BAREKENG: Journal of Mathematics and Its Applications
September 2026 Volume 20 Issue 3 Page 2027-2044
P-ISSN: 1978-7227 E-ISSN: 2615-3017
https://doi.org/10.30598/barekengvol20iss3pp2027-2044

A STUDY ON THE APPLICABILITY OF TRAPEZOIDAL FUZZY AHP WITH FEATURE SELECTION: THE CASE OF SKSS SCHOLARSHIP RECIPIENTS AT BAZNAS EAST JAVA

Syamil Waris Dien Muhammad[1], **Abdulloh Hamid**[2], **Hani Khaulasari**[3*], **Dian Candra Rini Novitasari**[4], **Moh. Hafiyusholeh**[5]

[1,2,3,4,5] *Department of Mathematics, Faculty of Science and Technology, UIN Sunan Ampel Surabaya Jln. Ahmad Yani., No. 117, Jemur Wonosari, Wonocolo, Surabaya, 60237, Indonesia*

*Corresponding author's e-mail: *hani.khaulasari@uinsa.ac.id*

Article Info

Article History:

Received: 17th July 2025
Revised: 31st October 2025
Accepted: 16th March 2026
Available online: 8th April 2026

Keywords:

BAZNAS;
Cramer's V;
Feature selection;
Pearson correlation;
Scholarship recipient;
SKSS;
Trapezoidal fuzzy AHP;
Variance threshold.

ABSTRACT

The One Family One Graduate (SKSS) scholarship program, managed by BAZNAS East Java, aims to alleviate the financial burden of higher education for underprivileged communities. However, the absence of clearly defined weights for each selection criterion may lead to unfairness in the selection process. This study aims to determine the objective weights of each criterion and to rank prospective scholarship recipients using the Trapezoidal Fuzzy AHP approach. The data were obtained from 78 scholarship applicants for the 2024 SKSS period and from questionnaires completed by three expert respondents (expert judgment). Feature selection was conducted to identify the most relevant criteria, resulting in 13 selected variables are tuition fee per semester (K_1), father's latest education level (K_2), father's income (K_3), mother's latest education level (K_4), mother's income (K_5), house size (K_6), amount of family installments (K_7), number of parental dependents (K_8), income of working family members (K_9), type of transportation used to campus (K_{10}), distance from home to campus (K_{11}), monthly allowance (K_{12}), and monthly income if the student is working (K_{13}). The results show that the criterion with the highest weight is tuition fee per semester (0.139142), while the lowest is Type of transportation to campus (0.059970). The highest priority subject is Subject 74 (S_74) with a total weight of 0.7964, whereas Subject 23 (S_23) ranks lowest with a total weight of 0.7723. These findings are expected to enhance the objectivity and fairness of the SKSS scholarship selection process.

How to cite this article:

S. W. D. Muhammad, A. Hamid, H. Khaulasari, D. C. R. Novitasari and M. Hafiyusholeh., "A STUDY ON THE APPLICABILITY OF TRAPEZOIDAL FUZZY AHP WITH FEATURE SELECTION: THE CASE OF SKSS SCHOLARSHIP RECIPIENTS AT BAZNAS EAST JAVA", *BAREKENG: J. Math. & App.*, vol. 20, no. 3, pp. 2027-2044, Sep, 2026.

Journal homepage: *https://ojs3.unpatti.ac.id/index.php/barekeng/*
Journal e-mail: *barekeng.math@yahoo.com; barekeng.journal@mail.unpatti.ac.id*

Research Article · Open Access

1. INTRODUCTION

Inclusive and equitable education has become a global issue since the adoption of the Sustainable Development Goals (SDGs) by the United Nations (UN). As part of the global community, Indonesia has also integrated this commitment into its national development agenda [1]. One of the primary objectives of the SDGs is to ensure fair and inclusive access to quality education at all levels, including higher education. In this context, universities hold a strategic role in building an inclusive social system [2] and enhancing the quality of human resources, and strengthening national competitiveness [3].

In Indonesia, access to higher education remains quite limited, particularly for individuals from lower-middle-income groups. This is largely due to the high costs involved, making higher education more accessible to those from economically privileged backgrounds [4].

A similar disparity is also evident at the regional level, including in East Java Province. Despite the presence of numerous higher education institutions, the increase in participation remains slow. Data from the Central Statistics Agency (BPS) show that the Gross Enrollment Rate (GER) for higher education rose only slightly from 31.84% [5] to 31.85% [6] between 2023 and 2024. This figure indicates that equitable access to higher education has not yet been achieved effectively.

Scholarships serve as a concrete effort to expand access to higher education for underprivileged communities [7]. The One Family One Graduate (SKSS) program, organized by Badan Amil Zakat Nasional (BAZNAS), is one such strategic initiative aimed at supporting economically disadvantaged students from families without a single university graduate. The selection process for this program is carried out under the authority of provincial-level BAZNAS offices, including in East Java [8]. The funds managed by BAZNAS originate from zakat, which remains relatively stable and tends to increase during certain Islamic religious events [9]. This substantial financial potential can be optimized to support various development sectors, including the provision of inclusive and equitable education.

The selection process for the One Family One Graduate (SKSS) scholarship still has several shortcomings, primarily due to its reliance on profiling and the absence of a structured weighting system [10]. The large number of criteria involved—such as economic condition, academic achievement, and family circumstances—presents specific challenges in the assessment process. Differences in evaluators' perspectives, the complexity of criteria, and the tendency to oversimplify problems can lead to bias and reduce the accuracy of decision-making [11]. Therefore, a multi-criteria decision-making approach is needed to support a more objective scholarship selection process. One commonly used method in this context is the Analytic Hierarchy Process (AHP) [12].

The Analytic Hierarchy Process (AHP) method offers advantages in structuring decision-making systematically and in measuring the logical consistency of judgments through the Consistency Ratio (CR) [13]. Prior research [14] demonstrated the successful implementation of AHP in selecting scholarship recipients by incorporating multiple criteria, including numerical data such as Grade Point Average (GPA), parental income, and number of dependents, as well as categorical data such as the occupations of both father and mother.

The classical AHP method has limitations due to its use of a fixed scale from 1 to 9, which is less capable of representing uncertainty and ambiguity in the evaluation process [15]. The fuzzy logic approach serves as a potential solution that can be integrated into AHP to enhance the flexibility and realism of assessments [16]. Commonly used types of fuzzy numbers include the Triangular Fuzzy Number (TFN) and the Trapezoidal Fuzzy Number (TrFN), which are distinguished by the degree of expansion from their crisp scale. The TrFN offers a broader range of expansion compared to the TFN, making it more representative in capturing uncertainty in values [17].

Based on the previously described issues, this study proposes a Fuzzy Analytic Hierarchy Process (FAHP) approach using Trapezoidal Fuzzy Numbers (TrFN) for the selection process of SKSS scholarship recipients in East Java in 2024. The selection criteria are derived from the information provided in the SKSS scholarship application forms submitted by prospective recipients. This mathematical approach is expected to produce decisions that are more objective, transparent, and aligned with the complexity of the criteria involved in the scholarship selection system, thereby ensuring that the scholarships are distributed more accurately and effectively.

2. RESEARCH METHODS

2.1 Source of Data

This study utilizes two types of data: primary and secondary data. The primary data were obtained through the distribution of questionnaires to respondents providing expert judgment [18]. Meanwhile, the secondary data were derived from information on prospective recipients of the One Family One Graduate (SKSS) scholarship, collected by BAZNAS of East Java Province, specifically from students who completed the registration form in 2024 [19]. Initially, the dataset comprised 29 evaluation criteria. To enhance analytical efficiency and reduce dimensionality, a feature selection process was applied, resulting in a refined set of 13 key criteria. These include: tuition fee per semester (K_1), father's latest education level (K_2), father's income (K_3) , mother's latest education level (K_4), mother's income (K_5), house size (K_6), amount of family installments (K_7), number of parental dependents (K_8), income of working family members (K_9), type of transportation used to campus (K_{10}), distance from home to campus (K_{11}), monthly allowance (K_{12}), and mounthly income if the student is working (K_{13}).

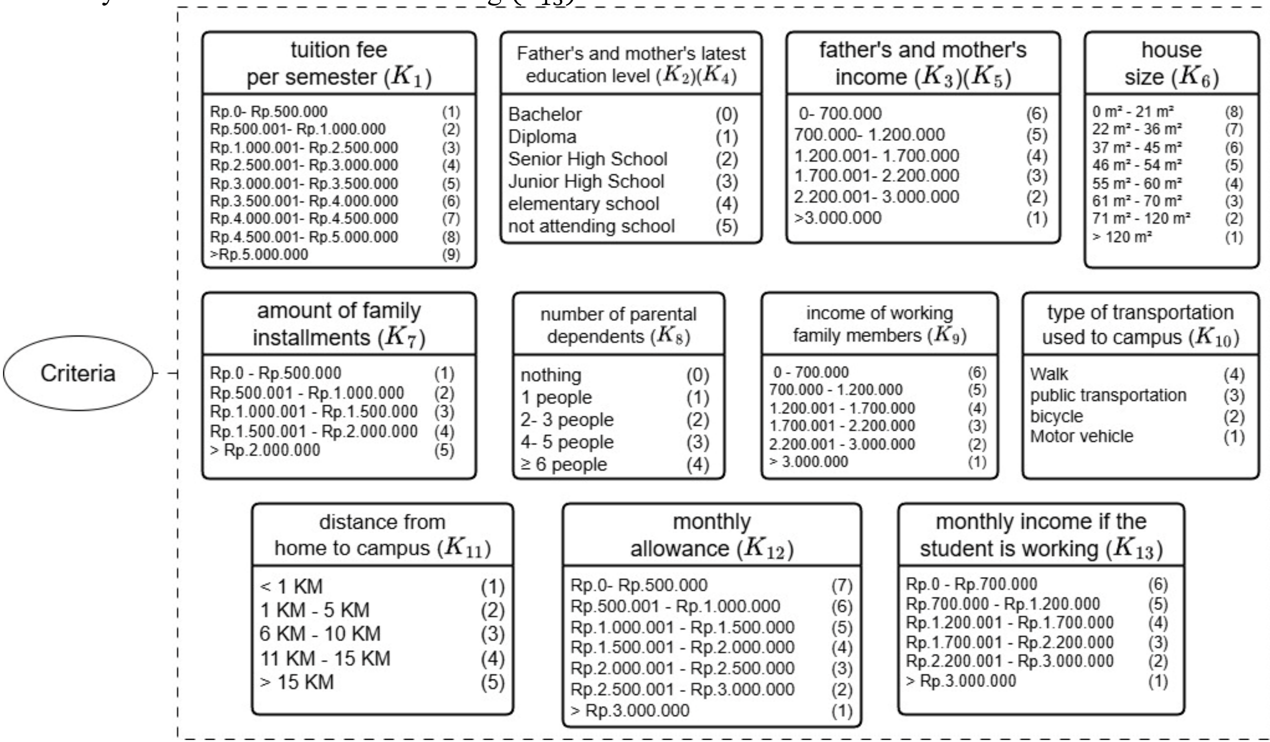

Figure 1. Research Criteria

Fig. 1 above illustrates each criterion and its corresponding sub-criteria, where each sub-criterion is assigned a weight by experts. In addition, each criterion has its own value that reflects the weight of that particular criterion as possessed by each subject.

The selection of the Trapezoidal Fuzzy AHP (F-AHP) as the primary method is based on its superiority in handling the ambiguity and uncertainty (fuzziness) of expert judgments, a significant drawback of the classical AHP method. The integration of F-AHP with Feature Selection is crucial for streamlining the initial 29 variables into 13 selected criteria, thereby increasing computational efficiency, ensuring criteria focus, and maintaining the consistency of the pairwise comparison matrix.

2.2 Research Flowchart

The flowchart illustrates a two-stage process for selecting scholarship recipients: Data Preprocessing and Processing and Priority Determination. The initial stage focuses on data quality by performing encoding, handling missing values, and selecting features using a variance threshold and correlation methods like Pearson and Cramer's V. Subsequently, the data moves to the processing stage where expert judgment is used to create a pairwise comparison matrix. This matrix is fuzzified, weights are calculated, defuzzified using NWS, and normalized to establish final criteria weights. Finally, after confirming the Consistency Ratio (CR $\leq$ 0.1), the global priority is calculated to determine the most suitable recipient. This research process is illustrated in Fig. 2.

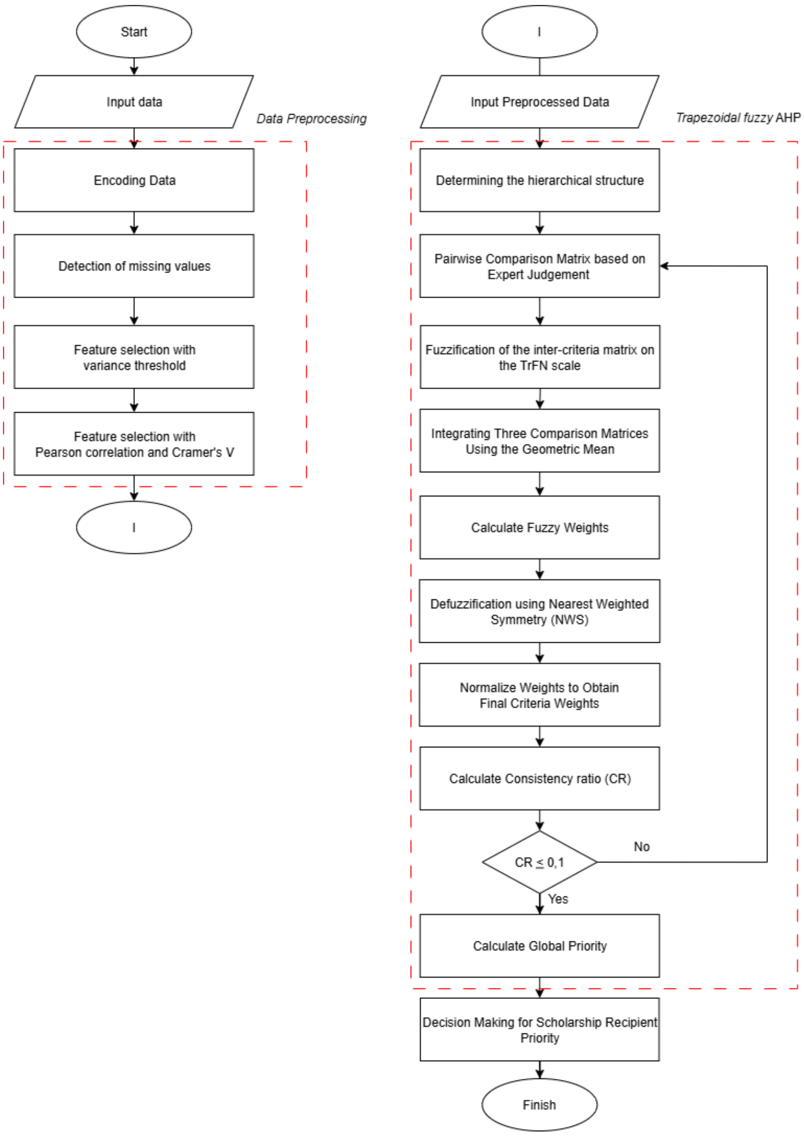

Figure 3. Research Flowchart

2.3 Feature Selection

Feature selection is a dimensionality reduction technique aimed at obtaining a subset of the most relevant features from the original set by eliminating irrelevant, redundant, or noisy features [20]. In this study, the feature selection methods employed include variance threshold, Pearson correlation, and Cramér's V.

2.3.1 Variance Threshold

This method is based on variance values, which rely on the degree of data dispersion to evaluate the usefulness of a feature, where features with higher variance are generally considered to be more informative. The procedure involves setting a threshold for the variance value and eliminating features whose variance falls below this threshold [21]. The calculation of this method is presented as follows [22].

$$\sigma_j^2 = \frac{1}{n-1}\sum_{i=1}^{n}(X_{ij} - \bar{x}_j)^2. \tag{1}$$

Let θ denote the predetermined threshold value. A feature will be eliminated if it satisfies the condition $\sigma_j^2 < \theta$. In this study, the threshold is determined based on the median or second quartile (Q_2), which is considered more appropriate and effective as a selection cutoff [23]. The corresponding equation is presented as follows.

$$median = data\frac{n+1}{2}. \tag{2}$$

2.3.2 Pearson Correlation

Correlation analysis is appropriate for numerical data and aims to identify the linear relationship between variables. The Pearson correlation coefficient ranges from -1 to 1, where values closer to either extreme indicate a stronger linear association, and a negative sign indicates an inverse relationship between the variables [24]. In this study, features with a correlation value greater than 0.8 ($|r| > 0.8$) are removed to reduce the risk of multicollinearity and overfitting during the modeling process [25]. The equation used is presented as follows [26].

$$r = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i - \bar{x})^2} \cdot \sqrt{\sum_{i=1}^{n}(x_i - \bar{y})^2}}. \tag{3}$$

2.3.3 Cramer's V Correlation

Cramér's V correlation coefficient is used to measure the strength of association between two nominal variables. Features with a Cramér's V value greater than 0.8 are removed to avoid redundancy [27].

$$V = \sqrt{\frac{x^2/n}{\min\,(r-1, c-1)}}, \tag{4}$$

where x^2 represents the chi-square correlation value, and r and c denote the number of rows and columns in the contingency table, respectively.

2.4 Trapezoidal Fuzzy AHP

The Trapezoidal Fuzzy AHP method is a numerical approach used in multi-criteria decision-making, designed to integrate both tangible and intangible factors, especially in situations where subjective judgment plays a significant role in the decision-making process. This method is an extension of the classical AHP, incorporating fuzzy logic to address uncertainties or hesitation in assessments, as not all issues can be evaluated with complete precision. In many real-world scenarios, some decision data can be clearly defined, while others remain uncertain or difficult to quantify [28]. The initial stage of this method begins with problem formulation, structured in a hierarchy as illustrated in Fig. 3.

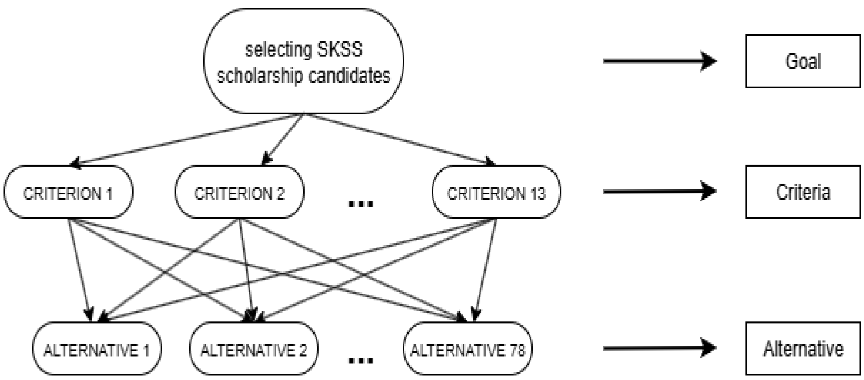

Figure 3. Hierarchical Structure

Next, a pairwise comparison matrix is constructed based on expert judgment by comparing each research criterion using the AHP scale ranging from 1 to 9, as shown in Table 1. Suppose there are n criteria, then the pairwise comparison matrix can be denoted as $A = a_{pq}$ where $a_{pq} = \frac{w_p}{w_q} > 0, p = 1, 2, 3, \dots, n$ and $q = 1, 2, 3, \dots, n$. The value a_{pq} represents the relative priority of criterion p compared to criterion q. The pairwise comparison matrix is presented in Eq. (5).

$$A = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1q} \\ a_{21} & a_{22} & \cdots & a_{2q} \\ \vdots & \vdots & \ddots & \vdots \\ a_{p1} & a_{p2} & \cdots & a_{pq} \end{bmatrix} = \begin{bmatrix} \frac{w_1}{w_1} & \frac{w_1}{w_2} & \cdots & \frac{w_1}{w_q} \\ \frac{w_2}{w_1} & \frac{w_2}{w_2} & \cdots & \frac{w_2}{w_q} \\ \vdots & \vdots & \ddots & \vdots \\ \frac{w_p}{w_1} & \frac{w_p}{w_1} & \cdots & \frac{w_p}{w_q} \end{bmatrix}. \tag{5}$$

The stage following the construction of the pairwise comparison matrix is the fuzzification of the matrix using the Trapezoidal Fuzzy Number (TrFN) scale, as shown in Table 1 [29].

Table 1. AHP Scale and Trapezoidal Fuzzy Number Scale

AHP	Fuzzy Scale	Reciprocal Fuzzy Scale	Description
1	$(1,1,1,1)$	$(1,1,1,1)$	Equally important
2	$(1,3/2,5/2,3)$	$(1/3,2/5,2/3,1)$	Between equal and slightly more important
3	$(2,5/2,7/2,4)$	$(1/4,2/9,2/5,1/2)$	Slightly more important
4	$(3,7/2,9/2,5)$	$(1/5,2/9,2/7,1/3)$	Between slightly more and more important
5	$(4,9/2,11/2,6)$	$(1/6,2/11,2/9,1/4)$	More important
6	$(5,11/2,13/2,7)$	$(1/7,2/13,2/11,1/5)$	Between more and strongly more important
7	$(6,13/2,15/2,8)$	$(1/8,2/15,2/13,1/6)$	Strongly more important
8	$(7,15/2,17/2,9)$	$(1/9,2/17,2/15,1/7)$	Between strongly and absolutely more important
9	$(8,17/2,9,9)$	$(1/9,1/9,2/17,1/8)$	Absolutely more important

Table 1 describes the transformation from the AHP numerical scale to the fuzzy scale, in which each number is converted into four expansion points represented by l, m, n, u. The reciprocal value represents the inverse of each fuzzy scale. Subsequently, the pairwise comparison matrices that have been transformed into the fuzzy scale are aggregated into a single combined matrix using the geometric mean method [30], as shown in Eq. (6).

$$(l,m,n,u)_{pq} = \left[\prod_{k=1}^{K}(l,m,n,u)_{pqk}\right]^{\frac{1}{k}}. \tag{6}$$

After the matrices are combined, the next step is to calculate the fuzzy weights for each criterion using the Fuzzy Synthetic Extent method [31], as shown in the following Eq. (7).

$$S_i = \sum_{q=1}^{m} M_p^g \odot \left[\sum_{p=1}^{n}\sum_{q=1}^{m} M_p^g\right]^{-1}, \tag{7}$$

where M_p^g is obtained from

$$\sum_{q=1}^{m} M_p^g = \left[\sum_{q=1}^{m} l_q, \sum_{q=1}^{m} m_q, \sum_{q=1}^{m} n_q, \sum_{q=1}^{m} u_q\right]. \tag{8}$$

After each weight is calculated, the next step is to transform it into a crisp value (defuzzification) using the Nearest Weighted Symmetry (NWS) method [32], as shown in Eq. (9).

$$DM_i = \frac{l_{si} + 2m_{si} + 2n_{si} + u}{6}, \tag{9}$$

The next step is normalization [33] using Eq. (10).

$$w_{C_{Tr}} = \frac{a_i}{\sum_{i=1}^{n} a_i}. \tag{10}$$

The next step is to test the consistency of the model by integrating all untransformed pairwise comparison matrices into a single matrix, followed by the calculation of λ_{max} and the Consistency Index (CI) [34].

$$CI = \frac{\lambda_{max} - n}{n - 1}. \tag{11}$$

The value of λ_{max} must satisfy the condition $> n$ where n is the number of criteria [35]. Next, the Consistency Ratio CR is calculated using Eq. (9).

$$CR = \frac{CI}{RI}. \tag{12}$$

The Random Index (RI) values were obtained from [36] below.

Table 2. Random Index

Matrix size	1,2	3	4	5	6	7	8	9	10	11	12	13
***RI* value**	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.48	1.56

Table 2 above presents the Random Index (RI) value which is the average consistency index derived from numerous randomly generated comparison matrices of a given size. This value serves as a reference for assessing how consistent the judgments in a comparison matrix are. The larger the number of criteria or the matrix size, the higher the RI value tends to be. RI is important in determining whether a set of judgments can be considered logical and acceptable.

3. RESULTS AND DISCUSSION

3.1 Feature Selection

The first feature selection was carried out using the Variance Threshold method. A total of 29 variables were evaluated by calculating their variance using Eq. (1). The resulting variance values are presented in Table 3 below.

Table 3. Variance Value

Variable	Variance Score	Variable	Variance Score
$V1$	0.2106	$V16$	0.2051
$V2$	1.90×10^{12}	$V17$	2.09×10^{11}
$V3$	0.2791	$V18$	1.4918
$V4$	0.1926	$V19$	0.1798
$V5$	1.4998	$V20$	6.95×10^{11}
$V6$	0.1407	$V21$	1.2288
$V7$	5.68×10^{11}	$V22$	410.75
$V8$	1.3526	$V23$	1640.68
$V9$	0.2251	$V24$	9.04×10^{10}
$V10$	3.20×10^{11}	$V25$	0.0719
$V11$	0.2831	$V26$	0.1132
$V12$	25697.7	$V27$	3.47×10^{10}
$V13$	0.4735	$V28$	0.2517
$V14$	0.2532	$V29$	0.1492
$V15$	0.1866		

The Table 3 above presents each variable along with its corresponding variance value. The threshold was then determined based on the median value (Q_2) which is 0.4735265. Based on this threshold, 14 variables were selected, including tuition fee per semester $(V2)$, father's latest education level $(V5)$, father's income $(V7)$, mother's latest education level $(V8)$, mother's income $(V10)$, house size $(V12)$, amount of family installments $(V17)$, number of parental dependents $(V18)$, income of working family members $(V20)$, type of transportation used to campus $(V21)$, distance from home to campus $(V22)$, $(V23)$, monthly allowance $(V24)$, and monthly income if the student is working $(V27)$.

The next process aims to avoid the existence of redundant variables characterized by the emergence of multicollinearity cases. Detection of redundant variables is carried out based on the type of data used. For ratio-scale numerical data, the value of the Pearson correlation coefficient in Fig. 3 is used. Meanwhile, for categorical data, the analysis was carried out using Cramér's V value in Table 4 to measure the strength of associations between variables. The Pearson correlation was calculated for the numerical data using Eq. (3). The results are visualized in Fig. 3.

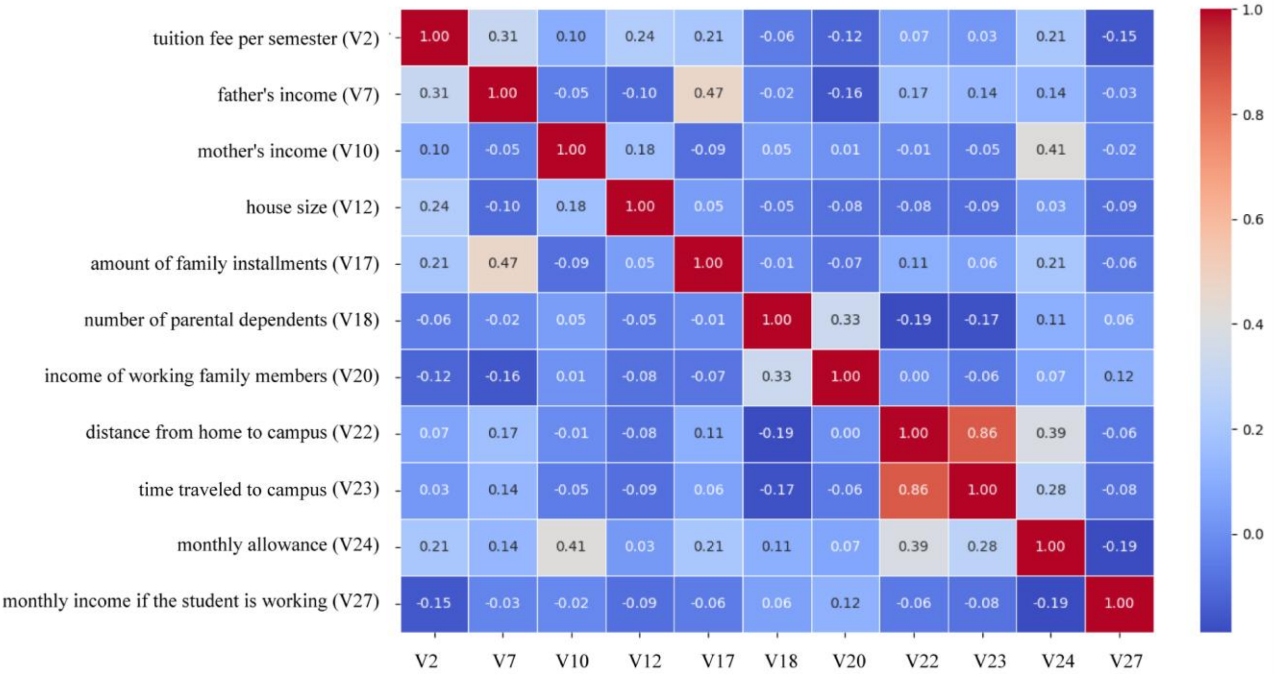

Figure 4. Heatmap Pearson Correlation

The figure above shows that the variable travel time to campus ($V23$) has a correlation of 0.86 with distance from home to campus ($V22$). Therefore, one of the variables, travel time to campus ($V23$), was removed from the analysis to avoid multicollinearity.

Table 4. Cramers' V Correlation

Comparison between Variables	Cramér's V
father's latest education level with type of transportation used to campus	0.223
father's latest education level with mother's latest education level	0.522
mother's latest education level with type of transportation used to campus	0.245

Table 4 shows that no variables correlate 0.8. Therefore, no variables were eliminated. The final variables used in this study are presented in Fig. 1. The selection of features with the variance threshold, Pearson's and Cramer's correlation obtained 13 variables to be used as criteria in the Fuzzy AHP process, including tuition fee per semester (K_1), father's latest education level (K_2), father's income (K_3) , mother's latest education level (K_4), mother's income (K_5), house size (K_6), amount of family installments (K_7), number of parental dependents (K_8), income of working family members (K_9), type of transportation used to campus (K_{10}), distance from home to campus (K_{11}), monthly allowance (K_{12}), and monthly income if the student is working (K_{13}).

3.2 Trapezoidal Fuzzy AHP

The first step is to define the research hierarchy, where the objective of applying the Fuzzy AHP method is to select SKSS scholarship candidates. The second level of the hierarchy consists of 13 criteria, and the third level includes 78 alternative candidates, as illustrated in Fig. 3.

The second step is to construct the pairwise comparison matrix, which is derived from the judgments of three experts relevant to the research context. The result are presented in Tables 5, 6, and 7 below.

Table 5. Pairwise Comparison Matrix by The First Expert Judgment

Criteria	K_1	K_2	K_3	K_4	K_5	K_6	K_7	K_8	K_9	K_{10}	K_{11}	K_{12}	K_{13}
K_1	1	5	1/7	7	3	1/5	1/3	1/7	5	3	5	5	1/3
K_2	1/5	1	1/3	3	1/3	1/5	1/3	1/5	1/3	3	3	3	1/3
K_3	7	3	1	5	3	1/3	3	3	3	3	3	3	3
K_4	1/7	1/3	1/5	1	1/3	1/3	1/3	1/3	1/2	3	1/3	3	1/3

Criteria	K_1	K_2	K_3	K_4	K_5	K_6	K_7	K_8	K_9	K_{10}	K_{11}	K_{12}	K_{13}
K_5	1/3	3	1/3	3	1	1/3	3	1/3	1/3	3	3	3	1/3
K_6	5	5	3	3	3	1	3	3	3	3	3	3	3
K_7	3	3	1/3	3	1/3	1/3	1	1/3	3	3	3	3	3
K_8	7	5	1/3	3	3	1/3	3	1	3	3	3	3	3
K_9	1/5	3	1/3	2	3	1/3	1/3	1/3	1	3	3	3	1/3
K_{10}	1/3	1/3	1/3	1/3	1/3	1/3	1/3	1/3	1/3	1	1/3	3	1/3
K_{11}	1/5	1/3	1/3	3	1/3	1/3	1/3	1/3	1/3	3	1	3	3
K_{12}	1/5	1/3	1/3	1/3	1/3	1/3	1/3	1/3	1/3	1/3	1/3	1	1/3
K_{13}	3	3	1/3	3	3	1/3	1/3	1/3	3	3	1/3	3	1

Table 6. Pairwise Comparison Matrix By The Second Expert Judgment

Criteria	K_1	K_2	K_3	K_4	K_5	K_6	K_7	K_8	K_9	K_{10}	K_{11}	K_{12}	K_{13}
K_1	1	3	2	5	3	1/2	2	5	5	3	7	4	5
K_2	1/3	1	3	5	1	5	5	1/5	1/4	4	3	4	4
K_3	1/2	1/3	1	5	3	1/2	5	1/3	5	3	3	3	3
K_4	1/5	1/5	1/5	1	1/2	1/4	1/5	1/2	1/3	3	1/5	4	1/5
K_5	1/3	1	1/3	2	1	1/5	1/2	1/5	5	3	3	1/5	1/2
K_6	2	1/5	2	4	5	1	1/3	3	2	2	2	3	3
K_7	1/2	1/5	1/5	5	2	3	1	3	5	5	3	4	3
K_8	1/5	5	3	2	5	1/3	1/3	1	3	3	5	5	3
K_9	1/5	4	1/5	3	1/5	1/2	1/5	1/3	1	3	2	3	1
K_{10}	1/3	1/4	1/3	1/3	1/3	1/2	1/5	1/3	1/3	1	1/2	5	1/2
K_{11}	1/7	1/3	1/3	5	1/3	1/2	1/3	1/5	1/2	2	1	5	4
K_{12}	1/4	1/4	1/3	1/4	5	1/3	1/4	1/5	1/3	1/5	1/5	1	1/7
K_{13}	1/5	1/4	1/3	5	2	1/3	1/3	1/3	1	2	1/4	7	1

Table 7. Pairwise Comparison Matrix by The Third Expert Judgment

Criteria	K_1	K_2	K_3	K_4	K_5	K_6	K_7	K_8	K_9	K_{10}	K_{11}	K_{12}	K_{13}
K_1	1	1/5	3	5	3	4	7	3	5	2	5	8	7
K_2	5	1	5	2	4	4	2	5	5	4	3	2	5
K_3	1/3	1/5	1	5	8	3	4	5	4	5	4	3	7
K_4	1/5	1/2	1/5	1	4	2	1/3	1/3	1/2	4	1/3	4	5
K_5	1/3	1/4	1/8	1/4	1	1/7	1/4	1/3	1/3	1/5	1/5	4	4
K_6	1/4	1/4	1/3	1/2	7	1	5	4	2	3	3	1	4
K_7	1/7	1/2	1/4	3	4	1/5	1	3	4	3	3	2	2
K_8	1/3	1/5	1/5	3	3	1/4	1/3	1	5	4	4	6	3
K_9	1/5	1/5	1/4	2	3	1/2	1/4	1/5	1	4	4	4	1/2
K_{10}	1/2	1/4	1/5	1/4	5	1/3	1/3	1/4	1/4	1	1/4	3	1/4
K_{11}	1/5	1/3	1/4	3	5	1/3	1/3	1/4	1/4	4	1	1/3	2
K_{12}	1/8	1/2	1/3	1/4	1/4	1	1/2	1/6	1/4	1/3	3	1	5
K_{13}	1/7	1/5	1/7	1/5	1/4	1/4	1/2	1/3	2	4	1/2	1/5	1

The three tables represent the assessments of each expert, where each row criterion is compared against the column criterion. The evaluations use a numerical scale ranging from one to nine, as shown in Table 1.

The third stage involves converting the three pairwise comparison matrices into an extended fuzzy scale with four parameters: l, m, n, and u, as defined in Table 1. This transformation, known as the fuzzyfication process, is applied systematically to each element in the matrices by encoding the expert's linguistic judgments into trapezoidal fuzzy numbers. The outcome is a fuzzy decision matrix, as illustrated in Table 8, which presents the results of this transformation based on the first expert's judgment.

Table 8. Transformed Matrix Into Trapezoidal Fuzzy Numbers By First Expert Judgement

Criteria	K_1				K_2				...	K_{12}				K_{13}			
	l	m	n	u	l	m	n	u	...	l	m	n	u	l	m	n	u
K_1	1	1	1	1	4	9/2	11/2	6	...	4	9/2	11/2	6	1/4	2/7	2/5	1/2
K_2	1/6	2/11	2/9	1/4	1	1	1	1	...	2	5/2	7/2	4	1/4	2/7	2/5	1/2
K_3	6	13/2	15/2	8	2	5/2	7/2	4	...	2	5/2	7/2	4	2	5/2	7/2	4
K_4	1/8	2/15	2/13	1/6	1/4	2/7	2/5	1/2	...	2	5/2	7/2	4	1/4	2/7	2/5	1/2

Criteria	K_1				K_2				...	K_{12}				K_{13}			
	l	m	n	u	l	m	n	u	...	l	m	n	u	l	m	n	u
K_5	1/4	2/7	2/5	1/2	2	5/2	7/2	4	...	2	5/2	7/2	4	1/4	2/7	2/5	1/2
K_6	4	9/2	11/2	6	4	9/2	11/2	6	...	2	5/2	7/2	4	2	5/2	7/2	4
K_7	2	5/2	7/2	4	2	5/2	7/2	4	...	2	5/2	7/2	4	2	5/2	7/2	4
K_8	6	13/2	15/2	8	4	9/2	11/2	6	...	2	5/2	7/2	4	2	5/2	7/2	4
K_9	1/6	2/11	2/9	1/4	2	5/2	7/2	4	...	2	5/2	7/2	4	1/4	2/7	2/5	1/2
K_{10}	1/4	2/7	2/5	1/2	1/4	2/7	2/5	1/2	...	2	5/2	7/2	4	1/4	2/7	2/5	1/2
K_{11}	1/6	2/11	2/9	1/4	1/4	2/7	2/5	1/2	...	2	5/2	7/2	4	2	5/2	7/2	4
K_{12}	1/6	2/11	2/9	1/4	1/4	2/7	2/5	1/2	...	1	1	1	1	1/4	2/7	2/5	1/2
K_{13}	2	5/2	7/2	4	2	5/2	7/2	4	...	2	5/2	7/2	4	1	1	1	1

The third stage is to integrate the three pairwise comparison matrices into a single aggregated matrix using Eq. (6). As an example, the calculation for Criterion 2 compared to Criterion 1 is presented below.

$$l_{21}=\left(\prod_{k=1}^{3} l_{21}\right)^{\frac{1}{3}}=\left(\frac{1}{6}\times\frac{1}{6}\times 4\right)^{\frac{1}{3}}\approx 0.48;\qquad m_{21}=\left(\prod_{k=1}^{3} m_{21}\right)^{\frac{1}{3}}=\left(\frac{1}{5}\times\frac{1}{5}\times\frac{9}{2}\right)^{\frac{1}{3}}\approx 0.53;$$
$$n_{21}=\left(\prod_{k=1}^{3} n_{21}\right)^{\frac{1}{3}}=\left(\frac{2}{9}\times\frac{2}{9}\times\frac{11}{2}\right)^{\frac{1}{3}}\approx 0.65;\qquad u_{21}=\left(\prod_{k=1}^{3} u_{21}\right)^{\frac{1}{3}}=\left(\frac{1}{4}\times\frac{1}{4}\times 6\right)^{\frac{1}{3}}\approx 0.72. \tag{13}$$

The above calculations were performed on each cell, and the results were rounded to one decimal place. The final results are presented in Table 9 below.

Table 9. Aggregated Matrix

Criteria	K_1				K_2				...	K_{12}				K_{13}			
	l	m	n	u	l	m	n	u	...	l	m	n	u	l	m	n	u
K_1	1.0	1.0	1.0	1.0	1.4	1.5	1.9	2.1	...	4.4	4.9	5.9	6.5	1.9	2.1	2.7	3.0
K_2	0.5	0.5	0.6	0.7	1.0	1.0	1.0	1.0	...	1.8	2.4	3.4	3.9	1.4	1.7	2.1	2.5
K_3	0.6	0.7	0.9	1.0	0.4	0.5	0.7	0.8	...	2.0	2.5	3.5	4.0	2.9	3.4	4.5	5.0
K_4	0.2	0.2	0.2	0.2	0.2	0.3	0.4	0.5	...	2.6	3.1	4.1	4.6	0.2	0.3	0.4	0.5
K_5	0.3	0.3	0.4	0.5	0.7	0.8	1.0	1.1	...	1.0	1.2	1.5	1.7	0.3	0.3	0.4	0.6
K_6	0.9	1.1	1.6	1.8	0.5	0.6	0.7	0.8	...	1.6	1.8	2.3	2.5	2.3	2.8	3.8	4.3
K_7	0.4	0.5	0.7	0.9	0.9	1.1	1.8	2.3	...	1.8	2.4	3.4	3.9	1.6	2.1	3.1	3.6
K_8	0.6	0.7	0.9	1.0	1.4	1.5	1.9	2.1	...	3.4	4.0	5.0	5.5	2.0	2.5	3.5	4.0
K_9	0.2	0.2	0.2	0.3	1.0	1.2	1.5	1.7	...	2.3	2.8	3.8	4.3	0.4	0.5	0.6	0.8
K_{10}	0.3	0.3	0.5	0.6	0.2	0.2	0.3	0.4	...	2.5	3.0	4.1	4.6	0.3	0.3	0.4	0.6
K_{11}	0.2	0.2	0.2	0.2	0.3	0.3	0.4	0.5	...	1.3	1.5	2.0	2.3	1.8	2.4	3.4	3.9
K_{12}	0.2	0.2	0.2	0.2	0.3	0.3	0.4	0.6	...	1.0	1.0	1.0	1.0	0.5	0.6	0.7	0.8
K_{13}	0.3	0.4	0.5	0.5	0.4	0.5	0.6	0.7	...	1.3	1.4	1.8	2.0	1.0	1.0	1.0	1.0

The fourth stage is to sum each row according to the respective scales $l, m, n,$ and u use Eq. (8). The following is the calculation for the first row $\left(\sum l_{1q},\ \sum m_{1q}, \sum n_{1q},\ \sum u_{1q}\right)$ with $q = 1, 2, 3, \ldots, 13$.

$$\begin{aligned}
l &= \sum l_q = \begin{pmatrix}1.00+1.39+0.96+4.58+2.00+0.55+1.14+1.00\\ +4.00+1.59+4.58+4.38+1.91\end{pmatrix} = 29.08\\
m &= \sum m_q = \begin{pmatrix}1.00+1.54+1.14+5.09+2.50+0.63+1.41+1.14\\ +4.50+2.11+5.09+4.91+2.13\end{pmatrix} = 33.29\\
n &= \sum n_q = \begin{pmatrix}1.00+1.89+1.48+6.10+3.50+0.87+1.96+1.44\\ +5.50+3.13+6.10+5.95+2.65\end{pmatrix} = 41.07\\
u &= \sum u_q = \begin{pmatrix}1.00+2.08+1.65+6.60+4.00+1.08+2.29+1.59\\ +6.00+3.63+6.60+6.46+3.00\end{pmatrix} = 45.98
\end{aligned} \tag{14}$$

Each row in the fuzzy judgment matrix, representing the total fuzzy value for a given criterion, is element-wise multiplied (Hadamard product) with the inverse of the total fuzzy weights vector. This involves multiplying corresponding components of trapezoidal fuzzy numbers. The results of the row-wise summation (a) in Table 9 are then used to calculate the Fuzzy Synthetic Extent (FSE) for each criterion (b) in Table 9 using Eq. (7). The calculation is performed for each row or criterion, from Criterion 1 to Criterion 13, as presented Eq. (15) below.

$$\begin{aligned} S_1 &= (29.08, 33.19, 41.57, 45.99) \odot \left(\frac{1}{344.81}, \frac{1}{303.13}, \frac{1}{228.57}, \frac{1}{192.90}\right) \\ &= (0.084323, 0.109498, 0.181858, 0.238419) \\ &\vdots \\ S_{13} &= (11.20, 13.50, 18.32, 20.96) \odot \left(\frac{1}{344.81}, \frac{1}{303.13}, \frac{1}{228.57}, \frac{1}{192.90}\right) \\ &= (0.032203, 0.044527, 0.080170, 0.108655). \end{aligned} \tag{15}$$

The complete results of the row-wise summation along with the Fuzzy Synthetic Extent values can be seen in Table 10 below.

Table 10. Summation Results and Fuzzy Synthetic Extent Results

Criteria	(a) Row-wise Summation				(b) Synthesized TrFN Fuzzy Weights			
	l	m	n	u	l	m	n	u
K_1	29.08	33.19	41.57	45.99	0.08432	0.1095	0.18186	0.23842
K_2	16.29	19.37	25.81	29.37	0.04725	0.06391	0.11291	0.15228
K_3	26.35	31.00	40.44	45.42	0.07642	0.10227	0.17695	0.23547
K_4	8.72	10.18	13.56	15.79	0.0253	0.03359	0.05932	0.08184
K_5	7.09	8.17	10.69	12.36	0.02058	0.02696	0.04675	0.06405
K_6	19.99	24.34	33.18	37.91	0.05797	0.0803	0.14517	0.19652
K_7	18.19	22.20	30.43	34.90	0.05275	0.07323	0.13311	0.18093
K_8	21.41	25.44	33.62	37.86	0.06208	0.08394	0.14709	0.19628
K_9	12.77	15.73	21.80	25.11	0.03705	0.05189	0.09539	0.13015
K_{10}	6.56	7.51	9.87	11.57	0.01902	0.02476	0.0432	0.05998
K_{11}	10.66	12.79	17.35	20.02	0.03092	0.04219	0.07592	0.10381
K_{12}	4.68	5.15	6.48	7.55	0.01358	0.01698	0.02837	0.03916
K_{13}	11.10	13.50	18.32	20.96	0.0322	0.04453	0.0801	0.10866
Total	192.9	228.57	303.13	344.81				

Part (b) of the table above presents the weights of each criterion in the fuzzy scale at the points $l, m, n,$ and u. The fifth stage is to perform defuzzification of the fuzzy weights using Eq. (9), as described in Eq. (16) below.

$$\begin{aligned} DM_1 &= \frac{0,084323 + 2 \times 0,109498 + 2 \times 0,181858 + 0,238419}{6} = 0,150909149 \\ &\vdots \\ DM_{13} &= \frac{0,032203 + 2 \times 0,044527 + 2 \times 0,080170 + 0,108655}{6} = 0,065042172. \end{aligned} \tag{16}$$

After completing all calculations, the sixth stage is to perform normalization using Eq. (10) to facilitate interpretation. The result of this normalization represents the final weights of each criterion, and the priority weights are visualized in the following Table 11.

Table 11. Defuzzified Weights and Final Weights of Each Criterion

No.	Cr.	Description	Defuzzified Weight	Final Weight	Rank
1.	K_1	Tuition Fee per Semester	0.150909	0.139142	1
2.	K_2	Father's Income	0.092193	0.085004	6
3.	K_3	Number of Parental Dependents	0.145054	0.133743	2
4.	K_4	House Size	0.048827	0.045020	10
5.	K_5	Family Installment Amount	0.038673	0.035657	11
6.	K_6	Father's Latest Education	0.117573	0.108405	4
7.	K_7	Income of Working Siblings	0.107726	0.099326	5
8.	K_8	Monthly Income if Working	0.120068	0.110705	3
9.	K_9	Distance from Home to Campus	0.076958	0.070957	7
10.	K_{10}	Mother's Latest Education	0.035820	0.033027	12
11.	K_{11}	Mother's Income	0.061824	0.057003	9
12.	K_{12}	Type of Transportation to Campus	0.023905	0.022041	13
13.	K_{13}	Monthly Allowance	0.065042	0.059970	8

Table 11 indicates that the criterion Tuition Fee per Semester (K_1) holds the highest weight, 0.139142, making it the top priority variable in the scholarship selection process. In contrast, the criterion Type of Transportation to Campus (K_{12}), has the lowest weight, at 0.022041. The criteria with the highest weights generally reflect indicators of financial hardship, such as the amount of tuition fees and the number of dependents. This is in line with the focus of the study, which emphasizes the allocation of scholarships to students from economically disadvantaged backgrounds. These findings are consistent with previous research [37], which showed that the highest weighted criteria were aligned with the specific context of the scholarship. In that study, which focused on the selection of merit-based scholarship recipients, the criteria related to academic achievement had the highest weights. The seventh stage is to test the consistency of the AHP model by calculating the consistency ratio, which begins with computing the geometric mean of the three pairwise comparison matrices prior to the fuzzification process.

Table 12. Aggregated Matrix from 3 Expert Judgements without Transformation to TrFN

Cr.	K_1	K_2	K_3	K_4	K_5	K_6	K_7	K_8	K_9	K_{10}	K_{11}	K_{12}	K_{13}
K_1	1	13/9	1	28/5	3	3/4	5/3	9/7	5	21/8	28/5	38/7	9/4
K_2	2/3	1	12/7	28/9	10/9	8/5	3/2	3/5	3/4	29/8	3	35/9	15/8
K_3	1	3/5	1	5	25/6	4/5	4	12/7	4	32/9	10/3	3	4
K_4	1/6	1/3	1/5	1	7/8	5/9	2/7	3/8	3/7	10/3	2/7	29/8	2/3
K_5	1/3	1	1/4	8/7	1	1/5	12/7	2/7	5/6	11/9	11/9	4/3	7/8
K_6	4/3	5/8	5/4	9/5	33/7	1	12/7	10/3	16/7	21/8	21/8	2	10/3
K_7	3/5	2/3	1/4	32/9	7/5	3/5	1	13/9	4	32/9	3	35/9	21/8
K_8	7/9	12/7	3/5	21/8	32/9	1/3	2/3	1	32/9	10/3	4	9/2	3
K_9	1/5	4/3	1/4	16/7	11/9	3/7	1/4	2/7	1	10/3	35/9	10/3	5/9
K_{10}	3/8	2/7	2/7	1/3	5/6	3/8	2/7	1/3	1/3	1	1/3	32/9	1/3
K_{11}	1/6	1/3	1/3	32/9	5/6	3/8	1/3	1/4	1/3	35/9	1	12/7	35/9
K_{12}	1/5	1/3	1/3	2/7	3/4	1/2	1/3	2/9	1/3	2/7	3/5	1	5/8
K_{13}	4/9	1/2	1/4	13/9	8/7	1/3	3/8	1/3	9/5	35/9	1/3	8/5	1
Total	7.37	10.9	7.62	31.71	24.55	7.75	13.08	11.39	24.45	34.16	28.09	36.91	24.02

Subsequently, normalization is applied to Table 13. followed by summation to determine the initial weights.

Table 13. Normalized Matrix from Table 12

Criteria	K_1	K_2	K_3	⋯	K_{11}	K_{12}	K_{13}	Total	Weight
K_1	0.136	0.143	0.125	⋯	0.199	0.147	0.094	1.75952	0.13535
K_2	0.094	0.099	0.224	⋯	0.107	0.078	0.078	1.33075	0.10237
K_3	0.143	0.058	0.131	⋯	0.118	0.081	0.166	1.83949	0.14150
K_4	0.024	0.032	0.026	⋯	0.010	0.098	0.029	0.52733	0.04056
K_5	0.045	0.090	0.032	⋯	0.043	0.036	0.036	0.53591	0.04122
K_6	0.184	0.062	0.165	⋯	0.093	0.056	0.137	1.66833	0.12833
K_7	0.081	0.066	0.034	⋯	0.107	0.078	0.109	1.18645	0.09127
K_8	0.105	0.169	0.077	⋯	0.139	0.121	0.125	1.38653	0.10666
K_9	0.027	0.133	0.034	⋯	0.103	0.089	0.023	0.76820	0.05909
K_{10}	0.052	0.027	0.037	⋯	0.012	0.096	0.014	0.42102	0.03239
K_{11}	0.024	0.033	0.040	⋯	0.036	0.046	0.120	0.64042	0.04926
K_{12}	0.025	0.034	0.044	⋯	0.021	0.027	0.026	0.34459	0.02651
K_{13}	0.060	0.053	0.033	⋯	0.012	0.044	0.042	0.59145	0.04550

The next step is to multiply the matrix in Table 12 by the weights from Table 13, as presented below.

$$\begin{bmatrix} 1 & 13/9 & 1 & \cdots & 38/7 & 9/4 \\ 2/3 & 1 & 12/7 & \cdots & 35/9 & 15/8 \\ 1 & 3/5 & 1 & \cdots & 3 & 4 \\ \vdots & \vdots & \vdots & \ddots & \vdots & \vdots \\ 1/5 & 1/3 & 1/3 & \cdots & 1 & 5/8 \\ 4/7 & 1/2 & 1/4 & \cdots & 8/5 & 1 \end{bmatrix}_{(13\times13)} \times \begin{bmatrix} 0.13535 \\ 0.10237 \\ 0.14150 \\ \vdots \\ 0.02651 \\ 0.04550 \end{bmatrix}_{(13\times1)} = \begin{bmatrix} 2.056 \\ 1.484 \\ 2.129 \\ 0.573 \\ 0.606 \\ 1.886 \\ 1.397 \\ 1.59 \\ 0.873 \\ 0.45 \\ 0.726 \\ 0.377 \\ 0.671 \end{bmatrix}_{(13\times1)} \tag{17}$$

Next, the value of D is determined by dividing the result of the previous matrix multiplication by the weights in Table 13, as explained in Eq. (18) below.

$$D = \begin{bmatrix} \frac{2.056}{0.13535} \\ \frac{1.484}{0.10237} \\ \vdots \\ \frac{0.377}{0.02651} \\ \frac{0.671}{0.04550} \end{bmatrix}_{(13\times1)} = \begin{bmatrix} 15.187 \\ 14.494 \\ 15.049 \\ 14.138 \\ 14.698 \\ 14.695 \\ 15.31 \\ 14.906 \\ 14.779 \\ 13.898 \\ 14.731 \\ 14.23 \\ 14.742 \end{bmatrix}_{(13\times1)}. \quad (18)$$

Next, the value of λ_{max} is first calculated by dividing the total value of D by the number of criteria, as shown below.

$$\lambda_{max} = \frac{\begin{pmatrix} 15.187 + 14.494 + 15.049 + 14.138 + 14.689 + 14.695 + 15.31 \\ +14.906 + 14.779 + 13.898 + 14.731 + 14.23 + 14.742 \end{pmatrix}}{13} = 14.6813. \quad (19)$$

The obtained value of λ_{max} satisfies the requirement of being greater than n, where n is the number of criteria. Therefore, the process can proceed to the next step, which is calculating the Consistency Index (CI) as follows, using Eq. (11).

$$CI = \frac{\lambda_{max} - n}{n - 1} = \frac{14.6813 - 13}{13 - 1} = 0.1515. \quad (20)$$

After obtaining the Consistency Index (CI) value, the next step is to calculate the Consistency Ratio (CR) using Eq. (12), with the Random Index (RI) value taken from Table 2.

$$CR = \frac{CI}{RI} = \frac{0.1515}{1.56} = 0.089813. \quad (21)$$

The final result of the consistency ratio is 0.089813, which meets the requirement as it is below the threshold of 0.1 (< 0.1). Therefore, the selection process for SKSS scholarship recipients using the Trapezoidal Fuzzy AHP method is considered consistent and justifiable.

The calculation results show that the consistency ratio is 0.089813, which is below the threshold of 0.1 (< 0.1). Thus, the pairwise comparison judgments in the selection process of SKSS scholarship recipients using the Trapezoidal Fuzzy AHP method can be considered consistent, meaning that they possess logical order without internal contradictions, so the results can be justified and utilized for decision-making. Conversely, if the consistency ratio exceeds 0.1, the judgments are considered inconsistent, and the process must be returned to the stage of constructing the pairwise comparison matrix through expert judgment for revision.

After obtaining the weights of each criterion and confirming the model's consistency, the next step is to rank the scholarship candidates. This is done by normalizing the data of each criterion for every subject, multiplying it by the corresponding criterion weights, and then summing each row to calculate the alternative weights or total scores of the subjects. These scores are then sorted from highest to lowest, where the subject with the highest score is given the top priority for the SKSS scholarship, and the subject with the lowest score is placed last in the priority list. The full ranking and order of all subjects can be seen in Table 14 below.

Table 14. Ranking of Alternatives by Priority

Rank	Subject	priority weight	Subject	Rank	priority weight	Rank	Subject	priority weight
1	S74	0.7964	S42	27	0.6372	53	S51	0.5748
2	S31	0.7723	S41	28	0.6249	54	S58	0.5727
3	S78	0.7475	S24	29	0.6236	55	S57	0.5707
4	S20	0.7421	S44	30	0.6210	56	S65	0.5702
5	S17	0.7345	S4	31	0.6205	57	S30	0.5696
6	S7	0.7041	S55	32	0.6199	58	S59	0.5675
7	S54	0.6975	S21	33	0.6191	59	S50	0.5670

Rank	Subject	priority weight	Subject	Rank	priority weight	Rank	Subject	priority weight
8	S6	0.6968	S62	34	0.6190	60	S56	0.5625
9	S77	0.6957	S39	35	0.6171	61	S38	0.5610
10	S73	0.6952	S13	36	0.6150	62	S33	0.5588
11	S25	0.6916	S26	37	0.6134	63	S63	0.5562
12	S12	0.6914	S34	38	0.6125	64	S53	0.5472
13	S15	0.6911	S40	39	0.6100	65	S1	0.546
14	S14	0.6906	S32	40	0.6090	66	S45	0.5442
15	S16	0.6903	S60	41	0.6016	67	S43	0.5440
16	S19	0.6738	S48	42	0.6001	68	S67	0.5425
17	S10	0.6688	S68	43	0.6000	69	S66	0.5425
18	S27	0.6649	S5	44	0.5963	70	S46	0.5424
19	S29	0.6640	S72	45	0.5909	71	S11	0.5404
20	S70	0.6630	S35	46	0.5893	72	S2	0.5330
21	S8	0.6577	S49	47	0.5893	73	S3	0.5330
22	S69	0.6531	S75	48	0.5814	74	S28	0.5185
23	S9	0.6493	S18	49	0.5778	75	S36	0.4998
24	S47	0.6455	S37	50	0.5774	76	S52	0.4991
25	S76	0.6412	S71	51	0.5768	77	S61	0.4215
26	S64	0.6381	S22	52	0.5765	78	S23	0.3986

Based on Table 14 above, it can be observed that subject 74 (S_{74}) holds the highest priority as a prospective scholarship recipient, followed by subject 31 (S_{31}) Meanwhile, subject 23 (S_{23}) ranks lowest in the priority list.

The final prioritization in this study is still limited to a simple calculation, which involves normalization, multiplying the weights across criteria, and subsequently summing the results to obtain the final score for each alternative. Furthermore, the study only considers the criteria available in the registration form, which had undergone dimensionality reduction. Therefore, further and more in-depth studies are needed to formulate specific criteria for the selection of SKSS scholarship recipients, considering that each study, although addressing scholarships, may differ in context and type, which in turn affects the determination of relevant criteria.

4. CONCLUSION

Based on the previous calculations, the weights for each criterion were obtained. The criterion with the greatest influence on the decision-making process is K_1 (tuition fee per semester) with a final weight of 0.139142, followed by K_3 (number of parental dependents) with 0.133743, and K_8 (monthly income if working) with 0.110705. Next, K_6 (father's latest education) has a weight of 0.108405, followed by K_7 (income of working siblings) with 0.099326, and K_2 (father's income) with 0.085004. The criterion K_9 (distance from home to campus) has a weight of 0.070957, followed by K_{13} (monthly allowance) with 0.059970, and K_{11} (mother's income) with 0.057003. Lower-weighted criteria include K_4 (house size) with 0.045020, K_5 (family installment amount) with 0.035657, K_{10} (mother's latest education) with 0.033027, and the lowest is K_{12} (type of transportation to campus) with a weight of 0.022041. Based on the final global weights, the subject with the highest priority as a potential SKSS scholarship recipient is Subject 74 (S_{74}) with a weight of 0.7964, followed by Subject 31 (S_{31}) with 0.7723, and Subject 78 (S_{78}) with 0.7475. Meanwhile, the subject with the lowest priority, ranked last, is Subject 23 (S_{23}) with a weight of 0.3980.

This study is limited to determining the priority of potential SKSS scholarship recipients based on the predefined criteria (K_1–K_{13}) using the Trapezoidal Fuzzy AHP method. The results reflect only the relative importance of the criteria within the given dataset and exclude external factors such as academic performance or psychological conditions. Findings are context-dependent and may vary if applied to different data or conditions.

Future research can focus on three main directions: (1) evaluating the criteria used and replacing them if they are deemed no longer relevant to current conditions; (2) incorporating other methods, such as Fuzzy AHP-TOPSIS, to improve the accuracy and reliability of the results; and (3) comparing the Trapezoidal Fuzzy AHP method with other multi-criteria decision-making methods.

Author Contributions

Syamil Waris Dien Muhammad: Conceptualization, Formal Analysis, Methodology, Visualization, and Writing – Review and Editing. Abdulloh Hamid: Data Curation, Resources, and Validation. Hani Khaulasari: Writing – Original Draft and Project Administration. Dian Candra Rini Novitasari: Project Administration and Software. Moh. Hafiyusholeh: Supervision and Resources. All authors reviewed and approved the final manuscript.

Funding Statement

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors. To be sure, this research was financed by the supervisor.

Acknowledgment

The authors sincerely thank all parties who have contributed to the completion of this research, especially to the supervisors who have assisted in data processing and analysis, manuscript editing, and valuable input during the writing process. Thanks are also extended to the reviewers for co`1nstructive suggestions and corrections in improving this article.

Declarations

This research is carried out jointly according to the division of tasks of each one, without any conflict between authors.

Declaration of Generative AI and AI-assisted Technologies

Generative AI tools were used solely for language refinement (grammar, spelling, and clarity). The scientific content, analysis, interpretation, and conclusions were developed entirely by the authors. The authors reviewed and approved all final text.

REFERENCES

[1] L. Ningrum, R. Nooraeni, S. M. Berliana, and L. K. Sari, "ASSOCIATION OF SDG INDICATORS OF THE SOCIAL DEVELOPMENT PILLAR IN INDONESIA USING THE APRIORI ALGORITHM," *Procedia Comput. Sci.*, vol. 245, pp. 450–459, 2024, doi: https://doi.org/10.1016/j.procs.2024.10.271

[2] M. Murtadlo *et al.*, "INCLUSIVE EDUCATION IN AFRICA: TRANSFORMING HIGHER EDUCATION IN LOW-INCOME COUNTRIES," *Sci. African*, vol. 28, no. February, p. e02708, 2025, doi: https://doi.org/10.1016/j.sciaf.2025.e02708

[3] L. Wu and J. Fang, "HOW HIGHER EDUCATION AFFECTS CORPORATE HUMAN CAPITAL INVESTMENT: BASED ON UPPER ECHELONS THEORY," *Financ. Res. Lett.*, vol. 69, p. 106019, 2024, doi: https://doi.org/10.1016/j.frl.2024.106019

[4] P. L. Review and K. P. Tinggi, "PELANGGARAN HAK ATAS PENDIDIKAN DI INDONESIA: DISKURSUS MENGENAI STUDENT LOAN SEBAGAI SOLUSI KOMERSIALISASI PERGURUAN TINGGI SARAH YESSIE HANA MONICA * , Nadine Fakhira Putri Ravanti **," vol. 12, pp. 196–211, 2024.doi : https://doi.org/10.56895/plr.v12i2.1833

[5] B. P. Statistik, "ANGKA PARTISIPASI KASAR (APK) PERGURUAN TINGGI (PT) MENURUT PROVINSI, 2023." Accessed: Jul. 05, 2025. [Online]. Available: https://www.bps.go.id/assets/statistics-table/2/MTQ0MyMy/angka-partisipasi-kasar--apk--perguruan-tinggi--pt--menurut-provinsi.html

[6] B. P. Statistik, "ANGKA PARTISIPASI KASAR (APK) PERGURUAN TINGGI (PT) MENURUT PROVINSI, 2024." Accessed: Jul. 05, 2025. [Online]. Available: https://www.bps.go.id/assets/statistics-table/2/MTQ0MyMy/angka-partisipasi-kasar--apk--perguruan-tinggi--pt--menurut-provinsi.html

[7] T. Mulyaningsih, S. Dong, R. Miranti, A. Daly, and Y. Purwaningsih, "TARGETED SCHOLARSHIP FOR HIGHER EDUCATION AND ACADEMIC PERFORMANCE: EVIDENCE FROM INDONESIA," *Int. J. Educ. Dev.*, vol. 88, p. 102510, 2022, doi: https://doi.org/10.1016/j.ijedudev.2021.102510

[8] B. A. Z. Nasional, "PETUNJUK TEKNIS BEASISWA SATU KELUARGA SATU SARJANA (SKSS)." Accessed: Jul. 01, 2025. [Online]. Available: https://bucket-api.baznas.go.id/bucket-api/file?bucket=bzn-fdr-smb-p5739641&file=attachments/pemberitahuan/1717338330015994579_990-JUKNIS-SKSS-2024.pdf

[9] L. P. Sari, A. Hamid, H. Khaulasari, L. P. Sari, A. Hamid, and H. Khaulasari, "FORECASTING ZAKAT POTENTIAL IN BAZNAZ EAST JAVA USING THE ARIMAX METHOD WITH CALENDAR VARIATION EFFECTS FORECASTING ZAKAT POTENTIAL IN BAZNAZ EAST JAVA USING THE ARIMAX METHOD WITH CALENDAR VARIATION EFFECTS," vol. 13, no. 2, pp. 181–187, 2025.doi : https://doi.org/10.37905/euler.v13i2.31456

[10] D. L. Fay, "ANALISIS METODE PENETAPAN CALON MUSTAHIK PENERIMA BEASISWA SATU KELUARGA SATU SARJANA (SKSS) DALAM PELAKSANAAN PENDISTRIBUSIAN ZAKAT DI BAZNAS KABUPATEN KUANTANG SINGINGI," *Angew. Chemie Int. Ed. 6(11), 951–952.*, pp. 269–277, 2023.

[11] G. A. Melnik-Leroy and G. Dzemyda, "HOW TO INFLUENCE THE RESULTS OF MCDM?—EVIDENCE OF THE IMPACT OF COGNITIVE BIASES," *Mathematics*, vol. 9, no. 2, pp. 1–25, 2021, doi: https://doi.org/10.3390/math9020121

[12] A. Hoveidafard, S. F. Moradinia, B. Golchin, and A. Ghaffari, "IDENTIFICATION OF REQUIRED STATIONS FOR AUTONOMOUS VEHICLES USING AHP AND TOPSIS METHOD WITH GIS APPROACH," *Sustain. Futur.*, vol. 10, no. June, p. 100755, 2025, doi: https://doi.org/10.1016/j.sftr.2025.100755

[13] M. T. Aziz *et al.*, "SITE SUITABILITY ASSESSMENT FOR SOLAR POWERED GREEN HYDROGEN PRODUCTION PLANTS: A GIS BASED AHP AND FUZZY APPROACH FOR BANGLADESH," *Renew. Energy*, p. 123675, 2025.doi : https://doi.org/10.1016/j.renene.2025.123675

[14] M. Risnasari and L. Cahyani, "REKOMENDASI PENERIMA BEASISWA MENGGUNAKAN METODE AHP DAN TOPSIS," *J. Infomedia*, vol. 3, no. 1, pp. 1–6, 2018, doi: https://doi.org/10.30811/jim.v3i1.621.

[15] G. Tepic, M. Djelosevic, N. Brkljac, and M. Vukovic, "PROBABILISTIC RANKING OF HAZMAT LOGISTICS SUBSYSTEMS UNDER UNCERTAINTY USING FUZZY AHP," *J. Loss Prev. Process Ind.*, p. 105563, 2025.doi : https://doi.org/10.1016/j.jlp.2025.105563

[16] M. Shameem, M. Nadeem, M. Niazi, S. Mahmood, and A. Kumar, "TAXONOMY OF METRICS FOR EFFECTIVELY ESTIMATING QUANTUM SOFTWARE PROJECTS: A FUZZY-AHP BASED ANALYSIS," *Appl. Soft Comput.*, p. 112816, 2025.doi : https://doi.org/10.1016/j.asoc.2025.112816

[17] D. H. Qendraj, E. Xhafaj, A. Xhafaj, and E. Halidini, "RANKING THE MOST IMPORTANT ATTRIBUTES OF USING GOOGLE CLASSROOM IN ONLINE TEACHING FOR ALBANIAN UNIVERSITIES: A FUZZY AHP METHOD WITH TRIANGULAR FUZY NUMBERS AND TRAPEZOIDAL FUZZY NUMBERS," *Adv. Sci. Technol. Eng. Syst.*, vol. 6, no. 1, pp. 297–308, 2021, doi: https://doi.org/10.25046/aj060134

[18] W. Syamil, "KUESIONER PENILAIAN KEPENTINGAN ANTAR KRITERIA." Accessed: Jul. 10, 2025. [Online]. Available: https://forms.gle/yJAit6ZQHLpPao6k8

[19] BAZNAS, "FORMULIR BEASISWA SATU KELUARGA SATU SARJANA." Accessed: Jul. 10, 2025. [Online]. Available: https://bucket-api.baznas.go.id/bucket-api/file?bucket=bzn-fdr-smb-p5739641&file=attachments/pemberitahuan/740-Formullir Pendaftaran Beasiswa SKSS.pdf

[20] J. Miao and L. Niu, "A SURVEY ON FEATURE SELECTION," *Procedia Comput. Sci.*, vol. 91, no. Itqm, pp. 919–926, 2016, doi : https://doi.org/10.1016/j.procs.2016.07.111

[21] A. Singh and A. Tiwari, "A STUDY OF FEATURE SELECTION AND DIMENSIONALITY REDUCTION METHODS FOR CLASSIFICATION-BASED PSINGH, A., & TIWARI, A. (2020). A STUDY OF FEATURE SELECTION AND DIMENSIONALITY REDUCTION METHODS FOR CLASSIFICATION-BASED PHISHING DETECTION SYSTEM. INTERNATIONAL," *Int. J. Inf. Retr. Res.*, vol. 11, no. 1, pp. 1–35, 2020, doi: https://doi.org/10.4018/IJIRR.2021010101.

[22] F. Kamalov, H. Sulieman, A. Alzaatreh, M. Emarly, H. Chamlal, and M. Safaraliev, "MATHEMATICAL METHODS IN FEATURE SELECTION: A REVIEW," *Mathematics*, vol. 13, no. 6, pp. 1–29, 2025, doi: 1https://doi.org/10.3390/math13060996.

[23] M. I. Prasetiyowati, N. U. Maulidevi, and K. Surendro, "THE ACCURACY OF RANDOM FOREST PERFORMANCE CAN BE IMPROVED BY CONDUCTING A FEATURE SELECTION WITH A BALANCING STRATEGY," *PeerJ Comput. Sci.*, vol. 8, pp. 1–15, 2022, doi: https://doi.org/10.7717/peerj-cs.1041

[24] N. T. Romadloni and Hilman F Pardede, "SELEKSI FITUR BERBASIS PEARSON CORRELATION UNTUK OPTIMASI OPINION MINING REVIEW PELANGGAN," *J. RESTI (Rekayasa Sist. dan Teknol. Informasi)*, vol. 3, no. 3, pp. 505–510, 2019, doi: https://doi.org/10.29207/resti.v3i3.1189.

[25] M. Díaz-Vallejo *et al.*, "ANALYSES OF THE VARIABLE SELECTION USING CORRELATION METHODS: AN APPROACH TO THE IMPORTANCE OF STATISTICAL INFERENCES IN THE MODELLING PROCESS," *Ecol. Modell.*, vol. 498, p. 110893, 2024, doi: https://doi.org/10.1016/j.ecolmodel.2024.110893

[26] S. N. Kurnia Ramadhan Putra, Sofia Umroh, Nur Fitrianti, "RESULTANT: DATA PREPARATION TECHNIQUES TO IMPROVE XGBOOST ALGORITHM PERFORMANCE," *J. MIND J. | ISSN*, vol. 8, no. 1, pp. 42–51, 2023, [Online]. Available: https://doi.org/10.69957/tanda.v3i01.945

[27] T. Mehmood, "REGULARIZED FEATURE SELECTION IN CATEGORICAL PLS FOR MULTICOLLINEAR DATA," *Math. Probl. Eng.*, vol. 2021, 2021, doi: https://doi.org/10.1155/2021/5561752

[28] S. G. Meshram, E. Alvandi, V. P. Singh, and C. Meshram, "COMPARISON OF AHP AND FUZZY AHP MODELS FOR PRIORITIZATION OF WATERSHEDS," *Soft Comput.*, vol. 23, no. 24, pp. 13615–13625, 2019, doi: https://doi.org/10.1007/s00500-019-03900-z

[29] C. Boonmee and N. Tanpruttianunt, "A FUZZY MULTI-CRITERIA DECISION FRAMEWORK FOR COMMUNITY ISOLATION CENTER SITE SELECTION TO ENHANCE PUBLIC HEALTH RESILIENCE," *J. Saf. Sci. Resil.*, p. 100227, 2025, doi: https://doi.org/10.1016/j.jnlssr.2025.100227.

[30] A. Paul and S. S. Mahapatra, "AN INTEGRATED FUZZY-AHP AND FUZZY-DEMATEL APPROACH FOR ANALYZING SUSTAINABLE SUPPLY CHAIN FACTORS IN THE MINING INDUSTRY," *Supply Chain Anal.*, vol. 10, no. February, p. 100113, 2025, doi: https://doi.org/10.1016/j.sca.2025.100113

[31] C. Singha, S. Sahoo, A. B. Mahtaj, A. Moghimi, M. Welzel, and A. Govind, "ADVANCING FLOOD RISK ASSESSMENT: MULTITEMPORAL SAR-BASED FLOOD INVENTORY GENERATION USING TRANSFER LEARNING AND HYBRID FUZZY-AHP-MACHINE LEARNING FOR FLOOD SUSCEPTIBILITY MAPPING IN THE MAHANANDA RIVER BASIN," *J. Environ. Manage.*, vol. 380, no. February, p. 124972, 2025, doi: https://doi.org/10.1016/j.jenvman.2025.124972

[32] M. Alipour-Bashary, M. Ravanshadnia, H. Abbasianjahromi, and E. Asnaashari, "A HYBRID FUZZY RISK ASSESSMENT FRAMEWORK FOR DETERMINING BUILDING DEMOLITION SAFETY INDEX," *KSCE J. Civ. Eng.*, vol. 25, no. 4, pp. 1144–1162, 2021, doi: https://doi.org/10.1007/s12205-021-0812-4

[33] E. B. Agyekum and V. I. Velkin, "MULTI-CRITERIA DECISION-MAKING APPROACH IN ASSESSING THE KEY BARRIERS TO THE ADOPTION AND USE OF SWH IN WEST AFRICA–COMBINATION OF MODIFIED DELPHI AND FUZZY AHP," *Int. J. Thermofluids*, vol. 23, no. August, p. 100795, 2024, doi:

https://doi.org/10.1016/j.ijft.2024.100795.

[34] A. V. Vitianingsih, C. Ullum, A. L. Maukar, V. Yasin, and S. F. A. Wati, "MAPPING RESIDENTIAL LAND SUITABILITY USING A WEB-GIS-BASED MULTI-CRITERIA SPATIAL ANALYSIS APPROACH: INTEGRATION OF AHP AND WPM METHODS," *J. RESTI*, vol. 8, no. 2, pp. 208–215, 2024, doi: https://doi.org/10.29207/resti.v8i2.4520

[35] S. Pant, A. Kumar, M. Ram, Y. Klochkov, and H. K. Sharma, "CONSISTENCY INDICES IN ANALYTIC HIERARCHY PROCESS: A REVIEW," *Mathematics*, vol. 10, no. 8, pp. 1–15, 2022, doi: https://doi.org/10.3390/math10081206

[36] Z. Xiaoxin, H. Jin, L. Ling, W. Yueping, and Z. Xinheng, "RESEARCH OF AHP/DEA EVALUATION MODEL FOR OPERATION PERFORMANCE OF MUNICIPAL WASTEWATER TREATMENT PLANTS," *E3S Web Conf.*, vol. 53, pp. 1–5, 2018, doi: https://doi.org/10.1051/e3sconf/20185304009

[37] Frieyadie, "PENERAPAN METODE AHP SEBAGAI PENDUKUNG KEPUTUSAN PENETAPAN BEASISWA," *J. Pilar Nusa Mandiri Vol.*, vol. 13, no. 2, pp. 49–58, 2017, doi: https://doi.org/10.1016/j.jfo.2016.08.015.