

Application of Fuzzy Logic Method and Analytical Hierarchy Process in Assessment of Education Quality at the Madrasah Aliyah Level

Muhammad Yusril Haffandi^{1✉}, Gunadi Widi Nurcahyo², Billy Hendrik³

^{1,2,3} Magister Teknik Informatika, Ilmu Komputer, Universitas Putra Indonesia YPTK, Padang, 25221, Indonesia

myusri1haffandi@gmail.com

Abstract

Madrasah have a strategic role in producing a generation of the nation that is intellectually intelligent as well as spiritually and emotionally mature, but the quality between madrasahs is still uneven, especially in rural areas such as Kerinci Regency. The assessment of the quality of madrasahs until now tends to be subjective and has not been based on a measurable, systematic, and widely replicated system. This research aims to develop an objective and structured quality evaluation system for madrasah education using a technology-based approach. The methods used are Fuzzy Logic and Analytical Hierarchy Process (AHP) which are combined into Fuzzy AHP. The scope of the research is focused on aliyah madrasahs under the coordination of the Ministry of Religious Affairs of Kerinci Regency. The data was obtained through direct interviews with the Head of the Madrasah Education Section and included eight aliyah madrasahs as the object of the research, which were assessed based on nine main criteria, namely: quality of teachers (0.190), teaching materials (0.153), infrastructure (0.117), school governance (0.117), learning environment (0.117), assessment system (0.088), leadership of school principals (0.157), parental support (0.079), and technology and digitalization (0.088). A web-based decision support system was developed to automatically manage Fuzzy AHP calculations, so that it can be used as a continuous evaluation tool. The results of the study show that this model is able to produce consistent, objective, and valid assessments with a Consistency Ratio (CR) value of < 0.1. Madrasah MA2 obtained the highest ranking in the assessment of the quality of education with a global weight value of 0.1562. The Fuzzy AHP approach has proven to be effective in multi-criteria education evaluation and can be the basis for policies that are more responsive to local needs.

Keywords: Fuzzy AHP, Education Evaluation, Madrasah Quality, Decision Support System, Ministry of Religion.

KomtekInfo Journal is licensed under a Creative Commons Attribution-Share Alike 4.0 International License.



1. Introduction

Madrasah education plays a strategic role in forming a generation with integrity that combines intellectual intelligence with Islamic values [1][2]. However, the quality of education in madrasahs, especially in rural areas such as Kerinci Regency, still faces serious challenges, including limited facilities, low teacher competence, and weak management systems [3][4].

This inequality shows that the evaluation mechanism used has not been able to fully capture the complex and multidimensional dimensions of education quality[5][6]. On the other hand, the existence of regulations such as Law Number 20 of 2003 concerning the National Education System as well as Government Regulation Number 19 of 2005 and Government Regulation Number 57 of 2021 concerning National Education Standards emphasizes that educational units, including madrasahs, are obliged to meet various quality standards such as graduate competence, infrastructure, and educators [7] [8] [9].

However, in reality, there are still many madrasahs, especially in areas such as Kerinci, that have not met these standards, especially in terms of facility feasibility, teacher competence, and management system. Assessments of the quality of madrasah education are often carried out subjectively and manually, so that they have the potential to cause bias and inconsistency in decision-making [10].

Problems in measuring the quality of education can adopt the concept of Artificial Intelligence (AI). Artificial Intelligence is a skill possessed by machines that can think just like humans[11]. Even though we think like humans, the knowledge generated by machines is certainly learned based on the data entered, tested and trained continuously by machines[12]. Artificial Intelligence can certainly solve various kinds of problems because it thinks like a human and thinks faster than humans in general[13].

As a solution, the Fuzzy Logic method and the Analytical Hierarchy Process (AHP) are seen as relevant to improve the objectivity and accuracy of multi-criterion-based educational evaluation. Fuzzy Logic has the advantage of processing linguistic data

into numerical through a double membership function approach [14], while AHP allows priority assessment based on the weights of hierarchically arranged criteria [15]. The combination of the two, namely Fuzzy AHP, has been shown to be effective in various studies, both nationally and internationally, such as in the selection of social assistance recipients [16], Production Waste Analysis [17], green supplier selection [18], Lecturer Performance Evaluation [19], manufacturing risk management [20], digital financial system [21], overtourism management [22], employee selection [23] Agricultural Land Evaluation[24], and so on.

Problems in measuring the quality of madrasah education that are still subjective can be overcome by utilizing the concept of Artificial Intelligence (AI) which is able to imitate the human mindset in processing data and making decisions quickly and accurately. In this context, the Fuzzy Logic method is used to transform qualitative assessments of a linguistic nature into measurable quantitative data [14], while the Analytical Hierarchy Process (AHP) provides a hierarchical framework for systematically determining the priority weight of each criterion[15]. The combination of the two, namely Fuzzy AHP, allows for multi-criteria assessment processing taking into account uncertainty and subjectivity, resulting in a more objective, consistent, and replicable evaluation[16]. This approach is relevant to answer the need for a structured and data-based quality assessment of madrasah education.

Based on the explanation presented above, this study aims to develop an objective, structured, and systematic model for evaluating the quality of madrasah education using the Fuzzy AHP method, with a case study in the Madrasah Education Section, Office of the Ministry of Religion of Kerinci Regency. This model is expected to assist local governments in developing data-driven policies that are responsive to local education challenges.

2. Method

This research method uses the Fuzzy Analytical Hierarchy Process (Fuzzy AHP) approach to evaluate the quality of madrasah aliyah education. This approach was chosen because it is able to combine the advantages of the AHP method in determining priority weights with the ability of fuzzy logic to handle the uncertainty and subjectivity of respondents' assessments[16]. By using this method, the results of the evaluation are expected to be more objective, consistent, and can be used as a basis for strategic decision-making related to improving the quality of madrasah education. In general:

a. Fuzzy Logic is used to convert qualitative assessments of a linguistic nature (e.g. "excellent", "adequate") into measurable quantitative numbers using triangular fuzzy

numbers (TFN). This approach facilitates the processing of data that contains uncertainty or subjectivity [25]. In this study, the use of TFN helps to provide a more flexible representation of respondents' perceptions, so that the evaluation results become more accurate and reliable.

- b. The Analytical Hierarchy Process (AHP) is a multi-criteria decision-making method that breaks down problems into a hierarchy of objectives, criteria, and alternatives[26], and then calculates the weight of priorities through pairwise comparison[27]. This method allows decision-makers to assess the level of importance of each criterion systematically and consistently. In this study, AHP plays an important role in determining the initial weight before it is integrated with fuzzy logic, resulting in a more comprehensive evaluation model.
- c. Fuzzy AHP combines both methods, where the AHP comparison matrix is expressed in the form of a fuzzy number to consider the ambiguity of respondents' judgments. This process results in more accurate and consistent criteria weights than conventional AHPs [28]. In the context of this study, the use of Fuzzy AHP allows the evaluation of the quality of madrasas to be carried out more objectively, so that the ranking results obtained can be a strong basis in the formulation of policies to improve the quality of education.

2.1 Research Stages

The stages of the research are shown in the following figure. The research process begins with the formulation of a model that includes the determination of criteria, subcriteria, and relationships between elements in the structure of the assessment hierarchy. The next stage is data collection through questionnaires that are distributed to respondents who understand the context of madrasah quality evaluation. After the data is collected, a Fuzzy AHP-based evaluation system is designed that integrates the calculation of criteria weights and madrasah rankings, so that the final results can be used as a basis for decision-making.

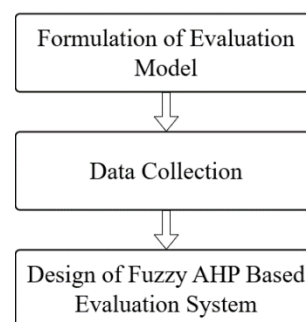


Figure 1. Research Stages

The research steps in this study are designed to ensure that the evaluation process runs systematically and in a directed manner. Each step is arranged to be interrelated, starting from the formulation of an evaluation model, data collection, to the design of a Fuzzy AHP-based evaluation system. By following this structured stage, the results of the research are expected to have a high level of accuracy and consistency in describing the quality of madrasah education.

- a. **Formulation of Evaluation Model**
The initial stage of research is to determine the problems to be studied, in this case the evaluation of the quality of madrasah aliyah education. The evaluation model is then prepared based on relevant criteria and reflects important aspects of education quality, such as teacher quality, leadership, and infrastructure. The formulation of the right model is essential so that the entire evaluation process runs according to the purpose and produces reliable information.
- b. **Data Collection**
Data collection was carried out through interviews, questionnaires, and documentation studies of competent parties and understood the conditions of the madrasah. Interviews aim to obtain in-depth information that is not always covered in questionnaires, whereas questionnaires

are used to obtain quantitative data from respondents systematically. Documentation studies are carried out to supplement the field data with written information, such as school reports and other official documents.

- c. **Design of Fuzzy AHP Based Evaluation System**
This stage combines the Fuzzy Logic and Analytical Hierarchy Process (AHP) methods in calculating the weights of the criteria. Fuzzy Logic is used to convert qualitative judgments into quantitative, processable numbers, whereas AHP provides a framework for systematically determining priority weights. The integration of these two methods results in an evaluation system that is able to accommodate the uncertainty of the assessment and provide more accurate and consistent results.

2.2 AHP Fuzzy Method Flow

The process flow is described in the following flowchart image. This flowchart displays the steps taken starting from determining criteria, collecting data, converting values into fuzzy numbers, to calculating weights and determining rankings. A detailed explanation of each step on the flowchart will help the reader understand how the Fuzzy AHP method is systematically applied in this study.

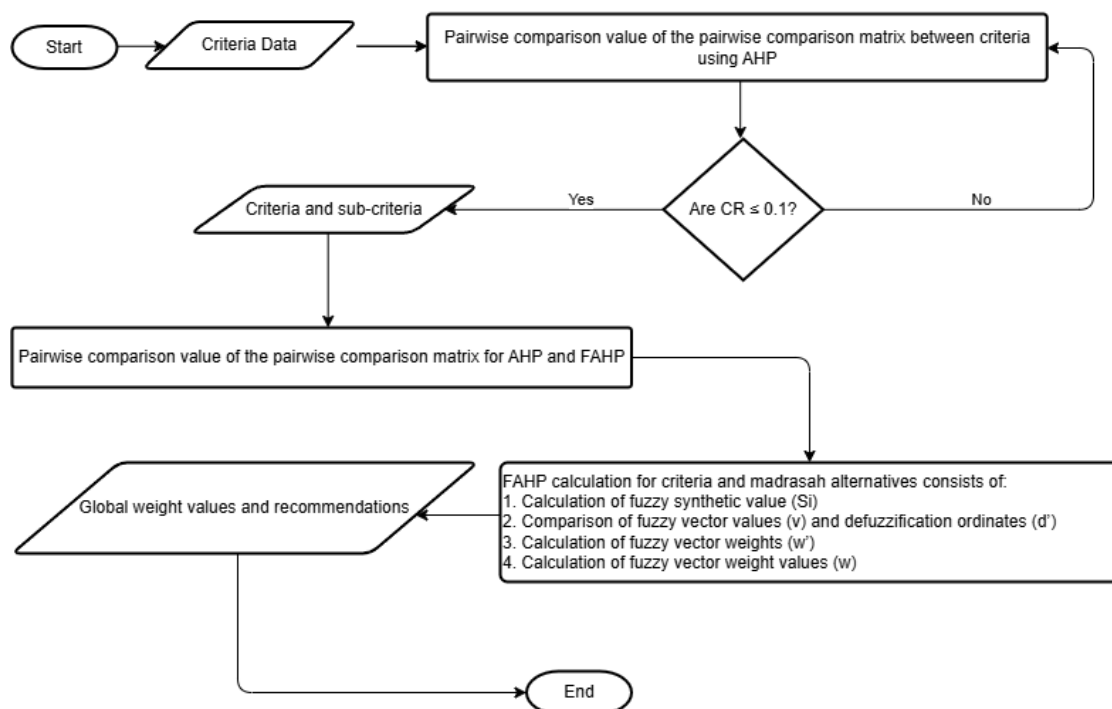


Figure 2. AHP Fuzzy Method Flowchart

The detailed stages of the Fuzzy AHP method describe the sequence of processes carried out in this study, starting from determining criteria to determining the final ranking of madrasahs. Each stage is interconnected and designed to produce an accurate and objective evaluation. By following these stages systematically, the assessment process can be carried out consistently and the results can be used as a basis for strategic decision-making. The detailed stages are explained as follows:

a. Determination of Criteria

The formulation of the assessment criteria in this study was carried out through a combination of literature review, regulatory analysis, and expert judgment. Previous studies on education quality evaluation and the application of AHP/FAHP methods were reviewed to identify relevant indicators, while national education regulations, including Law No. 20 of 2003 on the National Education System, Government Regulation No. 19 of 2005, and Government Regulation No. 57 of 2021 on National Education Standards, were analyzed to ensure consistency with established quality standards. Furthermore, expert judgment was obtained through interviews with the Head of the Madrasah Education Section and several madrasah principals in Kerinci Regency, so that the criteria selected would reflect the actual conditions of madrasah education. Based on this process, nine main criteria (K1–K9) and their respective subcriteria were formulated as presented in Table 1.

Table 1 Criteria and Subcriteria

Code	Criteria	Subcriteria for Assessment
K1	Teacher Quality	1) Very competent, 2) Competent, 3) Fairly competent, 4) Less competent, 5) Not competent
K2	Teaching Materials	1) Very complete, 2) Complete, 3) Fairly complete, 4) Less complete, 5) Not complete
K3	Infrastructure	1) Very adequate, 2) Adequate, 3) Fairly adequate, 4) Less adequate, 5) Not adequate

Code	Criteria	Subcriteria for Assessment
K4	Governance Management	1) Very good, 2) Good, 3) Fairly good, 4) Less good, 5) Not good
K5	Learning Environment	1) Very conducive, 2) Conducive, 3) Fairly conducive, 4) Less conducive, 5) Not conducive
K6	Assessment System	1) Very objective, 2) Objective, 3) Fairly objective, 4) Less objective, 5) Not objective
K7	Principal's Leadership	1) Very visionary, 2) Visionary, 3) Fairly visionary, 4) Less visionary, 5) Not visionary
K8	Parental Support	1) Very high, 2) High, 3) Fairly high, 4) Low, 5) Very low
K9	Technology & Digitalization	1) Very good, 2) Good, 3) Fairly good, 4) Less good, 5) Not good

b. Pairwise Comparison

At this stage, the respondents were asked to compare the relative importance of each criterion (K1–K9) with respect to the goal of evaluating madrasah education quality. Pairwise comparison was carried out by constructing a square comparison matrix in which each criterion was compared to every other criterion. For example, Teacher Quality (K1) was compared with Teaching Materials (K2), Infrastructure (K3), and the remaining criteria, and so on until all comparisons were completed. The judgments were expressed using the Saaty fundamental scale ranging from 1 to 9, where a value of 1 indicates that both criteria are equally important, 3 indicates moderate importance of one criterion over another, 5 indicates strong importance, 7 indicates very strong importance, and 9 indicates extreme importance. Intermediate values of 2, 4, 6, and 8 were used to express compromise judgments. If criterion *i* was judged more important than criterion *j*, the corresponding entry a_{ij} was assigned according to the scale, while the

reciprocal $a_{ij} = 1/a_{ji}$. Since this study applies the Fuzzy AHP approach, each crisp value from the Saaty scale was further transformed into a Triangular Fuzzy Number (TFN) to handle uncertainty in respondents' judgments. For instance, the crisp value "5 = strongly important" was converted into a TFN (4, 5, 6). These fuzzy pairwise comparisons were then used to calculate the fuzzy synthesis value of each criterion.

c. Competency Test

The competency or consistency test is conducted to ensure that the pairwise comparisons provided by respondents are logically consistent [29]. Inconsistencies may occur if the judgments contradict each other, for example, if Criterion A is more important than Criterion B, Criterion B is more important than Criterion C, but Criterion C is also more important than Criterion A. To measure consistency, the following steps are carried out:

- i. Calculate the maximum eigenvalue (λ_{max}) of the pairwise comparison matrix. This value reflects the degree of consistency in respondents' assessments.

- ii. Compute the Consistency Index (CI) using the formula:

$$CI = \frac{\lambda_{max} - n}{n - 1} \quad (1)$$

where n is the number of criteria (in this study, $n = 9$).

- iii. Determine the Consistency Ratio (CR) by dividing CI by the Random Index (RI):

$$CR = \frac{CI}{RI} \quad (2)$$

The RI value is a standard constant depending on the matrix size (for $n = 9$, $RI = 1.45$ based on Saaty's table).

- iv. If $CR < 0.1$, the matrix is considered consistent, and the respondents' judgments can be used in further analysis. If $CR \geq 0.1$, the comparisons must be revised to improve consistency.

In this study, the calculation of CI and CR for all pairwise comparison matrices resulted in CR values below 0.1, indicating that respondents' assessments were consistent and reliable for further processing in the Fuzzy AHP method.

d. Fuzzy Synthesis Value (S_i)

In the Fuzzy AHP method, the pairwise comparison judgments expressed as Triangular Fuzzy Numbers (TFN) are aggregated to obtain the fuzzy synthesis value for each criterion. The fuzzy synthesis value S_i for the i -th criterion is calculated as:

$$S_i = \frac{\sum_{j=1}^n M_{ij}}{\sum_{i=1}^n \sum_{j=1}^n M_{ij}} \quad (3)$$

Where:

- i. M_{ij} represents the fuzzy comparison value of criterion i against criterion j ,
- ii. n is the total number of criteria (in this study, $n = 9$).

The numerator is the sum of all fuzzy comparison values for a given criterion, while the denominator is the sum of all fuzzy comparison values across all criteria. For example, the fuzzy synthesis value for Teacher Quality (K1) was obtained by summing all fuzzy judgments where K1 was compared against other criteria (K2–K9), and then dividing by the total sum of fuzzy comparisons for all criteria. As a result, K1 received the highest fuzzy synthesis value, indicating that it is the most influential factor in determining madrasah education quality.

e. Degree of Probability (V)

Degrees of probability are calculated to compare each criterion using the formula:

$$V(S_i \geq S_j) = \begin{cases} 1, & \text{if } m_i \geq m_j \\ 0, & \text{if } l_j \geq u_i \\ \frac{l_j - u_i}{(m_i - u_i) - (m_j - l_j)}, & \text{otherwise} \end{cases} \quad (4)$$

where S_i and S_j are the fuzzy synthesis values of criteria i and j . This stage aims to determine how likely one criterion is to be more important than another. The results of this study showed that Teacher Quality (K1) and Principal's Leadership (K7) obtained the highest probabilities compared to the other criteria, indicating that these two criteria are the most dominant in influencing the quality of madrasah education. On the other hand, Parental Support (K8) and Assessment System (K6) showed the lowest probability values, meaning that they are relatively less influential in determining education quality compared to the other criteria.

f. Fuzzy Vector Weights (w') and Normalization

After obtaining the degree of probability for each pair of criteria, the fuzzy vector weight (w') of each criterion is calculated. These weights are then normalized to ensure that the total weight of all criteria equals 1, making the results comparable. The normalization process is carried out by dividing each fuzzy vector weight by the total sum of all fuzzy vector weights, as expressed in the formula:

$$w_i = \frac{w'_i}{\sum w'_i} \quad (5)$$

where w_i is the normalized weight of criterion i . For example, if the fuzzy vector weights obtained

for three criteria were $w'_1 = 0.190$, $w'_2 = 0.153$, and $w'_3 = 0.117$, then their normalized weights would be calculated as:

$$w_1 = \frac{0.190}{0.190 + 0.153 + 0.117} = 0,38$$

$$w_2 = \frac{0.153}{0.190 + 0.153 + 0.117} = 0,30$$

$$w_3 = \frac{0.117}{0.190 + 0.153 + 0.117} = 0,23$$

This process was repeated for all nine criteria. As a result, Teacher Quality (K1 = 0.190) and Principal's Leadership (K7 = 0.190) had the largest normalized weights, while Assessment System (K6 = 0.000) and Technology & Digitalization (K9 = 0.000) had the smallest. These normalized values were then used as the basis for calculating the global weights of the alternatives (MA1–MA8).

g. Global Weights & Rankings

In the stage of determining the Global Weights and Rankings, the global weight of each alternative is obtained by multiplying the normalized weight of each criterion (derived from FAHP) with the corresponding local weight of the alternative under that criterion, and then summing up all these products. In other words, every criterion contributes proportionally to the final score according to its assigned importance. The higher the weight of a criterion, the stronger its influence on the overall global weight of an alternative. For instance, for Madrasah 2 (MA2), the weight of criterion K1 is 0.190 and the local weight of MA2 under K1 is 0.193. The multiplication of these two values gives a contribution of 0.0367. This procedure is repeated for all criteria (K1 to K9), and the results are summed, yielding a global weight for MA2 of 0.1562. This value indicates that MA2 has the highest overall score among the alternatives and is therefore ranked first. The same process was applied to the other alternatives. Both MA1 and MA3 resulted in the same global weight of 0.1553, which places them jointly in the second rank. MA4 achieved a value of 0.1287 (third rank), MA7 and MA8 both obtained 0.1126 (fourth rank), MA5 reached 0.0981 (fifth rank), while MA6, with a score of 0.0819, occupied the

lowest position. Thus, the global ranking provides a more comprehensive evaluation as it accounts for both the criterion weights (from FAHP) and the local weights of each alternative. This ensures that the final ranking reflects the overall performance across all relevant aspects rather than being based on a single dimension.

3. Results and Discussion

3.1 Research Results

This research produced a model for evaluating the quality of aliyah madrasah education based on the Fuzzy Analytical Hierarchy Process (Fuzzy AHP) method which integrates qualitative and quantitative assessments objectively. The assessment was carried out on eight aliyah madrasahs in Kerinci Regency based on nine main criteria, namely teacher quality, teaching materials, facilities and infrastructure, school governance or management, learning environment, evaluation system, principal's leadership, parental support, and technology and digitalization. This model is designed to provide a comprehensive overview of the quality of education in each madrasah, so that the results can be a reference in the preparation of a targeted quality improvement strategy.

The calculation process includes the conversion of linguistic values to the form of Triangular Fuzzy Number (TFN), the calculation of the fuzzy synthesis value (Si), the determination of the degree of probability, the normalization of the weight of the criteria, and the determination of the global weight. All of these stages are carried out systematically to ensure that the results obtained are accurate and accountable. The Consistency Ratio (CR) value across the comparison matrix was below the 0.1 threshold, indicating that respondents' assessments were consistent and feasible to use in subsequent analysis.

As shown in Table 1, nine criteria (K1–K9) were established to evaluate the quality of madrasah. For clarity, these codes are consistently used in the following analysis. Table 2 presents the local weights of each alternative with respect to the defined criteria.

Table 2 Global Weights

Criterion	Weighting Criteria	MA1	MA2	MA3	MA4	MA5	MA6	MA7	MA8
K1	0,190	0,193	0,193	0,193	0,084	0,084	0,084	0,084	0,084
K2	0,153	0,193	0,193	0,193	0,084	0,084	0,084	0,084	0,084
K3	0,117	0,157	0,072	0,157	0,157	0,072	0,072	0,157	0,157
K4	0,117	0,146	0,146	0,146	0,146	0,061	0,061	0,146	0,146
K5	0,117	0,125	0,125	0,125	0,125	0,125	0,125	0,125	0,125
K6	0,000	0,237	0,088	0,088	0,088	0,088	0,088	0,237	0,088
K7	0,190	0,157	0,157	0,157	0,157	0,157	0,072	0,072	0,072
K8	0,117	0,079	0,171	0,079	0,171	0,079	0,079	0,171	0,171
K9	0,000	0,088	0,088	0,088	0,237	0,088	0,088	0,237	0,088
Global Weight	-	0,1554	0,1562	0,1554	0,1285	0,0980	0,0818	0,1123	0,1123
Ranking	-	2	1	2	3	5	6	4	4

Based on the global weight obtained from the calculation results, MA2 ranks first with a value of 0.1562. The next ranking is occupied by MA1 and MA3 in second place, followed by MA4 in third place, MA7 and MA8 in fourth place, MA5 in fifth place, and

MA6 in last position. These results show that there is a variation in the quality of education achievement between madrasas, which can be used as a basis for determining the priorities of coaching programs and quality improvement in a more targeted manner.

3.2 Discussion

These results indicate that the criteria for teacher quality (K1) and the leadership of school principals (K7) have the greatest weight in determining the quality of madrasah education. These two factors have a significant influence because they play a direct role in shaping the quality of the learning process, teacher motivation, student discipline, and the direction of madrasah management policies. These findings emphasize that improving teacher competence and strengthening the leadership capacity of school principals are strategic steps that can have a real impact on improving the overall quality of education.

MA2 achieved the highest score thanks to the consistency of high performance on both dominant criteria, namely teacher quality (K1) and principal leadership (K7), accompanied by good support on other criteria such as teaching materials and learning environment. This combination of strength in the aspect of human resources and the educational environment makes MA2 able to maintain quality as a whole. In contrast, MA6, which is ranked last, has low scores on most of the main criteria, especially teacher quality and leadership, so it requires a more intensive coaching program focused on increasing the capacity of educators and strengthening madrasah management.

The Fuzzy AHP method in this study has proven to be effective in integrating qualitative and quantitative data in the evaluation process. This approach is able to reduce the subjectivity bias that often arises in perception-based assessments, so that the results obtained become more accurate and accountable. With these advantages, this method provides results that are worthy of being used as a basis for strategic policy-making by madrasah managers and related agencies in an effort to improve the quality of education in a sustainable manner.

4. Conclusion

This research has succeeded in developing a model for evaluating the quality of aliyah madrasah education based on the Fuzzy Analytical Hierarchy Process (Fuzzy AHP) method which is able to integrate qualitative and quantitative data in an objective, systematic, and structured manner. The results of the study show that the criteria for teacher quality and the leadership of school principals have a dominant weight in determining the quality of education, so that it is the main focus in the strategy to improve the quality of madrasahs. This model has been proven to be effective with a Consistency Ratio (CR) value of < 0.1 , and is able to produce accurate and consistent madrasah rankings, where MA2 ranks highest with a global weight value of 0.1562.

The main contribution of this research is the provision of multi-criteria based evaluation tools that can be used by madrasah managers and related agencies as a basis






for policy making that is responsive to local needs. With this system, the assessment process can be carried out in a sustainable manner, reducing subjective bias, and making it easier to plan coaching programs that are more targeted. In the future, this model can be adapted and developed for other educational contexts, with adjustments to criteria according to the needs of each educational unit.









References

- [1] Baitiyah, A. K. Nafilah, and Mabnunah, "Strategi Pengembangan Pendidikan Madrasah di Bangkalan (Sinergi Tradisi dan Modernitas)," *J. Dimens. Pendidik. dan Pembelajaran*, vol. 12, no. 1, 2024.
- [2] A. Ghofur, F. Choiriyah, M. Nashrullah, B. Purwoko, and Budiyanto, "ANALISIS PENDIDIKAN KARAKTER MELALUI KURIKULUM MADRASAH IBTIDAIYAH (MI)," *Learn. J. Inov. Penelit. Pendidik. dan Pembelajaran*, vol. 4, no. 4, pp. 1128–1135, 2024, [Online]. Available: <https://jurnalp4i.com/index.php/learning>
- [3] A. Rohman *et al.*, "Challenges in Islamic Education Curriculum Development: A Comparative Study of Indonesia, Pakistan, and India," *Int. J. Learn. Teach. Educ. Res.*, vol. 23, no. 6, pp. 504–523, 2024, doi: 10.26803/ijlter.23.6.23.
- [4] S. Solekha, Purwati, and Nurkolis, "KEBIJAKAN ASESMEN KOMPETENSI MINIMUM," *DE JOURNAL (Dharmas Educ. Journal)*, vol. 5, no. 2, pp. 972–979, 2024, [Online]. Available: http://ejournal.undhari.ac.id/index.php/de_journal
- [5] A. Hasanah, "Penguatan Karakter Kebangsaan Melalui Pendekatan Integratif pada Mapel Rumpun PAI di Madrasah," *Edukasi Islam. J. Pendidik. Islam*, vol. 11, no. 1, pp. 741–752, 2022, doi: 10.30868/ei.v11i01.1900.
- [6] Y. A. Tobondo, "Challenges and Solutions in the Implementation of Educational Policies in Indonesia: A Literature Analysis of Merdeka Belajar Kampus Merdeka and Teacher Reform," *EDUKASIA J. Pendidik. dan Pembelajaran*, vol. 5, no. 1, pp. 1157–1164, 2024, doi: 10.62775/edukasia.v5i1.997.
- [7] Pemerintah Pusat, *Undang-undang (UU) Nomor 20 Tahun 2003 tentang Sistem Pendidikan Nasional*. 2003. doi: 10.24967/ekombis.v2i1.48.
- [8] Peraturan Pemerintah, *Peraturan Pemerintah (PP) Nomor 19 Tahun 2005 tentang Standar Nasional Pendidikan*. 2005.
- [9] Peraturan Pemerintah, *Peraturan Pemerintah (PP) Nomor 57 Tahun 2021 tentang Standar Nasional Pendidikan*. 2021.
- [10] U. Kulsum and A. Muhid, "Pendidikan Karakter melalui Pendidikan Agama Islam di Era Revolusi Digital," *J. Intelekt. J. Pendidik. dan Stud. Keislam.*, vol. 12, no. 2, pp. 157–170, 2022, doi: 10.33367/ji.v12i2.2287.
- [11] R. D. Hasiholan and W. Silahahi, "Analisis Kualifikasi Hukum terhadap Penyalahgunaan Teknologi Artificial Intelligence dalam Penggandaan Citra Masyarakat," *Artic. J. Tana Mana*, vol. Vol. 4 No., no. 1, pp. 1–3, 2023, [Online]. Available: <https://ojs.staialfurqan.ac.id/jtm/>
- [12] Saiddaeni, A. A. Zulfandika, A. A. Fitriana, F. N. A. Nugroho, and I. N. Huda, "Meningkatkan Kemampuan Skill Membaca dan Berfikir Kritis Menghadapi Ancaman AI di Era Digital Semakin Modern," vol. 7, pp. 589–596, 2024.

- [13] S. H. Qurrahman, S. Ayunil, and T. A. Rahim, "Kedudukan dan Konsep Pertanggungjawaban Artificial Intelligence dalam Positif Hukum Indonesia," *J. Huk.*, vol. 12, no. 1, pp. 45–60, 2024.
- [14] M. Fikri Hanif, H. Sasty Pratiwi, and J. H. Hadari Nawawi, "Analisis Perbandingan Single Membership Function dan Double Membership Function pada Diagnosis Penyakit ISPA," vol. 10, no. 1, pp. 144–153, 2024.
- [15] M. Gusvarizon, P. T. S. Ningsih, and A. D. Prasetyo, "Perancangan Sistem Pendukung Keputusan Pemilihan Karyawan Terbaik dengan Metode Analytical Hierarchy Process pada PT Hyper Mega Shipping," *J. Teknol. Inform. dan Komput.*, vol. 8, no. 2, pp. 416–430, 2022, doi: 10.37012/jtik.v8i2.1311.
- [16] A. Fitriani Sahe, A. Faisol, and R. Primaswara Prasetya, "Penerapan Metode Fuzzy Ahp Pada Sistem Pendukung Keputusan Penerima Bantuan Pkh Di Desa Ndiwar Kabupaten Manggarai Berbasis Website," *JATI (Jurnal Mhs. Tek. Inform.)*, vol. 7, no. 1, pp. 928–933, 2023, doi: 10.36040/jati.v7i1.6193.
- [17] E. A. Yuanita, P. Deoranto, A. Hidayat, R. Septifani, and W. G. Rohmah, "Waste analysis of coated peanut production using Fuzzy Analytical Hierarchy Process (Fuzzy AHP)," *Afssaae*, pp. 123–133, 2023, [Online]. Available: <https://afssaae.ub.ac.id/index.php/afssaae/article/view/2092>
- [18] V. I. Ramadhanti and F. Pulansari, "Integration of fuzzy AHP and fuzzy TOPSIS for green supplier selection of mindi wood raw materials," *J. Sist. dan Manaj. Ind.*, vol. 6, no. 1, pp. 1–13, 2022, doi: 10.30656/jsmi.v6i1.4332.
- [19] H. Do Quang, T. T. Van, and T. T. The, "Evaluating lecturer performance in Vietnam: An application of fuzzy AHP and fuzzy TOPSIS methods," *Heliyon*, vol. 10, no. 11, p. e30772, 2024, doi: 10.1016/j.heliyon.2024.e30772.
- [20] I. Perić, K. Klarić, A. Pirc Barčić, K. Vukman, T. Sedlar, and P. Grošelj, "Optimising Risk Management in Wood-based Manufacturing: A Fuzzy AHP-FMEA Framework Approach," *BioResources*, vol. 20, no. 2, pp. 2979–3001, 2025, doi: 10.15376/biores.20.2.2979-3001.
- [21] B. Mârza, R. Bratu, R. Şerbu, S. Stan, and C. Oprean-Stan, "Applying ahp and fuzzy ahp management methods to assess the level of financial and digital inclusion," *Econ. Comput. Econ. Cybern. Stud. Res.*, vol. 55, no. 4, pp. 165–182, 2021, doi: 10.24818/18423264/55.4.21.11.
- [22] J. G. Mestanza and R. Bakhat, "A Fuzzy AHP-MAIRCA Model for Overtourism Assessment: The Case of Malaga Province," 2021.
- [23] Murnawan, S. Lestari, and R. Samihardjo, "Penerapan Metode F-AHP dan F-TOPSIS Dalam Proses Seleksi Karyawan Untuk Bidang Teknologi Informasi," *Teknika*, vol. 13, no. 1, pp. 35–44, 2024, doi: 10.34148/teknika.v13i1.688.
- [24] I. Ali, V. Gunawan, and K. Adi, "Land-use suitability evaluation for organic rice cultivation using fuzzy-AHP ELECTRE method," *Regist. J. Ilm. Teknol. Sist. Inf.*, vol. 7, no. 1, pp. 1–15, 2021, doi: 10.26594/register.v7i1.2080.
- [25] A. A. A. D. Aflahin, M. I. A. Fathoni, and F. Cindarbumi, "Penerapan Sistem Pendukung Keputusan (Spk) Dengan Menggunakan Metode Fuzzy Ahp (Analytical Hierarchy Process) Sebagai Penentuan Penerima Beasiswa Pip," *J. Lebesgue J. Ilm. Pendidik. Mat. Mat. dan Stat.*, vol. 4, no. 3, pp. 1452–1467, 2023, doi: 10.46306/lb.v4i3.411.
- [26] Dinda Helma Saputry and R. S. Wahyuni, "Analisis Pendukung Keputusan Pemilihan Benih Tomat untuk Pertanian Perkotaan Menggunakan Analytical Hierarchy Process (AHP)," *J. KomtekInfo*, vol. 11, pp. 71–79, 2024, doi: 10.35134/komtekinfo.v11i3.520.
- [27] P. R. Sihombing, A. M. Arsani, R. C. Puspitasari, and H. W. Wiranegara, *Analytical Hierarchy Process (AHP) dalam Berbagai Software*. 2024. doi: 10.1002/9781118644898.ch2.
- [28] M. Ashek-Al-Aziz, S. Mahmud, M. Azizul Islam, J. Al Mahmud, and K. Md Hasib, "A Comparative Study of AHP and Fuzzy AHP Method for Inconsistent Data," *Int. J. Sci. Basic Appl. Res.*, vol. 54, no. 4, pp. 16–37, 2020, [Online]. Available: <http://gssrr.org/index.php?journal=JournalOfBasicAndApp> lied
- [29] N. A. H. Nadia, G. W. Nurcahyo, and A. Ramadhanu, "Metode AHP dan WASPAS untuk Menentukan Prioritas Pegawai Pemerintah dengan Perjanjian Kerja (PPPK)," *J. KomtekInfo*, vol. 11, no. 4, pp. 306–313, 2024, doi: 10.35134/komtekinfo.v11i4.568.

Biographies of Authors

	<p>Muhammad Yusril Haffandi     Muhammad Yusril Haffandi, S.T., born in Koto Baru Hiang on April 17, 2000, is a Master's student in Computer Engineering at Universitas Putra Indonesia "YPTK" Padang, originally from Kerinci Regency, Jambi Province. He completed his Bachelor's degree in Computer Engineering at Sultan Syarif Kasim State Islamic University of Riau. He can be contacted via email at myusrilhaffandi@gmail.com. He is currently working as a Technical Staff at the Office of the Ministry of Religious Affairs of Kerinci Regency. His current field of expertise is Intelligent Systems.</p>
-------------------------------------------------------------------------------------	----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

	<p>Gunadi Widi Nurcahyo    Assoc. Prof. Dr. Ir. Gunadi Widi Nurcahyo, M.Sc. was born in Temanggung, 14 March 1969. He was graduated Bachelordegree in Informatics Management at Universitas Putra Indonesia YPTK Padang in 1992.He completed his Master and PhD in Computer Science at Universiti Teknologi Malaysia in2003. Scopus Id is 57200563356. E-mail: gunadiwidi@yahoo.co.id</p>
	<p>Billy Hendrik    Billy Hendrik, S.Kom., M.Kom., Ph.D., is a male, born on March 18, 1983. He earned his Bachelor's degree from the Faculty of Computer Science, majoring in Computer Engineering, followed by a Master's degree in Information Technology at Universitas Putra Indonesia YPTK Padang, and a Doctoral degree at Universiti Kebangsaan Malaysia. He teaches at Universitas Putra Indonesia "YPTK" Padang. His expertise includes Technology, Education, and Robotics. He is currently active as the Deputy Head of the Student and Alumni Affairs Bureau and serves as the Chairman of the Madinah Islamic Education Foundation. The author conducts research in the field of Robotics and its applications in Education. He is also an active contributor of articles to various national and international scientific journals. Phone contact 085272557211, email address billy_hendrik@upiptk.ac.id.</p>