAPE

MAPE is a commonly used metric in forecasting and prediction models, providing a reliable assessment of the model's predictive capabilities. The Mean Absolute Percentage Error (MAPE) is calculated using the absolute error at each period divided by the observed values evident for that period [20]. This approach is practical when the size or size of the prediction variable is significant in evaluating prediction accuracy [20]–[22]. MAPE (Mean Absolute Percentage Error) has an equation (3) as follows:

$$\text{MAPE} = \frac{1}{n}\sum_{i=1}^{n}\left|\frac{A_1 - F_1}{A_1}\right| x\ 100\% \tag{3}$$

Where:
n is the sample size
Ai is the actual data value
Fi is the approximate data value

3. RESULTS AND DISCUSSION

3.1 Identification of Input and Output Variables

Based on the dataset that has been obtained, input and output variables can be determined. There are 3 input variables and 2 output variables. More details can be seen in Table 4.

Table 4. Determination of input and output variables

Function	Variable
Input	Target
	Rate Standard
	Rate Superior
Output	Occupancy Standard
	Occupancy Superior

The table above explains that the target, standard rate, and superior rate variables are input variables, while standard occupancy and excellent occupancy are output variables.

3.2 Fuzzification

At this stage of fuzzification, the dataset is used as a reference for the determination of the speaker's universe according to predetermined variables. Each variable has 3 membership functions. More details can be seen in Table 5.

Table 5. Fuzzy set of input and output variables

Function	Variable	Fuzzy Set	Domain	Speaker's Universe
Input	Target	Small	170.000.000–250.000.000	[170.000.000–250.000.000]
		Big	170.000.000–250.000.000	
	Rate Standard	Low	225.000–335.000	[225.000–335.000]
		Tall	225.000–335.000	
	Rate Superior	Low	285.000–425.000	[285.000–425.000]
		Tall	285.000–425.000	
Output	Occupancy Standard	Low	0–330	[0–1100]
		Normal	330–650	
		High	650–1100	
	Occupancy Superior	Low	0–80	[0–150]
		Normal	80–100	

Function	Variable	Fuzzy Set	Domain	Speaker's Universe
		High	100–150	

In the table above, it can be known that the speaker universe for each variable is the lowest and highest data owned by each variable according to the previously obtained dataset.

3.3 Creating Fuzzy Rules

Next is the formation of fuzzy rules. At this stage, fuzzy control is formed as IF-THEN, which describes the relationship between input and output variables. The membership value is obtained by running the membership function on a fuzzy set. The determination or formation of fuzzy rules is carried out based on an analysis of the boundaries of each fuzzy set so that 8 fuzzy rules are obtained with the arrangement of fuzzy rules IF target IS ... AND rate standard IS ... AND rate superior IS ... THEN occupancy standard IS ... AND occupancy superior IS ...

Table 6. Fuzzy Rules

No	Target	Input		Output	
		Rate Standard	Rate Superior	Occ Standard	Occ Superior
1	Small	Low	Low	Normal	Normal
2	Small	Low	High	Normal	Low
3	Small	High	Low	Low	Normal
4	Small	High	High	Low	Low
5	Big	Low	Low	High	High
6	Big	Low	High	High	Normal
7	Big	High	Low	Normal	low
8	Big	High	High	low	low

Based on the table above, the fuzzy rules that have been formed are combined to produce more accurate conclusions. The composition of the vague rules in the study was carried out using the FUZZY MIN operator.

3.4 Defuzzification

At this stage, the defuzzification used is weighted Average defuzzification. Defuzzification with Weighted Average is one of the methods in fuzzy logic to convert output undefined values into crisp values. This method involves the calculation of a weighted average of the crisp values corresponding to each fuzzy set of outputs. The steps to defuzzification with a Weighted Average are as follows:

1. Calculate the α (alpha) membership value for each fuzzy output set.
2. For example, specify a crisp value for each fuzzy output set using a middle or centroid value.
3. Calculate the weighted value of the crisp value corresponding to each fuzzy output set, with a weight equal to the α membership value of each fuzzy output set.

The calculation of the Weight Average on the Sugeno method is carried out using the following equation 4:

$$WA = \frac{\alpha_1 Z_1 + \alpha_2 Z_2 + \alpha_3 Z_3 + \cdots + \alpha_n Z_n}{\alpha_1 + \alpha_2 + \alpha_3 + \cdots + \alpha_n} \qquad \text{……………….(4)}$$

Where:

WA is an average value
α_n is the nth predicate value
Zn is an index of the nth output value

3.5 Fuzzy Logic Implementation

In the implementation of fuzzy logic, the Sugeno method in this study uses the application MATLAB R2017b. The use of this MATLAB application is to facilitate and accelerate the implementation of fuzzy logic. The prediction results in this study can be used as a reference in determining the number of room sales for each room type so that an effort to achieve the target can be more directed and controlled. The initial step of implementation is the formation of input and output variables. See Figure 2 for more detailed information.

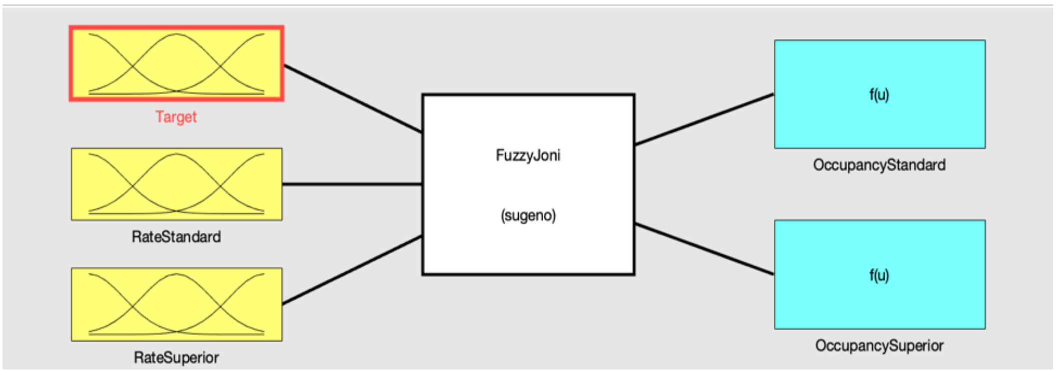


Figure 2. Variable input and output

In the picture above, you can see that the input variable on the left is yellow, and the output variable on the right is blue. There are 3 variables with the input function and 2 with the output function. Next, enter into the stage of formation of fuzzy sets. The fuzzy set and membership function of the target variable can be seen in Figure 3.

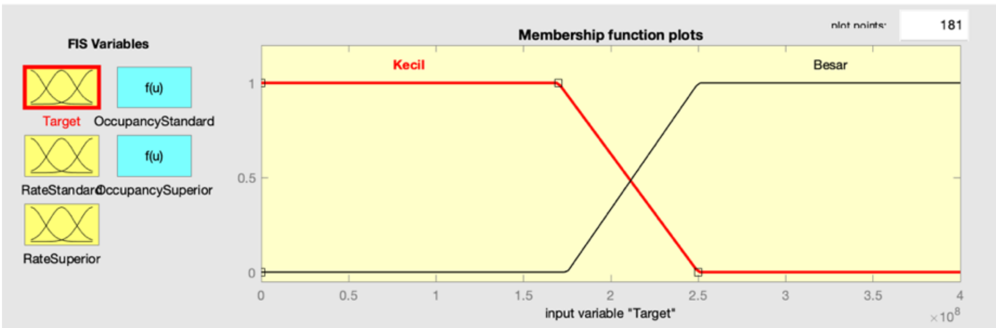


Figure 3. Target variable membership function

Based on the picture above, the Target variable has 2 membership functions: SMALL and BIG. For all membership functions, use trapmf. Parameters of the SMALL membership function [0 0 170000000 250000000] and the BIG membership function [175000000 250000000 400000000 450000000]. The membership value can be obtained using the following equations 5 and 6:

$$\mu[x]\text{SMALL} = \begin{cases} 1, & x \leq 170000000 \\ \dfrac{250000000 - x}{250000000 - 170000000}, & 170000000 \leq x \leq 250000000 \\ 0, & x \geq 250000000 \end{cases} \tag{5}$$

$$\mu[x]BIG = \begin{cases} 0, & x \leq 170000000 \\ \frac{x - 170000000}{250000000 - 170000000}, & 170000000 \leq x \leq 250000000 \\ 1, & x \geq 250000000 \end{cases} \tag{6}$$

The membership function and fuzzy set of the Standard Rate variable can be seen in Figure 4.

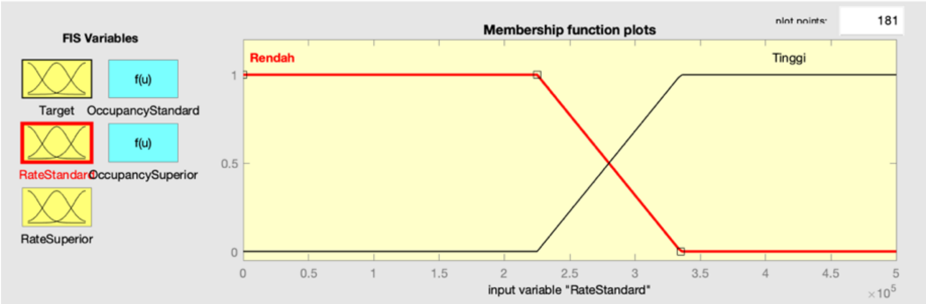


Figure 4. Standard variable rate membership function

Based on the picture above, the standard variable rate membership function has 2 membership functions using trapmf, namely LOW and HIGH. The parameters for each membership function are LOW [0 0 225000 335000] and HIGH [225000 335000 500000 550000]. For membership values, you can use the following equations 7 and 8:

$$\mu[x]LOW = \begin{cases} 1, & x \leq 225000 \\ \frac{335000 - x}{335000 - 225000}, & 225000 \leq x \leq 335000 \\ 0, & x \geq 335000 \end{cases} \tag{7}$$

$$\mu[x]HIGH = \begin{cases} 0, & x \leq 225000 \\ \frac{x - 225000}{335000 - 225000}, & 225000 \leq x \leq 335000 \\ 1, & x \geq 335000 \end{cases} \tag{8}$$

The membership function and fuzzy set of superior rate variables can be seen in Figure 5.

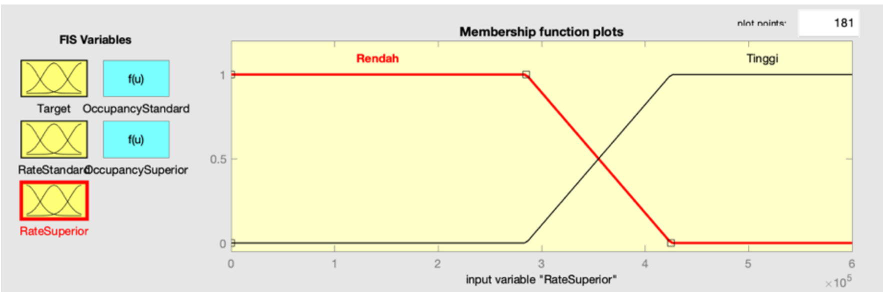


Figure 5. Superior variable rate membership function

From the picture above, the superior rate variable has 2 membership functions using trapmf, and each function has parameters LOW [0 0 285000 425000] and HIGH [285000 425000 600000 650000]. For its membership value, can use the following equations 9 and 10:

$$\mu[x]LOW = \begin{cases} 1, & x \leq 285000 \\ \frac{285000 - x}{425000 - 285000}, & 285000 \leq x \leq 425000 \\ 0, & x \geq 425000 \end{cases} \quad (9)$$

$$\mu[x]HIGH = \begin{cases} 0, & x \leq 250000 \\ \frac{x - 285000}{425000 - 285000}, & 250000 \leq x \leq 280000 \\ 1, & x \geq 280000 \end{cases} \quad (10)$$

Similar to the variables in the input, each variable in the output has 3 membership functions, namely LOW, NORMAL, and HIGH. The type for each membership function on each variable is constant. The membership function on the output variable is formed to make the expected result more accurate in setting parameters for each membership function by analyzing the sales history of available rooms and rooms. So, the parameters will differ from the same membership function on different variables. For more details about the membership function for each variable can be seen in Figures 6 and 7.

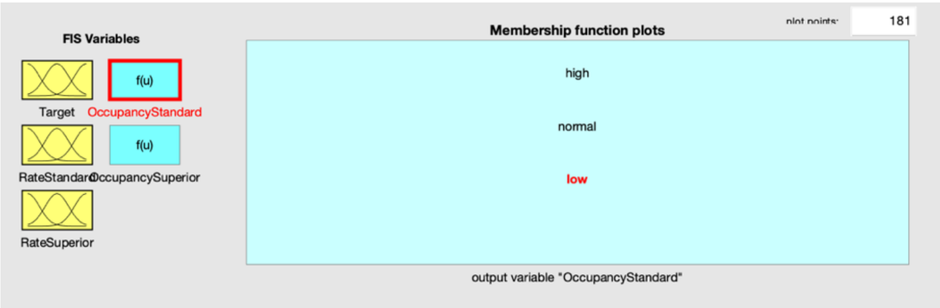


Figure 6. Standard occupancy variable membership function

In the picture above, the membership function parameters of the legal occupancy variables are LOW [330], NORMAL [650], and HIGH [1100].

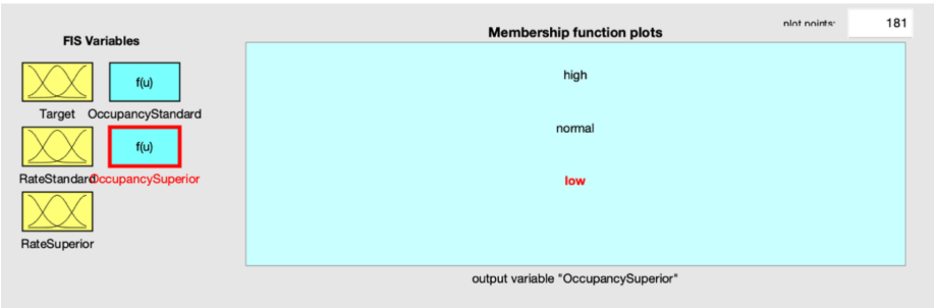


Figure 7. Superior occupancy variable membership function

In the picture above, the membership function parameters of the foremost occupancy variables are LOW [80], NORMAL [100], and HIGH [150]. Next is preparing fuzzy rules based on fuzzy rules that have been formed according to Table 3.3. For the preparation of fuzzy rules in the MATLAB application, you can see Figure 8.

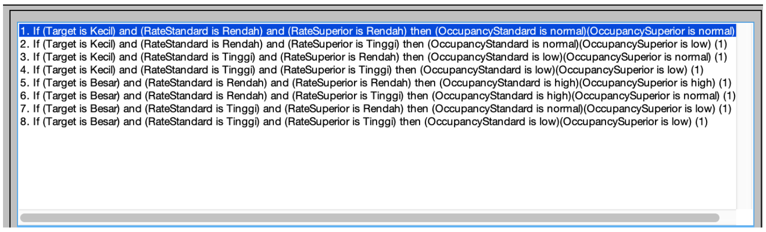


Figure 8. Fuzzy Rules

The image above is a partial display of the fuzzy rules compiled in the MATLAB application. There is 1 fuzzy rule resulting from 2 membership functions from 3 input variables. A simulation of vague practices that have been collected can be done on the rule viewer page, as shown in Figure 9.

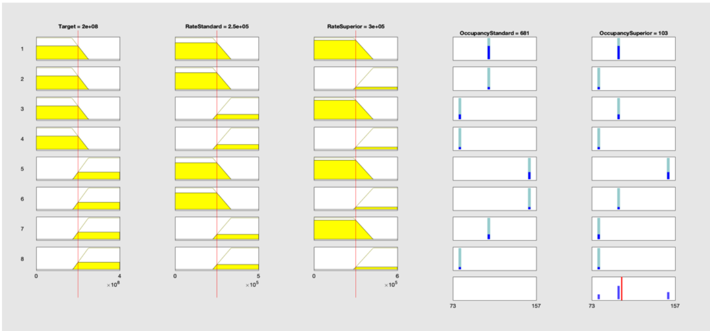
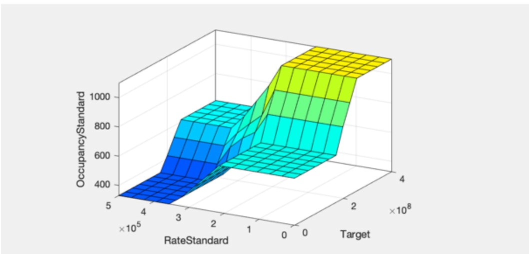
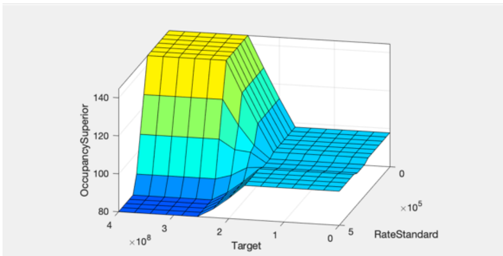


Figure 9. Display rules viewer

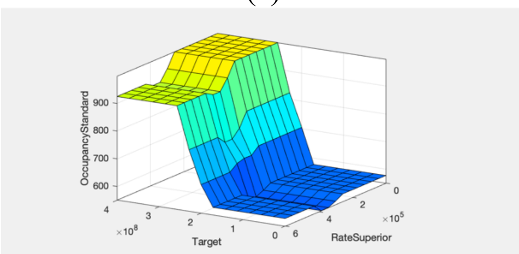
In Figure 9, optimization of target values, standard rates, and superior rates can be carried out to predict how many rooms must be sold for each room type in one month to achieve the predetermined target. In the picture, optimization is carried out with a target value of 200000000, standard rate of 250000, and superior rate of 300000; then a prediction is generated for the sale of standard rooms of 681 rooms and superior 103 rooms. A surface diagram is obtained from the fuzzy rules that have been formed, as shown in Figure 10.



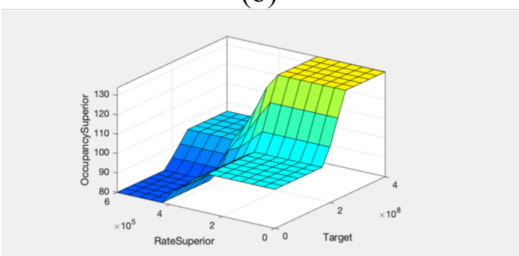
(a)



(b)



(c)



(d)

Figure 10. Diagram Surface (a) target, rate standard dan occupancy standard, (b) target, rate standard dan occupancy superior, (c) target, rate superior dan occupancy standard, (d) target, rate superior dan occupancy superior.

There are 4 forms of surface diagrams, each with a different shape depending on the variables. A GUI was created for the fuzzy logic system with a display to make optimization easier, as shown in Figure 11.

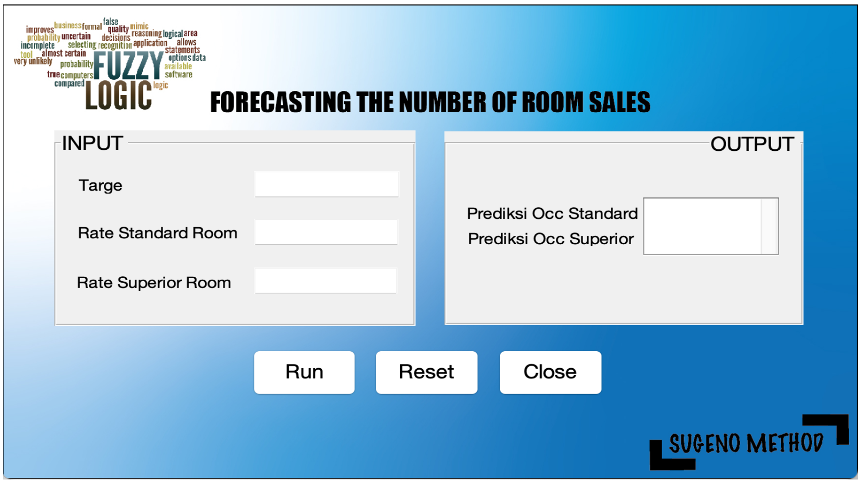


Figure 11. Fuzzy Sugeno GUI

Furthermore, researchers optimize the input variable data that has been obtained previously so that the prediction of room sales can be used as a reference for room sales targets in each month in 2023. The results of recommendations from optimizing input variable data can be seen in Table 7.

Table 7. Implementation of fuzzy logic

Month	Target	Rate		Occupancy		Est Revenue
		STD	SPR	STD	SPR	
Jan	175.000.000	230.000	275.000	635	100	173.550.000
Feb	170.000.000	225.000	280.000	650	100	174.250.000
Mar	185.000.000	250.000	300.000	630	98	186.900.000
Apr	200.000.000	275.000	315.000	636	99	206.085.000
May	230.000.000	290.000	325.000	674	97	226.985.000
Jun	210.000.000	270.000	320.000	661	100	210.470.000
Jul	185.000.000	250.000	300.000	630	98	186.900.000
Aug	195.000.000	275.000	300.000	627	101	202.725.000
Sep	180.000.000	250.000	300.000	604	97	180.100.000
Oct	187.000.000	270.000	300.000	605	99	193.050.000
Nov	195.000.000	280.000	325.000	613	96	202.840.000
Dec	245.000.000	300.000	350.000	702	96	244.200.000

In the table above, you can see the results of sales recommendations for each room type. To determine the accuracy of the offer, effects can be done using MAPE, which can be seen in Table 8, where the target is the actual data value and the estimated revenue is the estimated data value.

Table 8. MAPE result

Month	A (target)	F (Prediksi Pendapatan)	MAPE
Januari	175.000.000	173.550.000	0,83
Februari	170.000.000	174.250.000	2,50
Maret	185.000.000	186.900.000	1,03
April	200.000.000	206.085.000	3,04

Month	A (target)	F (Prediksi Pendapatan)	MAPE
Mei	230.000.000	226.985.000	1,31
Juni	210.000.000	210.470.000	0,22
Juli	185.000.000	186.900.000	1,03
Agustus	195.000.000	202.725.000	3,96
September	180.000.000	180.100.000	0,06
Oktober	187.000.000	193.050.000	3,24
November	195.000.000	202.840.000	4,02
Desember	245.000.000	244.200.000	0,33
MAPE			1,80

The result of the MAPE calculation is 1.80%, so it can be interpreted that the recommendation results are very accurate. The results of these recommendations can be used as a reference in determining the number of rooms that must be sold and can be used as information for a decision support system to carry out marketing strategies.

CONCLUSION

This research uses one method in fuzzy logic, namely the Sugeno method, which is one approach in fuzzy logic used to infer or conclude fuzzy rules that have been made. This method is easy to understand and can provide accurate results in determining output values. Overall, this study proves that using fuzzy logic methods, especially the Sugeno method, can provide a practical approach to determining the number of room sales by considering various important factors such as room availability, the best available rate, and revenue targets. In this study, evaluation using MAPE also showed that the proposed fuzzy logic model had an acceptable level of accuracy. Therefore, the results of this study can provide a solid basis for making better decisions in optimizing room sales in the hospitality industry.

This research is the beginning of future studies in optimizing revenue in the hospitality industry. The use of fuzzy logic can be done not only for optimizing room sales but also in other things in the hospitality industry, such as room pricing, amniotic production, and others. It is hoped that further researchers can develop the use of fuzzy logic in the hotel industry.

BIBLIOGRAPHY

[1] A. Mun'im, "PENYEMPURNAAN PENGUKURAN KONTRIBUSI PARIWISATA: ALTERNATIF PERCEPATAN PERTUMBUHAN EKONOMI INDONESIA Improvement on the Measurement of Tourism Contribution: An Alternative to Accelerating Indonesia's Economic Growth," Jurnal Kepariwisataan Indonesia, vol. 16, no. 1, pp. 1–14, 2022.

[2] Y. P. Kristiutami and S. N. Raharjo, "STRATEGI PEMASARAN HOTEL GRAND ASRILIA DI MASA PANDEMI COVID-19," Media Wisata, vol. 19, no. 1, 2021, doi: 10.36275/mws.

[3] kompas.com, "Mengukur Dampak Wabah Virus Corona ke Bisnis Hotel," kompas.com, 2020.

[4] A. Dahlia Siberian et al., "Laptop Price Prediction with Machine Learning Using Regression Algorithm," Jurnal Sistem Informasi dan Ilmu Komputer Prima(JUSIKOM PRIMA), vol. 6, no. 1, pp. 87–91, Sep. 2022, doi: 10.34012/JURNALSISTEMINFORMASIDANILMUKOMPUTER.V6I1.2850.

[5] L. Diayudha, "Industri Perhotelan Di Indonesia Pada Masa Pandemi Covid-19: Analisis deskriptif," Journal FAME: Journal Food and Beverage, Product and Services,

Accommodation Industry, Entertainment Services, vol. 3, no. 1, pp. 1–56, 2020, doi: 10.30813/fame.v3i1.2166.

[6] R. Pujiarso Nugroho, B. Darma Setiawan, and M. Tanzil Furqon, "Penerapan Metode Fuzzy Tsukamoto untuk Menentukan Harga Sewa Hotel (Studi Kasus: Gili Amor Boutique Resort, Dusun Gili Trawangan, Nusa Tenggara Barat)," Jurnal Pengembangan Teknologi Informasi dan Ilmu komputer, vol. 3, no. 3, pp. 2581–2588, 2019, [Online]. Available: http://j-ptiik.ub.ac.id

[7] M. Yunus, "Optimasi Penentuan Nilai Parameter Himpunan Fuzzy dengan Teknik Tuning System," MATRIK : Jurnal Manajemen, Teknik Informatika dan Rekayasa Komputer, vol. 18, no. 1, pp. 21–28, Nov. 2018, doi: 10.30812/matrik.v18i1.334.

[8] A. Amalia, M. Radhi, S. H. Sinurat, D. R. H. Sitompul, and E. Indra, "PREDIKSI HARGA MOBIL MENGGUNAKAN ALGORITMA REGRESSI DENGAN HYPER-PARAMETER TUNING," Jurnal Sistem Informasi dan Ilmu Komputer Prima(JUSIKOM PRIMA), vol. 4, no. 2, pp. 28–32, Feb. 2021, doi: 10.34012/JURNALSISTEMINFORMASIDANILMUKOMPUTER.V4I2.2479.

[9] D. Y. Darmawi, G. W. Nurcahyo, and S. Sumijan, "Fuzzy Sistem Fuzzy Menggunakan Metode Sugeno Dalam Akurasi Penentuan Suhu Kandang Ayam Pedaging," Jurnal Informasi dan Teknologi, vol. 3, no. 2, pp. 72–77, 2021, doi: 10.37034/jidt.v3i2.95.

[10] S. Amalia, R. Andari, and R. Syukriansyah, "STUDI PEMODELAN SISTEM PENGONTROLAN SUHU RUANGAN BERBASIS LOGIKA FUZZY SUGENO," Jurnal Sains dan Teknologi: Jurnal Keilmuan dan Aplikasi Teknologi Industri, vol. 20, no. 2, pp. 175–180, 2020, doi: 10.36275/stsp.v20i2.287.

[11] A. Prayogi and E. santoso, "Sistem Pendukung Keputusan Untuk Penentuan Jumlah Produksi Nanas Menggunakan Metode Fuzzy Tsukamoto (Studi kasus PT.Great Giant Pineapple)," Jurnal Pengembangan Teknologi Informasi dan Ilmu Komputer, vol. 2, no. 6, pp. 2032–2037, 2018, [Online]. Available: http://j-ptiik.ub.ac.id

[12] S. Retno Andani et al., "SISTEM PENDUKUNG KEPUTUSAN DALAM MENENTUKAN PENERIMA BEASISWA DENGAN FUZZY SUGENO," TECHSI, vol. 10, no. 1, pp. 63–79, 2018, doi: 10.29103/techsi.v10i1.580.

[13] B. Sutara and H. Kuswanto, "ANALISA PERBANDINGAN FUZZY LOGIC METODE TSUKAMOTO, SUGENO, MAMDANI DALAM PENENTUAN KELUARGA MISKIN," Jurnal Infotekmesin, vol. 10, no. 2, pp. 75–86, 2019, doi: 10.35970/infotekmesin.v10i2.42.

[14] M. Mukaromah, "PENERAPAN METODE FUZZY SUGENO UNTUK MENENTUKAN JALUR TERBAIK MENUJU LOKASI WISATA DI SURABAYA," Jurnal Matematika, Sains, dan Teknologi, vol. 20, no. 2, pp. 95–101, 2019.

[15] A. D. Saputri, R. D. Ramadhani, and R. Adhitama, "LOGIKA FUZZY SUGENO UNTUK PENGAMBILAN KEPUTUSAN DALAM PENJADWALAN DAN PENGINGAT SERVICE SEPEDA MOTOR," Journal of Informatics, Information System, Software Engineering and Applications, vol. 2, no. 1, pp. 049–055, 2019, doi: HTTPS://DOI.ORG/10.20895/INISTA.V2I1.

[16] F. A. Mustika, "Metode Fuzzy Sugeno untuk Penilaian Kinerja Guru SMK Tamansiswa 3 Jakarta," STRING (Satuan Tulisan Riset dan Inovasi Teknologi), vol. 6, no. 1, pp. 16–22, 2021, doi: 10.30998/string.v6i1.8817.

[17] S. L. M. Sitio, "Penerapan Fuzzy Inference System Sugeno Untuk Menentukan Jumlah Pembelian Obat (Studi Kasus: Garuda Sentra Medika)," Jurnal Informatika Universitas Pamulang, vol. 3, no. 2, pp. 104–109, 2018.

[18] D. Y. Darmawi, G. W. Nurcahyo, and S. Sumijan, " Fuzzy Fuzzy System Using Sugeno Method in Accuracy of Broiler Coop Temperature Determination," Journal of Information and Technology, 2020.

[19] R. Alfita, D. Mamlu'ah, M. Ulum, and R. V. Nahari, "Implementation of Fuzzy Sugeno

Method for Power Efficiency,” International Journal of Advanced Engineering Research and Science, vol. 4, no. 9, pp. 1–5, 2017, doi: 10.22161/ijaers.4.9.1.

[20] U. Khair, H. Fahmi, S. Al-Hakim, and R. Rahim, "Forecasting Error Calculation with Mean Absolute Deviation and Mean Absolute Percentage Error," J Phys Conf Ser, vol. 930, no. 1, pp. 1–6, Dec. 2017, doi: 10.1088/1742-6596/930/1/012002.

[21] J. McKenzie, “Mean absolute percentage error and bias in economic forecasting,” Econ. Lett, vol. 113, no. 3, pp. 259–262, 2011.

[22] A. de Myttenaere, B. Golden, B. Le Grand, and F. Rossi, "Mean Absolute Percentage Error for Regression Models," Neurocomputing, vol. 192, pp. 38–48, 2016.