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The Selection of KORPRI Scholarship Recipients Using Sugeno's Fuzzy Logic

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A B S T R A C T

Student Scholarship Allowance Selection is a routine practice carried out by the Bukittinggi City KORPRI (Civil Servants Corps), which is given to the sons and daughters of civil servants in the Bukittinggi City area who are currently pursuing higher education. Determining scholarship recipients always goes through a strict selection process due to the large number of applicants each year. The selection of scholarship recipients is based on specific criteria and requirements set by KORPRI Bukittinggi City. The criteria/requirements for awarding scholarships are based on three factors: Grade Point Average (GPA), parental income/salary, and number of dependents. In this research, the author applies Sugeno's fuzzy logic in determining scholarship allocation because Sugeno's fuzzy logic can select candidates validly, transparently, and fairly, thus guaranteeing that the selected candidates truly deserve to receive a scholarship. To conduct research effectively, the author designed a research framework that helps the scholarship allocation process using Sugeno fuzzy logic, implemented through the Visual Basic 2010 and MySQL programming languages. Research findings show that the Sugeno fuzzy method can provide accurate and objective recommendations in the scholarship recipient selection process using relevant variables and predetermined rules. This recommendation system can produce fair and transparent decisions. This research aims to contribute to the development of a more effective and efficient scholarship recipient selection system.

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1. Introduction

Education is an essential aspect required by every individual, spanning from children to adults. Fundamentally, education is a conscious and planned effort to create a learning environment and a learning process so that learners actively develop their potential to possess spiritual and religious strength, self-control, personality, intelligence, noble character, as well as the necessary skills for themselves and society. As with education in general, it is known that education is a universal activity in human life, occurring within the family environment where parents act as educators, within the community, and within the school environment—from early childhood education (PAUD), kindergarten (TK), elementary school (SD), junior high school (SMP), and high school (SMA), as well as in higher education institutions [1].

Student scholarships/allowances are generally supportive factors provided to students or scholars as financial aid for their educational expenses. Scholarships can also serve as a significant motivating factor for students or scholars during their academic pursuits. The cost of education for university studies has



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increasingly become expensive in this era, thereby necessitating scholarships for students whose families have a lower to middle economic income to support their educational expenses. However, many scholarships offered by institutions or universities often miss their intended targets.

The selection of scholarship recipients by humans has several weaknesses, including the possibility of human bias towards a specific candidate due to personal factors or a decline in performance caused by physical or psychological fatigue [2]. A scholarship is a form of financial assistance provided to individuals with the aim of supporting the continuation of their education. Scholarships can be granted by government institutions, companies, or foundations. The provision of scholarships can be categorized into unconditional grants or grants with work commitments (commonly referred to as a work bond) after the completion of education [3].

The KORPRI Secretariat is a government organization that plays a role in providing financial aid for the education expenses of students or learners whose parents are Civil Servants (PNS). Student allowances/scholarships must be awarded to deserving and eligible recipients. The number of scholarship applicants has increased from year to year. Consequently, the selection process has become more rigorous. Not all applicants aspiring to receive the scholarship will be accepted; only those who meet the specified criteria will be awarded the scholarship. Hence, there is a need for a decision support system that can assist, expedite, and simplify the decision-making process.

Fundamentally, scholarships are considered income for those who receive them. This aligns with the provisions of Article 4 paragraph (1) of the Income Tax Law No. 36 of 2008. Any economic capability received or obtained in any form and under any name from sources within or outside Indonesia that can be used for consumption or to increase the wealth of taxpayers (WP) is considered income. As scholarships can be interpreted as augmenting the economic capacity of the recipient, they are therefore regarded as income. According to the Kamus Besar Bahasa Indonesia (1996:13), a scholarship is financial aid provided by the government, private sector, or social institutions to financially disadvantaged or high-achieving students or scholars to assist with educational expenses [4]. A scholarship is one form of praise given to an individual to pursue education at a higher level. This recognition can take the form of special access to specific institutions or financial assistance. Typically, this assistance comes in the form of funds aimed at covering educational expenses or as a substitute for the funds that students or scholars would otherwise have to expend during their educational journey [5].

In every educational institution, particularly universities, numerous scholarships are offered to students. These scholarships can originate from the government or private entities. To qualify for these scholarships, students must adhere to the established rules and criteria. The criteria typically include academic performance indices, parental income, number of siblings, parental dependents, semester standing, and other relevant factors. Therefore, not all students who apply for scholarships can be granted them due to the large number of applicants and the multitude of assessment criteria. Hence, there is a need to develop a decision support system that can assist in recommending scholarship recipients [6].

Many methods can be used to design a decision support system, one of which is fuzzy logic. Fuzzy, linguistically interpreted as vague or ambiguous, allows a value to simultaneously possess truth and falsehood because fuzzy logic values range between 0 and 1. Fuzzy logic is utilized in processing data that cannot be represented in binary form (0 and 1). Fuzzy Logic is a rule-based decision-making process aimed at solving problems where there is ambiguity and uncertainty. It is a method of fuzzy logic. The fuzzy method has a concept that is relatively easy to comprehend for researchers who will be utilizing this method [7]. Fuzzy Logic is a method of computation using linguistic variables as a replacement for numerical computations. The terms utilized in fuzzy logic may not be as precise as numbers, but they are much closer to human intuition. Through fuzzy logic, human expertise can be easily and efficiently implemented into machine language [8]. In fuzzy logic methods, there exist several inference models, including Mamdani, Sugeno, and Tsukamoto [9].

In this research, the fuzzy logic to be applied is Sugeno fuzzy logic. Sugeno fuzzy logic is a method used to determine the best alternative among several available alternatives based on specific criteria in the form of rules or criteria utilized in the decision-making process. The Sugeno method generates a system output that is beneficial for applications in medical diagnosis and the development of future systems. Calculations using the Sugeno method conclude that it can determine accurate detection in existing conditions [10]. Fuzzy Sugeno is a fuzzy logic method employed in decision-making through IF-THEN rules. This method models the relationship between input and output using fuzzy membership functions and implications. The advantage of Fuzzy Sugeno lies in its capability to generate numerical output based on linear combinations of inputs [11]. Fuzzy logic comprises three main components: fuzzification, inference, and defuzzification. In the fuzzification process, crisp truth-valued inputs are transformed into fuzzy input forms using membership functions [12]

The reasoning in the Fuzzy Sugeno method is almost identical to that of the Mamdani method, with the distinction lying in the system's output (consequence). In this method, the system's output is not presented as a fuzzy set but rather as a constant or a linear equation. This approach was introduced by Takagi-Sugeno Kang in 1985 [13].

Zero-Order Fuzzy Sugeno Model

In general, the form of the Zero-Order SUGENO fuzzy model is:

$$\text{IF } (x_1 \text{ is } A_1) \bullet (x_2 \text{ is } A_2) \bullet (x_3 \text{ is } A_3) \bullet \dots \bullet (x_N \text{ is } A_N) \text{ THEN } z=k \quad (1)$$

where A_i is the i th fuzzy set as the antecedent, and k is a constant (firm) as the consequent..

First-Order Fuzzy Sugeno Model

In general, the form of the First-Order SUGENO fuzzy model is:

$$\text{IF } (x_1 \text{ is } A_1) \bullet \dots \bullet (x_N \text{ is } A_N) \text{ THEN } z = p_1*x_1 + \dots + p_N*x_N + q \quad (2)$$

where A_i is the i th fuzzy set as the antecedent, and p_i is the i th (firm) constant and q is also a constant in the consequent.

If the rule composition uses the Sugeno method, then defuzzification is carried out by finding the average value.

There are several steps that must be carried out in the fuzzy Sugeno calculation, namely: [10]

Fuzzification. The fuzzification stage is the process of transforming existing definite values into membership functions. Fuzzification involves converting input values that are in the form of classical sets (crisp sets) into fuzzy values, represented as linguistic variables and degrees of membership. The degree of membership is calculated according to the form of the membership function. [9]

Basic rules. The basic rule of fuzzy logic control is a form of relational rule "IF-THEN" or "if then" with the formula:

$$\text{if } x \text{ is } A \text{ then } y \text{ is } B \quad (3)$$

Where A and B represent linguistic values interpreted as ranges of variables X and Y respectively. The statement " x is A " is referred to as the premise or antecedent, while the statement " y is B " is termed as the consequence or conclusion..

Implications. The implication is the process of obtaining the output value from the IF-THEN rules by finding the minimum value from the formed rules. Since Sugeno's rule base formation stage employs the AND operator, this is the formula used to determine the minimum value in the implication step:

$$\mu_A \cap B = \min(\mu_A(x), \mu_B(x)) \quad (4)$$

Defuzzification. Defuzzification is the opposite process of fuzzification. In Sugeno's calculation method, the defuzzification process involves using the weighted average (WA) with the following formula:

$$\alpha_1 * Z_1 + \alpha_2 * Z_2 + \dots + \alpha_n * Z_n \\ Z = \alpha_1 + \alpha_2 + \dots + \alpha_n \quad (5)$$

Information:

Z_n = The value that has been established based on the output variable.

α -predicate = The value generated from the implication process.

Therefore, Sugeno Fuzzy Logic is highly suitable for implementing a scholarship decision support system. Determining whether an individual is eligible for a scholarship should not be based solely on one aspect, such as GPA alone. There are several other criteria to consider, such as the applicant's parents being civil servants, parental responsibilities, and the applicant's age. For example, suppose there are two applicants. The first applicant has a high GPA, comes from a high-ranking parental civil servant family, and has minimal parental responsibilities. On the other hand, the second applicant has an average GPA, belongs to a lower-ranking parental civil servant family, and has significant parental responsibilities. Based solely on GPA, the first applicant seems more eligible for the scholarship. However, when considering the parent's civil servant ranking and parental responsibilities, the second applicant appears to be more deserving. By employing fuzzy logic, each criterion is categorized into membership functions. Consequently, a set of rules or guidelines can be established through fuzzy logic to determine who is more deserving of the scholarship based on a comprehensive evaluation of multiple criteria.

2. Method

The author has designed a framework used in the research methodology for this study. Figure 1 is the research framework that will be used:

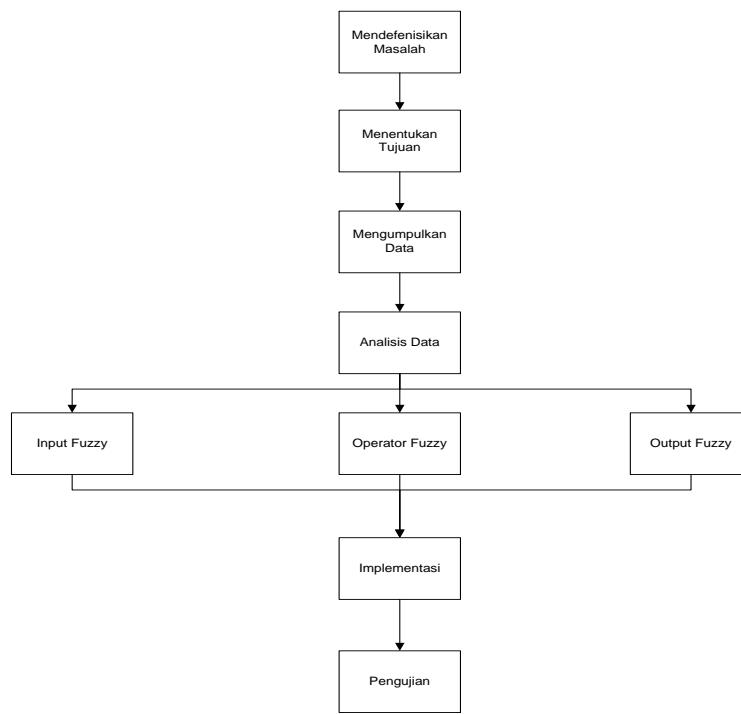


Figure 1. Research Framework

Based on the framework in Figure 3.1, each procedure in the processing for problem analysis is described as follows:

Define the problem. In this initial stage, the author defines the problem and determines the scope of the problem. During this phase, the author collects the existing problems related to determining the criteria for student allowance/scholarship recipients. The identified problems obtained are as follows: (a) Subjectivity in Decision-Making is one of the major issues in the scholarship selection process. Decisions are often made based on individual assessments, which could potentially be influenced by personal relationships; (b) Evaluation Factor Complexity, there are numerous factors that need to be considered in the selection process, such as academic performance, financial circumstances, and family environment. Organizing and assessing all these factors can become an exceedingly complex task; (c) Uncertainty and Variability, information used in the selection process often tends to be uncertain or varies over time. For instance, a student's academic performance might change from one semester to another; (d) Lack of Transparency, the scholarship selection process often lacks transparency, leading to doubts and dissatisfaction among potential scholarship recipients; and (e) Efficiency and Effectiveness, the scholarship selection process often requires significant time and resources. There is a need for more efficient and effective methods in conducting the selection process.

Determine goals. After comprehending the issues, the objectives to be achieved in this research are established. These objectives define the targets aimed at primarily addressing the existing problems. At this stage, the author determines the goal, which is to establish the precise criteria for providing student allowances/scholarships. The obtained criteria include academic achievement, income, and family responsibilities.

Collect Data. In collecting data, observations were conducted through direct observation at the research site to gain a clear understanding of the existing issues. Subsequently, interviews were conducted with the aim of acquiring necessary information or data. Additionally, a literature review was conducted by reading supportive books to analyze the data and gather pertinent information. The data collection process in the selection of scholarship recipients at the Bukittinggi City Civil Service Corps Secretariat could involve several steps:

Criteria Identification. The initial step in data collection involves identifying the criteria to be utilized in the selection process. These criteria may encompass academic achievement, extracurricular activities, and financial conditions: (a) Data Collection: Following the determination of criteria, data can be collected from various sources. Academic achievement data may be obtained from school or university records. Extracurricular activity data may be retrieved from student activity logs. Financial condition data can be acquired from documents such as parents' salary slips or other income proofs; (b) Data Verification: Once data is collected, it is crucial to verify it to ensure accuracy and validity. Verification can be done by cross-checking supporting documents or conducting interviews with prospective scholarship recipients or relevant individuals; and (c) Data Storage and Processing: Upon data verification, it can be stored and processed for use in the decision-making process. Data can be stored in a database and processed using methods such as Sugeno fuzzy logic to generate recommendations for the selection of scholarship recipients..

The data collection process is crucial to ensure that decisions made in the scholarship selection process are based on accurate and relevant information. With precise data, the selection process can become more objective and fair.

Data analysis. In this stage, an analysis will be conducted on the data obtained during the data collection phase. Based on the collected data, it will be organized and categorized into tables. The data compiled in these tables will facilitate the author in analyzing the students' data who applied for the scholarship from the KORPRI (Civil Service Corps) of Bukittinggi using fuzzy Sugeno.

Following are the steps for scholarship selection using the Sugeno fuzzy method:

Fuzzification. The first step that must be taken is to find the fuzzy membership degree value for each variable. GPA has linguistic values in the form of sufficient, high and very high, show in Table 1.

Table 1. Linguistic Value of The GPA Variable

Value	GPA
Sufficient (c)	3.00 - 3,25
High (t)	3,25 - 3,50
Very high (st)	3,50 - 4,00

The following is the membership function for GPA:

$$\mu_{cukup}(x) = \begin{cases} 1 & ; \quad x < 3.00 \\ \frac{3.25-x}{0.25} & ; \quad 3.00 \leq x < 3.25 \\ 0 & ; \quad x \geq 3.50 \end{cases} \quad (6)$$

$$\mu_{tinggi}(x) = \begin{cases} 0 & ; \quad x < 3.00 \\ \frac{x-3.00}{0.25} & ; \quad 3.00 \leq x < 3.25 \\ \frac{3.50-x}{0.25} & ; \quad 3.25 \leq x < 3.50 \\ 0 & ; \quad x \geq 3.50 \end{cases} \quad (7)$$

$$\mu_{sangat_tinggi}(x) = \begin{cases} 0 & ; \quad x < 3.25 \\ \frac{x-3.25}{0.25} & ; \quad 3.25 \leq x < 3.50 \\ 1 & ; \quad x \geq 3.50 \end{cases} \quad (8)$$

The fuzzy set for each linguistic term uses a curve as shown in the Figure 2.

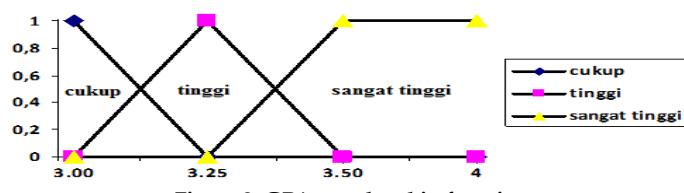


Figure 2. GPA membership function

The basic salary is categorized into very low, low, high, and very high. Shown in Table 2.

Table 2. Linguistic values of basic salary variables

Value	Basic Salary
Low (r)	$\leq \text{Rp.}2.000.000$
Medium (s)	Rp.2.000.000 - Rp.3.500.000
High (t)	$\geq \text{Rp.}3.500.000$

The following is the membership function for basic salary:

$$\mu_{rendah}(x) = \begin{cases} 1 & ; \quad x < 0 \\ \frac{2.000.000 - x}{2.000.000} & ; \quad 0 \leq x < 2.000.000 \\ 0 & ; \quad x \geq 2.000.000 \end{cases} \quad (9)$$

$$\mu_{sedang}(x) = \begin{cases} 0 & ; \quad x < 0 \\ \frac{x - 0}{2.000.000} & ; \quad 0 \leq x < 2.000.000 \\ \frac{3.500.000 - x}{1.500.000} & ; \quad 2.000.000 \leq x < 3.500.000 \\ 0 & ; \quad x \geq 3.500.000 \end{cases} \quad (10)$$

$$\mu_{tinggi}(x) = \begin{cases} 0 & ; \quad x < 2.000.000 \\ \frac{x - 2.000.000}{1.500.000} & ; \quad 2.000.000 \leq x < 3.500.000 \\ 1 & ; \quad x \geq 3.500.000 \end{cases} \quad (11)$$

The fuzzy set for each linguistic term uses a curve like the Figure 3 below.

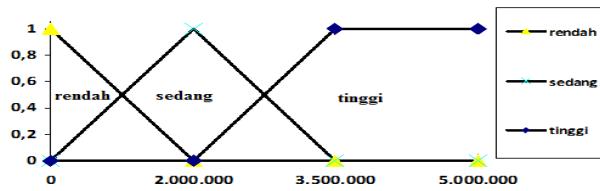


Figure 3. Basic Salary Membership Function

The number of dependents is categorized as few, sufficient, and many. Shown in Tabel 3.

Table 3. Linguistic Value of The Variable Number of Dependents

Value	Number of dependents
Few (s)	1 – 3
Sufficient (c)	3 – 5
Many (b)	> 5

The following is the membership function for the number of dependents:

$$\mu_{sedikit}(x) = \begin{cases} 1 & ; \quad x < 1 \\ \frac{3-x}{2} & ; \quad 1 \leq x < 3 \\ 0 & ; \quad x \geq 3 \end{cases} \quad (12)$$

$$\mu_{cukup}(x) = \begin{cases} 0 & ; \quad x < 1 \\ \frac{x-1}{2} & ; \quad 1 \leq x < 3 \\ \frac{5-x}{2} & ; \quad 3 \leq x < 5 \\ 0 & ; \quad x \geq 5 \end{cases} \quad (13)$$

$$\mu_{banyak}(x) = \begin{cases} 0 & ; \quad x < 3 \\ \frac{x-3}{2} & ; \quad 3 \leq x < 5 \\ 1 & ; \quad x \geq 5 \end{cases} \quad (14)$$

The fuzzy set for each linguistic term uses a curve like the Figure 4 below.

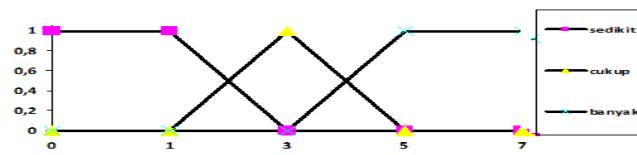


Figure 4. Membership Function of Number of Dependents

The second step to take is to look for rules. The rules obtained are in Table 4.

Table 4. Generated Rules

No	GPA	Basic Salary	Dependents	Decision
1	Sufficient	Low	Few	Accept
2	Sufficient	Low	Sufficient	Accept
3	Sufficient	Low	Many	Accept
4	Sufficient	Medium	Few	Reject
5	Sufficient	Medium	Sufficient	Reject
6	Sufficient	Medium	Many	Accept
7	Sufficient	High	Few	Reject
8	Sufficient	High	Sufficient	Reject
9	Sufficient	High	Many	Reject
10	High	Low	Few	Accept
11	High	Low	Sufficient	Accept
12	High	Low	Many	Accept
13	High	Medium	Few	Accept
14	High	Medium	Sufficient	Accept
15	High	Medium	Many	Accept
16	High	High	Few	Reject
17	High	High	Sufficient	Reject
18	High	High	Many	Reject
19	Very High	Low	Few	Accept
20	Very High	Low	Sufficient	Accept
21	Very High	Low	Many	Accept
22	Very High	Medium	Few	Accept
23	Very High	Medium	Sufficient	Accept
24	Very High	Medium	Many	Accept
25	Very High	High	Few	Reject
26	Very High	High	Sufficient	Reject
27	Very High	High	Many	Reject

These rules represent a set of conditional statements defining decision outcomes based on certain criteria:

R1 If GPA = sufficient and basic salary = low and dependents = few, then decision = accepted.

R2 If GPA = sufficient and basic salary = low and dependents = sufficient, then decision = accepted.

R3 If GPA = sufficient and basic salary = low and dependents = many, then decision = accepted.

R4 If GPA = sufficient and basic salary = medium and dependents = few, then decision = rejected.

R5 If GPA = sufficient and basic salary = medium and dependents = sufficient, then decision = rejected.

R6 If GPA = sufficient and basic salary = medium and dependents = many, then decision = accepted.

R7 If GPA = sufficient and basic salary = high and dependents = few, then decision = rejected.

R8 If GPA = sufficient and basic salary = high and dependents = sufficient, then decision = rejected.

R9 If GPA = sufficient and basic salary = high and dependents = many, then decision = rejected.

R10 If GPA = high and basic salary = low and dependents = few, then decision = accepted.

R11 If GPA = high and basic salary = low and dependents = sufficient, then decision = accepted.

R12 If GPA = high and basic salary = low and dependents = many, then decision = accepted.

R13 If GPA = high and basic salary = medium and dependents = few, then decision = accepted.

R14 If GPA = high and basic salary = medium and dependents = sufficient, then decision = accepted.

R15 If GPA = high and basic salary = medium and dependents = many, then decision = accepted.

R16 If GPA = high and basic salary = high and dependents = few, then decision = rejected.

R17 If GPA = high and basic salary = high and dependents = sufficient, then decision = rejected.

R18 If GPA = high and basic salary = high and dependents = many, then decision = rejected.

R19 If GPA = very high and basic salary = low and dependents = few, then decision = accepted.

R20 If GPA = very high and basic salary = low and dependents = sufficient, then decision = accepted.

R21 If GPA = very high and basic salary = low and dependents = many, then decision = accepted.

R22 If GPA = very high and basic salary = medium and dependents = few, then decision = accepted.

R23 If GPA = very high and basic salary = medium and dependents = sufficient, then decision = accepted.

R24 If GPA = very high and basic salary = medium and dependents = many, then decision = accepted.

R25 If GPA = very high and basic salary = high and dependents = few, then decision = rejected.

R26 If GPA = very high and basic salary = high and dependents = sufficient, then decision = rejected.

R27 If GPA = very high and basic salary = high and dependents = many, then decision = rejected.

Defuzzification. The input from the defuzzification process is a fuzzy set obtained from the composition of fuzzy rules, while the output generated is a number within the domain of that fuzzy set. Therefore, when given a fuzzy set within a certain range, a specific crisp value must be derived. There are several methods of defuzzification, and the one used is the weighted average method..

Implementation. The implementation is a phase involving the analysis of student allowance data using the Sugeno fuzzy method, implemented in the Visual Basic 2010 programming language and MySQL. Here are the reasons for choosing the Visual Basic 2010 programming language: (a) Ease of use for applications, especially for novice users such as secretariat employees of KORPRI Kota Bukittinggi, as users can easily learn and utilize available syntaxes and tools; (b) Seamless integration with Microsoft Office, particularly with Microsoft Excel. If the selection process data is stored in Microsoft Excel, it becomes easier to manage; (c) Visual Basic applications offer comprehensive facilities for data management; and (d) Application management is straightforward, including installation and removal. Visual Basic applications have a large and active community, facilitating support and assistance.

Testing. The next stage after the implementation phase is system testing. This is done to determine whether the designed Fuzzy logic is genuinely capable of appropriately selecting scholarship recipients

within the civil servant community of KORPRI Kota Bukittinggi. After conducting the data analysis phase, the subsequent step involves testing using the Sugeno fuzzy method. Consider the following case: there are two individuals applying for a scholarship at the KORPRI Bukittinggi department. Among these two applicants, only one will be accepted. Applicant A works as a Grade III/d civil servant in the Agriculture Office of Bukittinggi, with a basic salary of Rp. 3,300,000, having one dependent, and their child's GPA is 3.00. Meanwhile, applicant B is an administrative staff member at SMAN 3 Bukittinggi, Grade II/a, with a salary of Rp. 1,095,000, three dependents, and GPA of 3.56. Who is eligible to receive the scholarship, applicant A or B ?.

There are three stages to solving the above case:

Fuzzification or looking for fuzzy membership degrees

GPA

Applicant A : $\mu_{cukup}(3.00) = 1$

Applicant B : $\mu_{sangat_tinggi}(3.56) = 1$

Basic Salary

Applicant A : $\mu_{rendah}(3.300.000) = 0.33$ dan $\mu_{sedang}(3.300.000) = 0.67$

Applicant B : $\mu_{rendah}(1.095.000) = 1$

The number of dependents

Applicant A : $\mu_{sedikit}(1) = 1$

Applicant B : $\mu_{cukup}(3) = 1$

Inference

For Applicant A

Applicant A has a GPA = sufficient(1), basic salary = low(0.33), basic salary = medium(0.67), and number of dependents = few(1). The applicable fuzzy rules are as follows:

R1 If GPA = sufficient(1) and basic salary = low(0.33) and few dependents(1), then decision = accepted(0.33).

R4 If GPA = sufficient(1) and basic salary = medium(0.67) and few dependents(1), then decision = rejected(0.67).

From the rules above, it can be observed that the decision 'accepted' appears once, and 'rejected' appears once.

For Applicant B

Applicant B has a GPA = very high(1), basic salary = low(1), and number of dependents = sufficient(1).

The rule that applies is:

R20 If GPA = very high(1) and basic salary = low(1) and number of dependents = sufficient(1), then decision = accepted(1).

Defuzzification

For Applicant A

For the Sugeno model, the weighted average method is used. So the eligibility value for applicant A is:

$$y = \frac{(nilai_fuzzy_ditolak)nilai_ditolak + (nilai_fuzzy_diterima)nilai_diterima}{(nilai_fuzzy_ditolak)+(nilai_fuzzy_diterima)}$$

$$y = \frac{(0.67)50 + (0.33)80}{0.67 + 0.33} = 59,9$$

For Applicant B

Applicant B has 1 rule whose decision results are accepted. So applicant B will definitely be accepted. To see the eligibility score of Applicant B, namely:

$$y = \frac{(0)50 + (1)80}{0+1} = 80$$

Using the fuzzy Sugeno method, the eligibility values obtained for A = 69.8 and B = 80. Based on these eligibility values, the scholarship recipient at the KORPRI Secretariat of Bukittinggi City is Applicant B.

Based on the test results, it can be observed that the fuzzy Sugeno logic is capable of providing options in decision-making at the KORPRI Secretariat of Bukittinggi City. Thus, decision-making can be carried out well, effectively, and efficiently.

3. Results and Discussion

Every year, KORPRI Bukittinggi provides scholarships to high-achieving children whose parents are civil servants. Over the years, the number of applicants has continued to increase, while the number of scholarships remains unchanged. Consequently, not all applicants can be granted scholarships. The current selection process is not fully computerized, still relying on Microsoft Excel, Microsoft Word, and analysis by employees. This manual approach consumes a significant amount of time in decision-making.

Following the analysis of Sugeno fuzzy logic data, an implementation was carried out using Visual Basic 2010 programming. This implementation aims to facilitate the Secretariat of KORPRI Kota Bukittinggi in decision-making processes.

After implementation into Visual Basic programming language and MySQL, the obtained output is as follows:

Login form. The initial step before accessing the system is the login process. Users are required to log in to access the system. Shown as Figure 5.

Figure 5. Login Form

Applicant form. This page contains the input of applicant data that needs to be filled along with the requirements that applicants must fulfill. The input data includes all information from applicants applying for scholarships at the KORPRI Bukittinggi Secretariat every semester. Below is the applicant data input form, shown as Figure 6.

DATA PELAMAR

Tahun Ajaran :

Input Data Pelamar

ID Pelamar	<input type="text"/>
NIP Pelamar	<input type="text"/>
Nama Pelamar	<input type="text"/>
Golongan	<input type="text"/>
Gaji	<input type="text"/>
Jumlah Tanggungan	<input type="text"/> Orang

Input Data Anak

Nama Anak	<input type="text"/>
Nama Perguruan Tinggi	<input type="text"/>
IP	<input type="text"/>

Control

	id_pelamar	NIP	nama	gol	gaji	jml_tanggungan	nama_anak
▶	P02	1963030219860...	Drs. ELVI SAHRI...	IV/a	2400000	4	Andy Saputra
	P01	1966032119860...	Dra. E. N. DEWI...	III/d	3000000	4	Anisa Fitriani
	P03	1968101319900...	TARMIZI, SH	I/d	2000000	3	Surya
	P04	1983121420100...	FIKA YOLANDA, ...	II/c	2400000	3	Susi
	P05	1970011820060...	ERJON	II/a	1500000	2	Trafalgar D. Law
*							

Figure 6. Applicant Form

Fuzzy form. This page will display the fuzzy values of each parameter and the results of the fuzzy Sugeno method in the form of eligibility values. First, search for the applicant's ID for which the fuzziness will be calculated. Then the system will display the fuzzy values and eligibility based on that applicant's ID. Shown as Figure 7.

METODE FUZZYSUGENO

ID Pelamar	<input type="text"/>																			
NIP	<input type="text"/>																			
Nama Pelamar <input type="text"/>																				
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 33%; padding: 5px;">IP <input type="text"/></td> <td style="width: 33%; padding: 5px;">GAJI <input type="text"/></td> <td style="width: 33%; padding: 5px;">TANGGUNGAN <input type="text"/></td> </tr> <tr> <td colspan="3" style="padding: 5px; font-size: small;"><i>Fungsi Keanggotaan</i></td> </tr> <tr> <td>Cukup <input type="text"/></td> <td>Rendah <input type="text"/></td> <td>Sedikit <input type="text"/></td> </tr> <tr> <td>Tinggi <input type="text"/></td> <td>Sedang <input type="text"/></td> <td>Cukup <input type="text"/></td> </tr> <tr> <td>Sangat Tinggi <input type="text"/></td> <td>Tinggi <input type="text"/></td> <td>Banyak <input type="text"/></td> </tr> <tr> <td colspan="3" style="text-align: center; padding: 5px;"> <input type="button" value="Hitung"/> <input type="button" value="Hitung"/> <input type="button" value="Hitung"/> </td> </tr> </table>			IP <input type="text"/>	GAJI <input type="text"/>	TANGGUNGAN <input type="text"/>	<i>Fungsi Keanggotaan</i>			Cukup <input type="text"/>	Rendah <input type="text"/>	Sedikit <input type="text"/>	Tinggi <input type="text"/>	Sedang <input type="text"/>	Cukup <input type="text"/>	Sangat Tinggi <input type="text"/>	Tinggi <input type="text"/>	Banyak <input type="text"/>	<input type="button" value="Hitung"/> <input type="button" value="Hitung"/> <input type="button" value="Hitung"/>		
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Sangat Tinggi <input type="text"/>	Tinggi <input type="text"/>	Banyak <input type="text"/>																		
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<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 33%;">id_pelamar</th> <th style="width: 33%;">NIP</th> <th style="width: 33%;">nama</th> </tr> </thead> <tbody> <tr><td>P02</td><td>1963030219860...</td><td>Drs. ELVI SAHF...</td></tr> <tr><td>P01</td><td>1966032119860...</td><td>Dra. E. N. DEW...</td></tr> <tr><td>P03</td><td>1968101319900...</td><td>TARMIZI, SH...</td></tr> <tr><td>P04</td><td>1983121420100...</td><td>FIKA YOLANDA...</td></tr> <tr><td>P05</td><td>1970011820060...</td><td>ERJON</td></tr> </tbody> </table>			id_pelamar	NIP	nama	P02	1963030219860...	Drs. ELVI SAHF...	P01	1966032119860...	Dra. E. N. DEW...	P03	1968101319900...	TARMIZI, SH...	P04	1983121420100...	FIKA YOLANDA...	P05	1970011820060...	ERJON
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<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; padding: 5px;">Nilai Defuzzifikasi</td> <td style="width: 50%; padding: 5px; text-align: center;">control</td> </tr> <tr> <td><input type="text"/></td> <td><input type="button" value="Simpan"/> <input type="button" value="Hapus"/> <input type="button" value="Batal"/> <input type="button" value="Keluar"/></td> </tr> <tr> <td><input type="text"/></td> <td></td> </tr> </table>			Nilai Defuzzifikasi	control	<input type="text"/>	<input type="button" value="Simpan"/> <input type="button" value="Hapus"/> <input type="button" value="Batal"/> <input type="button" value="Keluar"/>	<input type="text"/>													
Nilai Defuzzifikasi	control																			
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<input type="text"/>																				

Figure 7. Data Processing Form with Fuzzy Sugeno

Scholarship recipient form. This page contains a list of participants who have been accepted as scholarship recipients which is the result of data processing using Sugeno fuzzy logic. Shown as Figure 8.

DATA PENERIMA										
Tahun Ajaran <input type="text"/> <input type="button" value="Tampil"/> <input type="button" value="Keluar"/>										
	id_pelamar	NIP	nama	gol	gaji	jml_tanggungan	nama_anak	nama_pt	IP	TA
*	P02	1963030219860...	Drs. ELVI SAHF...	IV/a	2400000	4	Andy Saputra	UNAND	3	2014/2015
	P01	1966032119860...	Dra. E. N. DEW...	III/d	3000000	4	Anisa Fitriani	UNP	3.6	2014/2015
	P03	1968101319900...	TARMIZI, SH...	I/d	2000000	3	Surya	UNP	3.75	2015/2016
	P04	1983121420100...	FIKA YOLANDA...	II/c	2400000	3	Susi	UNPAD	3.15	2013/2014
	P05	1970011820060...	ERJON	II/a	1500000	2	Trafalgar D. Law	UI	3.3	2014/2015

Figure 8. Scholarship Recipient Student Form

Feasibility report. The eligibility report is the output received by the secretary of KORPRI Kota Bukittinggi after undergoing data processing using Sugeno fuzzy logic implemented into Visual Basic 2010 programming language and MySQL. Shown as Figura 9.



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DAFTAR NILAI KELAYAKAN
BEASISWA SEKRETARIAT KORPRI

Tahun Ajaran : 2014/2015

id_pelamar	NIP	nama	gol	gaji	mt_tanggungan	nama_anak	nama_pk	IP	Nilai_K
P02	1963030219	Drs. ELVI SAHRI I	IV/a	00,000	4	Andy Saputra	UNAND	3.00	5.81
P01	1966032119	Dra. E. N. DEWITI,	III/d	00,000	4	Anisa Fitriani	UIN	3.60	5.50
P05	1970011820	ERJON	II/a	00,000	2	Trafalgar D. L	UI	3.30	5.50

Bukittinggi 20-November-2014

Djasman, S.SH

Figure 9. Scholarship Recipient Eligibility Report

4. Conclusion

Based on the research conducted by the author regarding the decision support system for scholarship recipients at the Secretariat of KORPRI Bukittinggi, several conclusions can be drawn as follows: (a) Overcoming Uncertainty: In the scholarship selection process, there is often a lot of uncertainty and variability. For instance, students' academic performance may change from semester to semester, and extracurricular activities can vary among students. Sugeno fuzzy logic can address this uncertainty by enabling us to make decisions based on uncertain or varying information; (b) Enhancing Objectivity: One of the main issues in the scholarship selection process is subjectivity in decision-making. Sugeno fuzzy logic can help enhance objectivity by allowing decisions to be made based on predefined rules rather than individual assessments; (c) Improving Efficiency and Effectiveness: The scholarship selection process often requires significant time and resources. By using Sugeno fuzzy logic, we can make this process more efficient and effective. For example, we can automate decision-making processes and reduce the time and effort required; and (d) Enhancing Transparency: The scholarship selection process is often non-transparent, which can lead to doubts and dissatisfaction among potential scholarship recipients. By employing Sugeno fuzzy logic, we can make this process more transparent because decisions are based on predefined rules that can be explained to all involved parties.

Based on the arguments above, it can be concluded that the use of Sugeno fuzzy logic is worthy of recommendation as a method in selecting scholarship recipients at the Secretariat of KORPRI Kota Bukittinggi. This is because it has proven to provide accurate decisions that align with the criteria established by the institution.

References

- [1] J. Salendah, P. Kalele, A. Tulenan, and ..., "Penentuan Beasiswa Dengan Metode Fuzzy Tsukamoto Berbasis Web Scholarship Determination Using Web Based Fuzzy Tsukamoto Method," *Proceeding Semin.*, no. 1, pp. 81–90, 2022, [Online]. Available: <https://proceeding.unived.ac.id/index.php/snaskom/article/view/80%0Ahttps://proceeding.unived.ac.id/index.php/snaskom/article/download/80/70>
- [2] H. S. A. K. Muhammad Fikri Khaid, Sujalwo, "Model Logika Fuzzy Sugeno Berbasis Web Untuk Seleksi Penerima

- Beasiswa," J. Ilm. SINUS, vol. 16, no. 1, p. 25, 2018, doi: 10.30646/sinus.v16i1.329.
- [3] S. K. Sundari Retno Andani, S.T, M.Kom, Subastian Wibowo, "Sistem Pendukung Keputusan Dalam Menentukan Penerima Beasiswa Dengan Fuzzy Sugeno," Open J. Unimal, vol. 10, no. 1, pp. 64-79, 2018.
- [4] R. U. Ginting et al., "Penentuan Penerima Beasiswa Mahasiswa Dari Universitas Sari Mutiara Medan Di Masa Pandemi Covid-19 Dengan Metode Logika Fuzzy Tsukamoto," J. Mahajana Inf., vol. 6, no. 1, pp. 73-77, 2021.
- [5] S. Susanti, G. R. Nawangsit, C. Responden, K. K. Beasiswa, F. Tsukamoto, and S. P. Keputusan, "Penerapan Metode Fuzzy Tsukamoto Pada Sistem Pendukung Keputusan Penentuan Pemberian Beasiswa," Jika, vol. ISSN, pp. 2722-2713, 2023.
- [6] D. Y. H. Putra, Apriansyah, "PENENTUAN PENERIMA BEASISWA DENGAN MENGGUNAKAN FUZZY MULTIPLE ATRIBUTE DECISION MAKING," J. Sist. Inf., vol. 3, no. 1, pp. 286-293, 2011.
- [7] R. Setiawan, A. Triayudi, and A. Gunawan, "Diagnosa Kecanduan Gadget Pada Anak Usia Dini dengan Metode Fuzzy Sugeno dan Fuzzy Mamdani," vol. 4, no. 2, pp. 315-325, 2023, doi: 10.47065/josyc.v4i2.3018.
- [8] N. Luthan, "Implementasi Logika Fuzzy Dengan Menggunakan Metode Mamdani Untuk Menentukan Penerimaan Beasiswa Dari Yayasan Rumah Zakat," Edik Inform., vol. 4, no. 1, pp. 40-51, 2018, doi: 10.22202/ei.2017.v4i1.2699.
- [9] K. Tarwati et al., "Metode Fuzzy Logic Untuk Penentuan Kelayakan Penerima Beasiswa Mahasiswa Di Universitas Muhammadiyah Sukabumi," JASISFO (Jurnal Sist. Informasi), vol. 1, no. 2, pp. 56-67, 2020.
- [10] M. R. Maulana, "Sistem Pakar Untuk Mengukur Tingkat Depresi Mahasiswa Menggunakan Metode Fuzzy Sugeno," vol. 2, no. 1, 2023.
- [11] D. Rifai and F. Fitriyadi, "Penerapan Logika Fuzzy Sugeno dalam Keputusan Jumlah Produksi Berbasis Website," Hello World J. Ilmu Komput., vol. 2, no. 2, pp. 102-109, 2023, doi: 10.56211/helloworld.v2i2.297.
- [12] M. S. Muttaqin, Y. Widiastiwi, and C. Nugrahaeni, "Implementasi Logika Fuzzy Untuk Setiap Pendukung Kepuasan Calon Penerima Beasiswa Kartu Jakarta Pintar (Studi Kasus : SMA N 76 Jakarta)," Semin. Nas. Mhs. Ilmu Komput. dan Apl. Jakarta-Indonesia, 14 Agustus 2020, pp. 455-465, 2020, [Online]. Available: <https://conference.upnvj.ac.id/index.php/senamika/article/view/535%0Ahttps://conference.upnvj.ac.id/index.php/senamika/article/download/535/455>
- [13] R. F. Ramadhan, K. Eliyen, U. Islam, N. Sayyid, and A. Rahmatullah, "IMPLEMENTASI METODE FUZZY SUGENO PADA PEMODELAN," vol. 6, no. 1, pp. 28-34, 2023.