

# Assessment of Barriers and Strategies for Halal Certification Adoption in MSMEs Using the Fuzzy AHP - Fuzzy TOPSIS Method

Dana Marsetiya Utama <sup>a\*</sup>, Tyas Yuli Rosiani <sup>a</sup>, Dwi Restu Wijaya <sup>a</sup>, Rahmad Wisnu Wardana <sup>a</sup>

<sup>a</sup> Department of Industrial Engineering, University of Muhammadiyah Malang, Indonesia

\* Corresponding author: [dana@umm.ac.id](mailto:dana@umm.ac.id)

## ARTICLE INFO

### Article history

Received, December 31, 2024

Revised, July 31, 2025

Accepted, August 11, 2025

Available Online, August 31, 2025

### Keywords

Halal Certification

MSMEs

Barriers

Strategies

Fuzzy AHP

Fuzzy TOPSIS

## ABSTRACT

The adoption of halal certification in the Micro, Small, and Medium Enterprises (MSME) sector in Indonesia remains low despite it being a legal requirement, creating a gap between regulations and implementation in the field. This study aims to identify and rank the primary barriers that hinder the adoption of halal certification and to determine priority strategies for overcoming them. The methodology used is the integration of the Fuzzy Analytical Hierarchy Process (Fuzzy AHP) method for determining the weight of obstacles and the Fuzzy Technique for Order Preference by Similarity to Ideal Solution (Fuzzy TOPSIS) for strategy ranking, based on expert survey data and field studies on food MSMEs in Malang City. The results show that the most significant barriers are limited human resources, lack of knowledge, and difficulties in meeting documentation requirements. The most effective strategies to overcome these barriers are increasing education and socialization, strengthening collaboration with stakeholders, and simplifying the certification process. This study makes theoretical contributions through the integrative application of the Fuzzy method in multi-criteria decision-making, as well as practical contributions in formulating more targeted policies and assistance programs for MSMEs. These findings support the acceleration of halal certification and increased competitiveness of MSME products in domestic and global markets.



This is an open access article under the [CC-BY-SA](https://creativecommons.org/licenses/by-sa/4.0/) license.



## 1. Introduction

The adoption of halal certification in Micro, Small, and Medium Enterprises (MSMEs) is of high urgency due to its strategic role in driving business growth and competitiveness in both domestic and global markets. Halal certification is not only a means of fulfilling basic needs for Muslim consumers [1], but also an important tool in building a positive reputation and brand image among consumers [2]. Halal-certified products offer clear differentiation, added value, and a significant competitive advantage



<https://doi.org/10.22219/JTIUMM.Vol26.No2.239-260>



<http://ejournal.umm.ac.id/index.php/industri>



[ti.jurnal@umm.ac.id](mailto:ti.jurnal@umm.ac.id)

in the market [3]. Furthermore, the existence of halal certification can increase consumer confidence in product safety, hygiene, and quality [4]. In this context, halal certification is not only religious in dimension, but also closely related to the principles of food safety and quality standards that are widely recognized [5]. The global demand for halal products is increasing as the world's Muslim population grows and awareness of product quality and safety improves [6]. According to the "State of Global Islamic Economy Report 2022", the spending level of Muslim consumers worldwide reached USD 2 trillion in 2021. It is expected to continue to grow to USD 2.8 trillion by 2025 [7]. This opportunity presents an excellent potential for Indonesian MSMEs to expand their market reach, not only domestically but also in export markets that require certainty of halal assurance. However, the implementation of halal certification among MSMEs still faces various structural and technical obstacles [8]. To overcome this condition, a thorough understanding of the obstacles faced by MSMEs in adopting halal certification is necessary. This step is crucial to increase business actors' understanding of certification procedures, long-term benefits, and to overcome technical obstacles that can hinder MSME participation. Thus, strategies to increase the adoption of halal certification will have a direct impact on improving the competitiveness of MSMEs [9], and strengthening their contribution in driving inclusive and sustainable national economic growth.

The primary issue that needs to be addressed immediately in the context of halal certification adoption in MSMEs is the low level of participation by business actors in obtaining this certification. This lack of adoption is due to various significant barriers, such as a lack of knowledge about halal certification procedures [10], low ability to access digital services [11], limited socialization activities [12], weak response to applicable regulations [13], and inadequate supporting facilities for the certification process [14]. These conditions have serious consequences for the ability of MSMEs to grow and compete, and prevent them from accessing the growing global halal market. Suppose these barriers are not identified and overcome immediately. In that case, MSMEs will be left behind in market competition, experience stagnation in growth, and lose the potential to make optimal contributions to the national economy. Therefore, solving the problem of halal certification must be done systematically through a thorough assessment of obstacles and selection of the most effective and applicable strategies. This step is needed to create an inclusive and conducive business ecosystem for MSMEs in obtaining halal certification, expanding market access, and encouraging sustainable improvements in community welfare.

Previous studies have made important contributions to understanding the barriers faced by MSMEs in adopting halal certification. The article [15] employs a fuzzy DEMATEL approach to assess barriers to the adoption of halal certification in India, highlighting the cause-and-effect relationship between factors influencing the certification process. Meanwhile, the research in the article [10] employs the PLS-SEM method to investigate the level of awareness of halal certification among food sector MSMEs in West Java, highlighting the significant role of knowledge and perceptions among business actors. Furthermore, the article [16] explores the factors inhibiting halal certification in the food service industry in East Kalimantan through a qualitative approach, which provides in-depth descriptions of the perceptions of business actors towards the obstacles they face. On the other hand, the article [17] highlights the challenges of implementing halal certification in food industry MSMEs in Malaysia, including regulatory barriers and limited resources. While all these studies have provided valuable insights into the dynamics of halal certification adoption, most of them are still limited to the use of a single methodological approach and have not comprehensively incorporated various evaluation techniques capable of handling uncertainty and data vagueness in the context of complex

multi- criteria decision-making. Therefore, a more holistic and systematic approach is needed to provide more accurate, reliable, and applicable results in formulating strategies to increase the adoption of halal certification among MSMEs.

Although various previous studies have contributed to identifying barriers to the adoption of halal certification in MSMEs, there are still fundamental shortcomings that have not been adequately answered in the existing literature. In general, the approaches used in previous studies tend to be limited to one method of analysis, either qualitative or quantitative, without integrating methods that can handle complexity and uncertainty in the decision-making process. In the context of formulating strategies to increase the adoption of halal certification, the uncertainty and ambiguity of data pose real challenges, primarily when information is based on the perceptions of experts or business actors, which are inherently linguistic and subjective. However, most previous studies have not utilized fuzzy-based quantitative approaches specifically designed to accommodate such uncertainty in multi-criteria decision making. Furthermore, previous studies have not simultaneously combined constraint assessment and strategy selection within an integrated analytical framework. This has resulted in the absence of a strong analytical foundation for developing well-targeted and evidence-based policies or strategic interventions. This lack of a holistic approach is an important gap that must be addressed immediately to support the acceleration of halal certification in the MSME sector. Therefore, research is needed that not only identifies and evaluates barriers, but also formulates and prioritizes strategies for solving them with an integrative, high-precision approach, and can process linguistic data through fuzzy methods. This approach will make a significant contribution to supporting efforts to accelerate, expand, and optimize the adoption of halal certification in the MSME sector in a structured, effective, and sustainable manner.

This study aims to identify and rank the barriers to the adoption of halal certification in MSMEs and determine the priority order of the most effective strategies to overcome them. To achieve these objectives, this research adopts a combined approach of the Fuzzy Analytical Hierarchy Process (AHP) and the Fuzzy Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) methods, which have been proven to provide a systematic and comprehensive evaluation framework in the context of complex multi-criteria decision-making [18]. This approach not only enables the quantitative prioritization of barriers and strategies but is also effective in dealing with the uncertainty and subjectivity inherent in data derived from expert and business opinions [19]. Thus, this research makes a significant contribution to enriching the literature in the field of quality management and halal certification, particularly through the integration of fuzzy-based decision-making methods that have been rarely used simultaneously in previous studies. In addition to theoretical contributions, the results of this study also provide practical guidance for MSME actors in recognizing and overcoming the obstacles they face, as well as supporting the formulation of more targeted government policies in encouraging the improvement of the competitiveness of Indonesian halal products, both in the domestic market and the growing international market.

## 2. Literature Review

Table 1 summarizes several previous studies related to halal certification and its application in various industrial sectors. The study [15] evaluates the barriers to the adoption of halal certification in India using the Fuzzy DEMATEL method. In contrast, the study [10] analyzes the awareness level of food sector MSMEs in Indonesia through a PLS-SEM approach. The inhibiting factors of halal certification in food services are



studied qualitatively in the study [16], while the study [17] addresses similar challenges in food MSMEs in Malaysia. Other research focuses on the dynamics of implementing halal certification nationally [20], the urgency of halal certification in the cosmetics sector [21], and the obstacles faced by the pharmaceutical industry [22]. In addition to the product aspect, research [23] highlights women's economic empowerment through halal fashion, followed by a study [24] that examines the effect of halal certification and awareness on purchasing decisions for halal fashion products. A comprehensive study of the challenges and opportunities in the halal industry in Indonesia has also been conducted [25]. All these studies provide an important foundation, but have not yet integrated the assessment of barriers and strategies in a multi-criteria decision-making-based analytical framework.

Table 1. Literature review

Research	Scope	Tools	Object	Country
[15]	Evaluation of barriers to halal certification adoption: a fuzzy DEMATEL approach	Fuzzy DEMATEL	-	India
[10]	Awareness and intention to apply for halal certification for micro and small-scale food businesses	PLS-SEM	MSMEs (focusing on the food industry)	Indonesia
[16]	Exploring various factors that hinder halal certification in the food service industry	Qualitative data	Restaurant and catering	Indonesia
[17]	Challenges in the implementation of halal certification among Small and Medium Enterprises (MSMEs)	Qualitative Study	MSMEs (focusing on the food industry)	Malaysia
[20]	Dynamics of halal certification implementation for business actors	Literature study approach	MSMEs	Indonesia
[21]	The urgency of halal certification for halal cosmetic brands in Indonesia	Qualitative methods	Cosmetic brands in Indonesia	Indonesia
[22]	Implementation and evaluation of the implementation of halal certification in the pharmaceutical industry in Indonesia	Analysis of legal regulations	Pharmaceutical products (drugs and vaccines)	Indonesia
[23]	Analysis of the role of halal fashion in women's economic empowerment	Descriptive qualitative	Market (focusing on the clothing industry)	Indonesia
[24]	The effect of halal certification, halal awareness, and product knowledge on purchasing decisions for halal fashion products	Quantitative	Fashion product consumers	Indonesia
[25]	Identification of challenges and opportunities in the development of the halal industry in Indonesia	Qualitative method and SWOT	Food, tourism, fashion, media, pharmaceutical, and cosmetic industries	Indonesia
This research	Identification barriers and Adoption halal certification	Fuzzy AHP- Fuzzy Topasis	MSMEs (focusing on the food industry)	Indonesia

### 3. Methods

This research employs a quantitative approach, utilizing the Fuzzy Analytical Hierarchy Process (Fuzzy AHP) and Fuzzy Technique for Order Preference by Similarity to Ideal Solution (Fuzzy TOPSIS) methods to analyze data on barriers and adoption strategies for halal certification in MSMEs. Fuzzy AHP overcomes the limitations of conventional AHP by using linguistic variables and fuzzy numbers to accommodate uncertainty in a more flexible decision-making process [26]. The application of Fuzzy TOPSIS accounts for uncertainty and ambiguity in judgment, enabling decision-makers to consider the subjective and sometimes imprecise nature of the criteria [27]. The integration of Fuzzy AHP and Fuzzy TOPSIS enables decision analysts to comprehend the evaluation process as a whole, providing more accurate, efficient, and systematic decision-making aids [28]. This approach was chosen to handle expert opinion-based data that is linguistically oriented and contains uncertainty. The stages of analysis are carried out sequentially and systematically, as shown in Figure 1, which presents the overall framework of the data processing process.

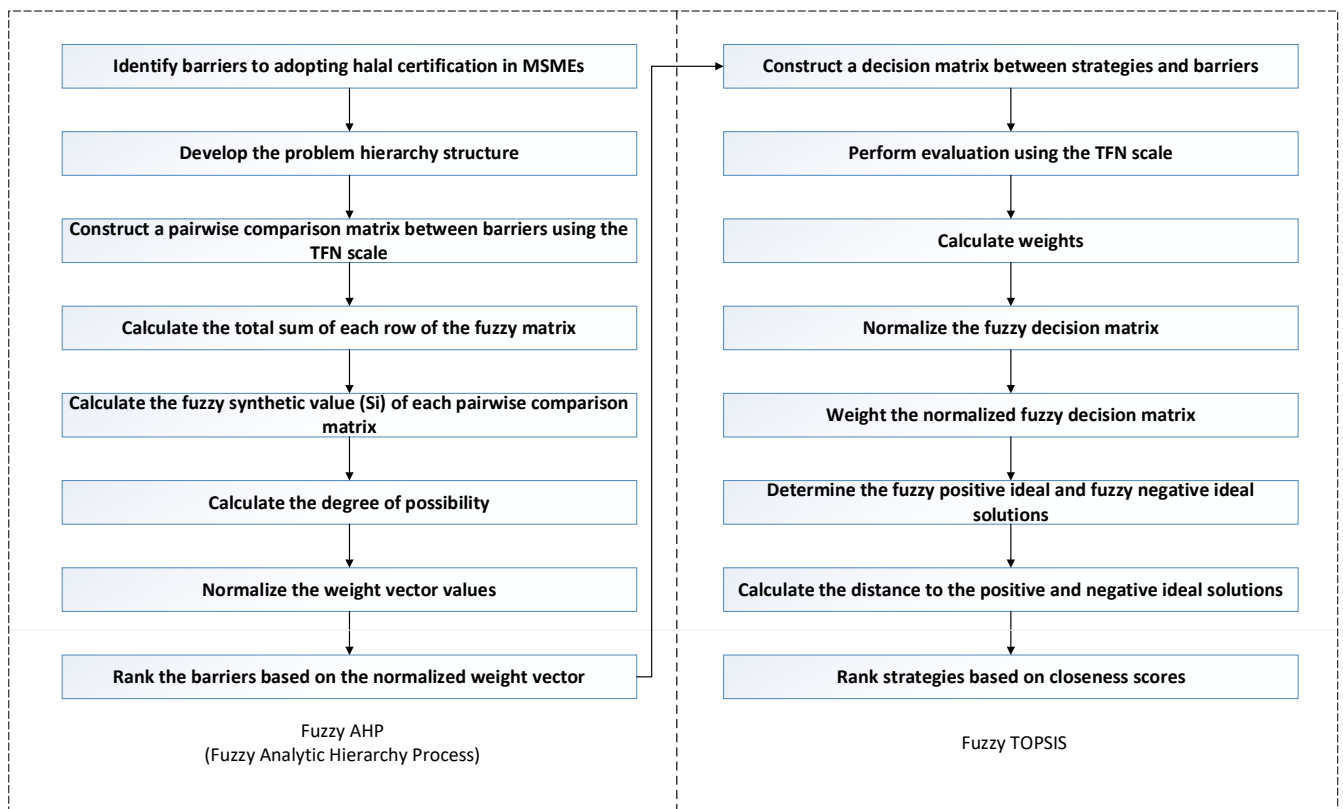


Figure 1. Framework of this research

#### 3.1 Fuzzy AHP

In this study, the method used to analyze barriers to the adoption of halal certification in MSMEs is Fuzzy Analytical Hierarchy Process (Fuzzy AHP). This method is a development of the Analytical Hierarchy Process (AHP) method combined with the concept of fuzzy set theory [29]. The purpose of this combination is to overcome the limitations of AHP in handling subjective and linguistic data. The fuzzy approach offers flexibility in measuring uncertain expert judgment by utilizing linguistic variables, which

are then converted into fuzzy numbers in the form of Triangular Fuzzy Numbers (TFNs) [30]. The conversion of AHP scale values to fuzzy numbers is performed using a standardized fuzzy logic approach [31]. The main advantage of the Fuzzy AHP method over conventional AHP lies in its ability to integrate quantitative and qualitative criteria into a comprehensive and reliable evaluation framework [32].

The fuzzy AHP model employed in this study is based on Chang's method [33]. The initial stage begins with forming a decision hierarchy structure, starting from the main objective, namely the identification of priority barriers to the adoption of halal certification, followed by relevant criteria and sub-criteria. Furthermore, the pairwise comparison matrix between barriers is compiled based on expert judgment, using a linguistic scale converted into a TFN, as shown in Table 2.

Table 2. Triangular Fuzzy Number Fuzzy AHP

Linguistic Variable	Description	Triangular Fuzzy Number	Reciprocal
EI	Both barriers are equally important	(1, 1, 1)	(1, 1, 1)
I (EI-MI)	Intermediate	(1/2, 1, 3/2)	(2/3, 1, 2)
MI	One barrier is moderately more important than the other	(1, 3/2, 2)	(1/2, 2/3, 1)
I (MI-SI)	Intermediate	(3/2, 2, 5/2)	(2/5, 1/2, 2/3)
SI	One barrier is more important than the other	(2, 5/2, 3)	(1/3, 2/5, 1/2)
I (SI-VS)	Intermediate	(5/2, 3, 7/2)	(2/7, 1/3, 2/5)
VS	One barrier is significantly more important than the other	(3, 7/2, 4)	(1/4, 2/7, 1/3)
I (VS-ES)	Intermediate	(7/2, 4, 9/2)	2/9, 1/4, 2/7)
ES	One barrier is absolutely more important than the other	(4, 9/2, 9/2)	2/9, 2/9, 1/4)

After the fuzzy matrix is formed, the next step is to calculate the total number of values for each row in the fuzzy matrix. If there are two criteria K1 and K2, then the total sum is calculated by Equation (1).

$$K_1 + K_2 = (l_1, m_1, u_1) + (l_2, m_2, u_2) = (l_1 + l_2, m_1 + m_2, u_1 + u_2) \tag{1}$$

The next step is to calculate the fuzzy synthesis value (Si) for each criterion using Equation (2).

$$Si = \sum_{j=1}^m M_i^j \times \frac{1}{\sum_{i=1}^n \sum_{j=1}^m M_i^j} \tag{2}$$

With components:

$$\sum_{j=1}^m M_i^j = \sum_{j=1}^m lj, \sum_{j=1}^m mj, \sum_{j=1}^m uj \tag{3}$$

$$\frac{1}{\sum_{j=1}^n \sum_{j=1}^m M_i^j} = \frac{1}{\sum_{i=1}^n ui, \sum_{i=1}^n mi, \sum_{i=1}^n li} \tag{4}$$

After the synthesis value is obtained, the next step is to calculate the degree of possibility between fuzzy synthesis values. If two fuzzy values,  $M_2 = (l_2, m_2, u_2)$  dan  $M_1 = (l_1, m_1, u_1)$ , then the probability vector value  $V(M_2 \geq M_1)$  is calculated by Equation (5).

$$V(M_2 \geq M_1) = \begin{cases} 1, & \text{if } m_2 \geq m_1, \\ 0, & \text{if } l_1 \geq u_2, \\ \frac{l_1 - u_2}{(m_2 - u_2) - (m_1 - l_1)}, & \text{others} \end{cases} \quad (5)$$

Suppose there are more than two fuzzy synthesis values. In that case, the value vector for each alternative is calculated by taking the minimum value of all comparisons can be seen in Equation (6).

$$\begin{aligned} V(M \geq M_1, M_2, \dots, M_k) &= V(M \geq M_1) \text{ and} \\ V(M \geq M_2) \text{ and } \dots V(M \geq M_k) &= \min V(M \geq M_i) \end{aligned} \quad (6)$$

Assume  $d'(A_i)$  is the minimum ordinate value of all comparisons for alternative  $A_i$  calculated by Equation (7).

$$d'(A_i) = \min V(S_i \geq S_k) \quad (7)$$

Furthermore, the unnormalized priority weight vector is expressed in Equation (8).

$$W' = (d'(A_1), d'(A_2), \dots, d'(A_n)) \text{ T} \quad (8)$$

After obtaining the fuzzy weights, a normalization process is carried out to ensure that the total weight equals one, using Equation (9).

$$W = (d(A_1), d(A_2), \dots, d(A_n)) \text{ T} \quad (9)$$

The final result of this process is a non-fuzzy priority weight for each barrier. These values serve as the basis for ranking the most significant barriers to the adoption of halal certification in MSMEs. With systematic stages and based on a strong theory, the application of the Fuzzy AHP method in this study provides a transparent and accountable quantitative basis for understanding the complexity of barriers to halal certification as a whole, while providing the numerical basis needed for the strategy selection stage through the Fuzzy TOPSIS method in the next stage.

### 3.2 Fuzzy TOPSIS

Fuzzy TOPSIS is a multi-criteria decision-making method used to rank alternatives based on their closeness to the ideal solution. This method is a development of the classic TOPSIS method, which allows decision-making to be done quickly and accurately according to the desired criteria [34]. The use of fuzzy TOPSIS accounts for uncertainty and vagueness in the assessment data through the fuzzy set theory approach, making it highly effective in various evaluation and ranking situations [35]. The assessment process is carried out systematically by identifying relevant criteria, assigning weights according to their importance, and calculating the proximity of each alternative to the ideal solution [36]. Fuzzy TOPSIS will rank alternatives based on the relative

closeness value to the positive ideal solution, so that the strategy with the highest score is considered the most optimal [37]. This research adopts the fuzzy TOPSIS model developed by Chen [38].

The first step in this method is to construct a fuzzy decision matrix that compares each strategy against the identified barriers based on expert judgment using linguistic scales converted into TFN as shown in Table 3. The assessment is carried out using fuzzy numbers in the form of triangular membership functions, with the notation  $(a_{ij}, b_{ij}, c_{ij})$  indicating the lower limit, middle value, and upper limit of the assessment of the strategy  $i$  on the criteria  $j$ . Furthermore, the weight of each criterion is calculated from the results of the experts' evaluation using Equation (10).

Table 3. Triangular Fuzzy Number Fuzzy TOPSIS

Linguistic TOPSIS	Linguistic set	Triangular Fuzzy Number
EI	Equal Importance	(1, 1, 1)
I (EI-MI)	Intermediate	(1/2, 1, 3/2)
MI	Moderately Important	(1, 3/2, 2)
I (MI-SI)	Intermediate	(3/2, 2, 5/2)
SI	Strongly Important	(2, 5/2, 3)
I (SI-VS)	Intermediate	(5/2, 3, 7/2)
VS	Very Strong	(3, 7/2, 4)
I (VS-ES)	Intermediate	(7/2, 4, 9/2)
ES	Extremely Strong	(4, 9/2, 9/2)

$$w_{j1} = \min k \{w_{j1}^k\}; w_{j2} = \frac{1}{k} \sum_{k=1}^k w_{j2}^k; w_{j3} = \max k \{c_{j3}^k\} \tag{10}$$

The next stage is normalizing the fuzzy decision matrix based on the type of criteria. For the criteria of the benefit type, normalization is carried out using Equation (11).

$$\tilde{r}_{ij} = \left[ \frac{a_{ij}}{c_j^+}, \frac{b_{ij}}{c_j^+}, \frac{c_{ij}}{c_j^+} \right]; c_j^+ = \max i \{c_{ij}\} \tag{11}$$

As for the cost-type criteria, Equation (12) is used.

$$\tilde{r}_{ij} = \left[ \frac{a_j^-}{c_{ij}}, \frac{a_j^-}{b_{ij}}, \frac{a_j^-}{a_{ij}} \right]; a_j^- = \min i \{a_{ij}\} \tag{12}$$

The normalization results are then multiplied by the weight of each criterion to obtain a weighted normalized decision matrix, as shown in Equation (13).

$$\begin{aligned} \tilde{v}_{ij} &= \tilde{r}_{ij} \times w_j \\ \tilde{A}_1 \times \tilde{A}_2 &= (a_1, b_1, c_1) \times (a_2, b_2, c_2) \\ \tilde{A}_1 \times \tilde{A}_2 &= (a_1 a_2; b_1 b_2; c_1 c_2) \end{aligned} \tag{13}$$

After the weighting matrix is obtained, the next step is to determine the positive ideal solution ( $A^+$ ) and negative ideal solution ( $A^-$ ) by selecting the maximum and minimum values of each criterion using Equations (14) and (15).

$$A^+(v_1^+, v_2^+, \dots, v_n^+); \tilde{v}_{ij}^+ = \max_i \{v_{ij}\} \quad (14)$$

$$A^-(v_1^-, v_2^-, \dots, v_n^-); \tilde{v}_{ij}^- = \min_i \{v_{ij}\} \quad (15)$$

Each alternative is then calculated for its distance to the positive and negative ideal solutions using the Euclidean formula for fuzzy numbers based on Equation (16).

$$d(\tilde{x}, \tilde{y}) = \sqrt{\frac{1}{3} [(a_1 - a_2)^2 + (b_1 - b_2)^2 + (c_1 - c_2)^2]} \quad (16)$$

From these calculations, the relative proximity score ( $CC_i$ ) for each alternative strategy is determined using Equation (17).

$$CC_i = \frac{d_i^-}{d_i^- + d_i^+} \quad (17)$$

The  $CC_i$  value shows how close an alternative is to the ideal solution. The higher the  $CC_i$ , the higher the level of preference for the strategy. The strategy with the highest  $CC_i$  value is stated as the top priority in overcoming barriers to the adoption of halal certification in MSMEs. All calculations are carried out systematically and consistently to ensure that the analysis results are valid, replicable, and can be used as a basis for strategic policy-making.

### 3.3 Data and Case Study

This study was conducted to evaluate barriers and formulate priority strategies for the adoption of halal certification by Micro, Small, and Medium Enterprises (MSMEs) in the food sector of Malang City. The data collection process begins with the preparation of a list of barriers and strategies based on the literature review and the results of field studies, including observations and in-depth interviews with MSME actors. A total of 16 key barriers were identified, as summarized in Table 4. Each barrier is coded H1 to H16 and explained in detail in the description column, which contains the operational context and supporting references. Additionally, five strategies were developed as alternative solutions to address the identified barriers. These strategies were determined based on the study of relevant literature and codified as S1 to S5. The full list of strategies is presented in Table 5.

All data were collected through an expert questionnaire specifically designed for two main purposes: comparing the relative importance of barriers and assessing the effectiveness of strategies in overcoming them. The questionnaire is structured in a linguistically based pairwise comparison format, with the results converted to Triangular Fuzzy Number (TFN) form. Respondents in this study consisted of seven experts who have more than five years of experience in the fields of halal certification, MSME assistance, and food industry policy. Each respondent is asked to provide an assessment of pairwise comparisons for 16 barriers and assign scores to 5 strategies against each barrier. The analysis stage is divided into two main segments. First, the assessment of barriers was conducted using the Fuzzy AHP method. The procedure starts with the formation of the

hierarchical structure of the problem as depicted in Figure 2, followed by the creation of the fuzzy pairwise comparison matrix presented in Table 6.

Table 4. Barriers to the adoption of halal certification in MSMEs

Code	Barriers	Description	Reference	Classification
H1	Lack of understanding of technology	Limited digital literacy hinders MSMEs in using online halal certification systems.	[13, 39]	Benefit
H2	Financial constraints	Certification costs burden MSMEs with limited budgets.	[16, 40]	Benefit
H3	Lack of knowledge	MSMEs lack understanding of halal rules, procedures, and requirements.	[14, 41, 42]	Benefit
H4	Business owners feel halal certification is not important	Some owners see halal certification as unnecessary if products sell well.	[16, 43]	Benefit
H5	Time constraints	Lengthy certification disrupts daily business operations.	[44, 45]	Benefit
H6	Business owners are not responsive to regulations	MSMEs find halal certification rules troublesome and risky.	[13, 46]	Benefit
H7	Limited human resources	Lack of skilled labor hampers halal supply chain management.	[47, 48]	Benefit
H8	Fear of trust and responsibility	Entrepreneurs fear inability to maintain consistent halal standards.	[9, 16]	Benefit
H9	Socialization is not optimal	Limited outreach causes low awareness of certification benefits.	[16]	Benefit
H10	Difficulty meeting document requirements	Incomplete documents hinder certification administration.	[44, 49]	Benefit
H11	Lack of halal certification service facilities	Absence of local halal centers limits MSME access to services.	[14, 49]	Benefit
H12	Limited free halal certification quota	Few free certification slots cause competition, especially in remote areas.	-	Benefit
H13	Availability of raw materials	Ensuring halal-compliant raw materials is challenging.	[16]	Benefit
H14	Stakeholder support is not optimal	Poor regulation and limited local government backing slow MSME development.	[13]	Benefit
H15	Lack of consumer demand	Weak consumer concern makes halal certification a low priority.	[16]	Benefit
H16	Infrastructure limitations	MSME facilities often fail to meet hygiene and halal standards.	-	Benefit

Table 5. Strategies to address barriers to halal certification adoption

Code	Strategy	Reference
S1	Increased education and socialization	[9, 48, 50]
S2	Financial assistance and incentives	[15, 51]
S3	Service optimization and process simplification	[51, 52]
S4	Awareness campaign and mentoring	[9, 41]
S5	Strengthening collaboration with stakeholders	[9, 53]

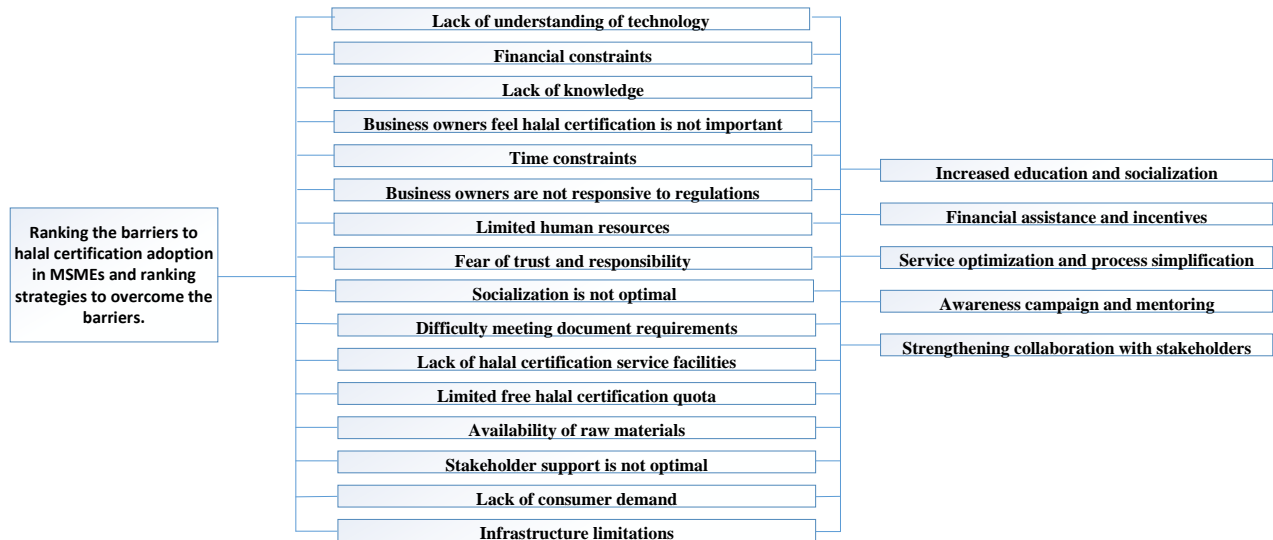


Figure 2. Hierarchy of problems

Table 6. Fuzzy AHP pairwise comparison matrix

	H1	H2	H3	H4	H5	H6	H7	H8	H9	H10	H11	H12	H13	H14	H15	H16
H1	EI	SI	1/VS	SI	1/I(EI-MI)	VS	1/VS	SI	1/MI	1/VS	MI	VS	SI	MI	MI	MI
H2		EI	1/VS	MI	1/I(EI-MI)	MI	1/VS	MI	1/MI	1/VS	MI	VS	SI	I(EI-MI)	SI	I(MI-SI)
H3			EI	ES	MI	VS	1/VS	MI	SI	1/VS	MI	SI	SI	MI	SI	ES
H4				EI	1/I(EI-MI)	1/I(EI-MI)	1/VS	1/MI	1/VS	1/VS	1/VS	1/VS	1/MI	1/I(MI-SI)	1/I(EI-MI)	1/MI
H5					EI	SI	1/VS	SI	MI	1/VS	I(EI-MI)	1/MI	MI	MI	SI	1/MI
H6						EI	1/VS	1/MI	1/VS	1/VS	1/VS	1/VS	1/MI	1/MI	I(EI-MI)	1/MI
H7							EI	VS	I(MI-SI)	VS	SI	SI	MI	VS	VS	VS
H8								EI	1/VS	1/VS	1/VS	1/VS	1/VS	1/MI	MI	1/MI
H9									EI	1/MI	1/I(EI-MI)	MI	1/MI	1/MI	MI	1/MI
H10										EI	VS	VS	1/VS	MI	I(SI-VS)	VS
H11											EI	I(EI-MI)	1/MI	I(EI-MI)	I(EI-MI)	1/VS
H12												EI	MI	MI	SI	1/MI
H13													EI	1/VS	VS	1/VS
H14														EI	VS	1/VS
H15															EI	1/VS
H16																EI

The second segment is strategy ranking using the Fuzzy TOPSIS method. The initial stage is carried out by compiling a strategy assessment matrix presented in Table 7 which is based on expert questionnaire input. Experts consist of seven people who have more than five years of experience, especially in the field of halal certification.

Table 7. Fuzzy TOPSIS strategy assessment matrix

	H1	H2	H3	H4	H5	H6	H7	H8	H9	H10	H11	H12	H13	H14	H15	H16
S1	ES	MI	ES	ES	SI	ES	ES	ES	VS	MI	MI	SI	VS	ES	MI	MI
S2	MI	ES	EI	EI	SI	MI	VS	MI	MI	SI	VS	ES	MI	VS	EI	ES
S3	VS	SI	VS	EI	ES	MI	ES	SI	ES	ES	ES	ES	EI	VS	EI	VS
S4	VS	EI	VS	VS	SI	VS	VS	VS	VS	VS	EI	EI	EI	EI	ES	EI
S5	VS	EI	VS	VS	EI	VS	VS	VS	ES	VS	VS	SI	ES	ES	VS	VS



## 4. Results and Discussion

### 4.1 Fuzzy AHP Results and Discussion

This study uses the Chang fuzzy AHP model to determine the weight of each obstacle in the adoption of halal certification in MSMEs. After determining the comparison matrix presented in Table 6, the computational process continues by calculating the synthetic index value ( $S_i$ ) for each obstacle using Equations (2)-(4). Then, the degree of possibility is calculated according to Equation (5), and the defuzzification ordinate value ( $d'$ ) is determined using Equations (6)-(8). All priority weights were normalized using Equation (9), resulting in the final ranking of barriers presented in Table 8.

Table 8. ranking of obstacle weights with fuzzy AHP.

Barriers Code	Barriers to Halal Certification Adoption	Weight Vector	Ranking
H1	Lack of understanding of technology	0.0751401	4
H2	Financial constraints	0.0346901	8
H3	Lack of knowledge	0.2002435	2
H4	Business owners feel halal certification is not important	0	13
H5	Time constraints	0.0139564	11
H6	Business owners are not responsive to regulations	0	14
H7	Limited human resources	0.2866825	1
H8	Fear of trust and responsibility	0	15
H9	Socialization is not optimal	0.0522386	5
H10	Difficulty meeting document requirements	0.1988980	3
H11	Lack of halal certification service facilities	0.0182131	9
H12	Limited free halal certification quota	0.0473456	6
H13	Availability of raw materials	0.0082231	12
H14	Stakeholder support is not optimal	0.0177572	10
H15	Lack of consumer demand	0	16
H16	Infrastructure limitations	0.0466113	7

Table 8 shows the final ranking of the 16 barriers to the adoption of halal certification based on the priority weights calculated using the Fuzzy AHP method. Limited human resources (H7) is the main obstacle with the highest weight of 0.2867. This barrier directly affects the internal ability of MSMEs to understand, prepare and carry out the complex and administrative halal certification process. Most MSMEs are managed by aged owners with limited managerial and technical skills, and do not have specialized staff capable of handling technical requirements and certification documents [54, 55]. The absence of trained labor results in a suboptimal process for identifying halal raw materials, recording production procedures, and final reporting [56]. Therefore, limited human resources are the dominant structural barrier, which not only impacts internal efficiency but also the mental and administrative readiness of MSMEs in undergoing a comprehensive and sustainable certification process.

Lack of knowledge (H3) has the second-highest weight, with a weight of 0.2002, because this obstacle has a direct impact on the readiness of MSMEs to understand and fulfill all halal certification requirements. Most MSME players lack access to sufficient information regarding the regulations, procedures, and stages required to obtain halal certification [54]. This lack of understanding leads to numerous fundamental errors in the submission process, including incomplete documents, unfamiliarity with raw material

standards, and non-compliance with applicable production procedures and regulations. This obstacle is also exacerbated by the lack of structured education and socialization from related parties, so MSMEs often rely solely on unofficial information that is not comprehensive [8]. These conditions create the perception that halal certification is a complex, expensive, and time-consuming process, thus reducing the motivation of MSME players to make applications immediately. Thus, lack of knowledge is a fundamental barrier that affects all stages of halal certification and slows down the adoption rate among MSMEs.

Difficulty meeting document requirements (H10) is the third-highest weighted barrier, with a weight of 1.9889, because the halal certification process demands strict and systematic administrative requirements. At the same time, most MSMEs lack adequate documentation procedures. Many MSME players are not accustomed to recording in detail the production flow, origin of raw materials, supplier lists, and quality control records required as evidence of compliance with halal standards [57]. This condition is exacerbated by the limited availability of human resources who understand the importance of documentation and the absence of a structured recording system. As a result, the process of collecting, compiling, and verifying documents is slow. It often does not comply with the certification body's requirements. These obstacles not only hinder the smooth process of applying for halal certification but also create the perception that certification is a heavy administrative burden. Therefore, the difficulty in fulfilling document requirements is an important barrier that slows down the adoption rate of halal certification among MSMEs.

This finding is consistent with research by [44] and [47], which confirm that barriers related to human resources are the most dominant obstacle to the adoption of halal certification among MSMEs, followed by a lack of knowledge and difficulty in fulfilling document requirements. Based on the results of the field study, other barriers, such as business owners feeling that halal certification is not important (H4), business owners not being responsive to regulations (H6), fear of trust and responsibility (H8), and lack of consumer demand (H15) have very low weights. This indicates that MSME players have increasingly recognized the importance of halal certification as a key factor in enhancing competitiveness and meeting global market demands. Therefore, the focus of strategic interventions should be directed at strengthening human resource capacity, increasing understanding of regulations, and enhancing the documentation system to accelerate the halal certification process.

## 4.2 Fuzzy TOPSIS Results and Discussion

This study employs the fuzzy TOPSIS method to identify the most effective and relevant strategies for overcoming barriers to the adoption of halal certification in MSMEs. After determining the strategy assessment matrix, the weights of the criteria are calculated using Equation (10). Next, normalization of the fuzzy decision matrix and weighting are carried out using Equations (11) and (13). The distance between alternatives and ideal solutions is calculated using Equation (16). In contrast, the relative closeness score is calculated using Equation (17), and the final results of the strategy ranking are shown in Table 9.

Table 9 shows the final ranking of the five strategies for barriers to the adoption of halal certification based on the value  $CC_i$  Calculated using the Fuzzy TOPSIS method, the strategy of increasing education and socialization (S1) obtained the highest score, 0.6856, because it directly addressed the main root problems faced by MSMEs in the halal certification adoption process, namely limited human resources and a lack of knowledge. Structured education enables MSME players to comprehend the benefits, procedures, and



standards required for halal certification. thereby enhancing their readiness to initiate the certification process [58]. Intensive socialization also plays a role in expanding access to information related to the latest regulations, administrative procedures, and support available from related institutions [59]. With increased understanding, MSMEs can minimize errors in document submission, strengthen their internal record-keeping systems, and be more confident in meeting audit requirements. In addition, this strategy has a long-term impact, as it creates changes in the behavior and mindset of MSME players regarding the importance of halal certification in enhancing business competitiveness. Therefore, increasing education and socialization is the most effective strategy that supports the successful implementation of other strategies in accelerating the adoption of halal certification.

Table 9. Ranking of strategies for barriers to adoption of halal certification

Code Strategy	Halal Certification Adoption Barrier Strategy	$d^{+i}$	$d^{-i}$	Cci	Ranking
S1	Increased education and socialization	10.51	22.92	0.6856408	1
S2	Financial assistance and incentives	20.38	12.94	0.3883290	5
S3	Service optimization and process simplification	13.31	20.04	0.6008511	3
S4	Awareness campaign and mentoring	19.82	13.57	0.4064246	4
S5	Strengthening collaboration with stakeholders	11.09	22.39	0.6687944	2

The strategy of strengthening collaboration with stakeholders (S5) has the second-highest score of 0.6688 because the successful adoption of halal certification cannot be achieved independently by MSMEs alone. Halal certification involves multiple parties, including certification bodies, government agencies, business associations, raw material suppliers, and supporting institutions. Strong collaboration enables the creation of synergies through technical assistance, easy access to information, streamlined administrative processes, and the availability of certified raw materials [60]. Cross-stakeholder support can also help overcome structural barriers such as limited human resources and difficulties in meeting document requirements, through joint training and the provision of a more integrated documentation system. In addition, collaboration strengthens the confidence of MSME actors in the certification process through a clear and sustainable support network. Thus, strengthening collaboration with stakeholders is an effective strategy to expedite the halal certification process and ensure the sustainability of MSME compliance with halal standards.

The strategy of optimizing services and simplifying processes (S3) has the third-highest score of 0.6009 because the halal certification process is often considered complex and time-consuming by MSME actors. A lengthy process with numerous administrative stages makes it challenging for MSMEs to fulfill all requirements, particularly those with limited human resources and inadequate documentation systems. Service optimization can include providing an integrated service center, digitizing the registration process, and increasing the capacity of certification bodies to accelerate verification and audits [61]. Meanwhile, process simplification aims to reduce the administrative burden without compromising the quality of supervision, making it easier for MSMEs to understand and comply with existing procedures. This strategy can directly reduce barriers related to document fulfillment difficulties and time constraints, while increasing the confidence of MSMEs in the halal certification system. Therefore, service optimization and process

simplification are relevant strategies to support increased adoption of halal certification more broadly.

Furthermore, awareness campaigns and mentoring (S4) ranked fourth with a score of 0.4064. This strategy can increase the motivation of MSME actors to apply for certification. However, its impact is more limited compared to basic education or collaboration strategies. The last strategy is financial assistance and incentives (S2), which has the lowest score of 0.3883. Although this strategy can reduce the burden of certification costs, its impact is more short-term. It does not address the root of the problems that hinder the adoption of halal certification. Therefore, the financial assistance strategy requires support from other strategies to be more effective. Overall, these results confirm that efforts to increase education and socialization, integrated with stakeholder collaboration and simplification of the certification process, will be key to success in accelerating the adoption of halal certification by MSMEs.

### 4.3 Implications and Recommendations

This research makes a theoretical contribution by integrating the Fuzzy AHP and Fuzzy TOPSIS approaches in the context of evaluating barriers and formulating halal certification adoption strategies in MSMEs. The integration of these methods strengthens scientific understanding of the priority relationship between barriers and the effectiveness of strategic solutions that can be applied. The combination of two fuzzy approaches enables a more comprehensive multi-criteria analysis by systematically considering uncertainty and expert subjectivity. Thus, this research expands the scope of the literature on fuzzy-based decision-making in halal certification and MSME development.

Managerially, this study provides strategic directions for the government, halal certification bodies, and industry players to strengthen their human resource capacity through ongoing education and training programs organized by the cooperative and MSME offices. Active involvement of halal certification bodies (LSH) is needed in providing practical training modules and free consultation services, as well as the establishment of affirmative policies in the form of free certification quotas, simplifying administrative bureaucracy, and providing tax incentives for halal-certified MSMEs. LSH can strengthen its mentoring role by leveraging synergies with universities and local industrial communities to enhance MSMEs' understanding of certification procedures. The expansion of cross-stakeholder partnerships, massive awareness campaigns, intensive technical assistance, and the provision of financial assistance and incentives will encourage the active participation of MSMEs in the halal certification process. The implementation of this collaborative strategy is expected to increase the competitiveness of MSMEs in the increasingly competitive global halal market.

### 4. Conclusion

This study successfully identified 16 barriers to the adoption of halal certification in MSMEs. It mapped out prioritized strategies to overcome them. The main findings show that limited human resources (H7) is the most significant barrier, with the highest weight, followed by a lack of knowledge (H3) and difficulty in meeting document requirements (H10). These barriers reflect the weak internal capacity of MSMEs in understanding regulations, managing administration, and effectively carrying out the halal certification process. To address these issues, the strategy of increasing education and socialization (S1) is the top priority, followed by strengthening collaboration with stakeholders (S5) and

optimizing services and simplifying processes (S3). The findings confirm that comprehensive and collaborative interventions can accelerate the adoption rate of halal certification in MSMEs and improve the competitiveness of their products in the halal market.

This research makes a significant contribution to knowledge development in halal certification management by combining a priority analysis of barriers and strategies using a structured approach. The results can be used as a guide for the government, halal certification bodies, and other stakeholders in designing educational programs, simplifying administrative processes, and strengthening partnership networks that are oriented towards sustainability. This research makes a significant contribution to understanding and overcoming barriers to halal certification in MSMEs, serving as a valuable reference for future policymakers and researchers.

The limitations of this study lie in its limited geographical coverage of Malang City and its focus on a single MSME sector, specifically cassava chips, with a limited number of expert respondents. Therefore, further research is recommended to cover other MSME sectors in different regions, explore consumer perceptions as well as the integration of digital technology, and compare the effectiveness of alternative multi-criteria decision-making (MCDM) methods. This approach will strengthen the generalizability of the results and provide a more comprehensive understanding of the most effective strategies in accelerating the adoption of halal certification among MSMEs.

## Data Availability

Describe the Data Availability in this section

## Declarations

**Author contribution:** Describe the contributions of each author in this section.

**Funding statement:** Describe research funding in this section.

**Conflict of interest:** describe the research conflicts of interest in this section.

**Additional information:** describe additional information in this section.

## References

- [1] M. Muksalmina, T. Tasyukur, F. Maghfirah, and M. Muammar, "Halal Certification in a Food Product as an Effort to Protect Law Against Muslim Consumers in Indonesia," in *2nd Malikussaleh Internasional Conference on Law, Legal Studies and Social Science*, Aceh, Indonesia, 2022, vol. 2, pp. 1-7. <https://doi.org/10.29103/micolls.v2i.78>.
- [2] J. Arifin Djakasaputra, B. Aditi, M. Fachrurazi, and A. Mas'ad, "The Influence of Halal Certification, Halal Awareness, and Brand Image on Purchase Intention Halal Food Products: an Empirical Study of Consumers in Indonesia," *International Journal of Islamic Business and Economics*, vol. 7, no. 2, pp. 103-115, 2023. <https://doi.org/10.28918/ijibec.v7i2.2003>.
- [3] F. Desvaria, R. F. Aulia, M. Solihah, A. Pardi, and K. Hartini, "Strategies for Strengthening the Competitive Advantage of Export Halal Food Products in Optimizing Expansion in the Global Market," in *International Conference on*

- Islamic Economics, Islamic Banking, Zakah and Waqf* Banyumas, Indonesia, 2023, pp. 835-850. <https://doi.org/10.24090/ieibzawa.v1i1.788>.
- [4] D. Yener, "The Effects of Halal Certification and Product Features on Consumer Behavior: A Scenario-Based Experiment," *International Journal of Management Studies (IJMS)*, vol. 29, no. 2, pp. 101-136, 2022. <https://doi.org/10.32890/ijms2022.29.2.5>.
- [5] N. M. Dahlal, S. M. Saniff, and C. N. C. Noh, "Harmonising food safety and friendly service through halal and toyyib principles," *Halalsphere*, vol. 4, no. 1, pp. 80-87, 2024. <https://doi.org/10.31436/hs.v4i1.89>.
- [6] H. Abbas, G. Tian, N. Faiz, M. Jiang, and H. Ullah, "Sustainable elements of the ongoing growth in the demand for halal products in OBOR regional markets," *Frontiers in Nutrition*, vol. 12, p. 1533322, 2025. <https://doi.org/10.3389/fnut.2025.1533322>.
- [7] D. Prayuda, S. Arby, I. Adli, and S. Al-Ayubi, "Halal industry: Opportunities and challenge in the global market," *Al-Infq: Jurnal Ekonomi Islam*, vol. 14, no. 2, pp. 267-284, 2023.
- [8] M. A. Fathoni, P. D. Priyatno, F. S. Wiryanto, and W. Rachbini, "Unlocking barriers and strategies of halal certification for micro and small enterprises in Indonesia: Analytic network process approach," *Problems and Perspectives in Management*, vol. 23, no. 1, p. 169, 2025. [http://dx.doi.org/10.21511/ppm.23\(1\).2025.13](http://dx.doi.org/10.21511/ppm.23(1).2025.13).
- [9] A. Haleem, M. I. Khan, and S. Khan, "Halal Certification, the Inadequacy of its Adoption, Modelling and Strategising the Efforts," *Journal of Islamic Marketing*, vol. 11, no. 2, pp. 384-404, 2020. <https://doi.org/10.1108/JIMA-05-2017-0062>.
- [10] H. Oemar, E. Prasetyaningsih, S. Z. A. Bakar, D. Djamaludin, and A. Septiani, "Awareness and Intention to Register Halal Certification of Micro and Small-Scale Food Enterprises," *F1000Research*, vol. 11, pp. 1-55, 2022. <https://doi.org/10.12688/f1000research.75968.3>.
- [11] S. L. Nurillah, "The Importance of Halal Certificates in Halal Food Using the Digital Platform," *International Journal of Law Dynamics Review*, vol. 1, no. 2, pp. 99-111, 2023. <https://doi.org/10.62039/ijldr.v1i2.20>.
- [12] C. S. Anggraeni and M. K. Anwar, "The influence of halal socialization and business capital on interest of halal certification in surabaya msmes," *istinbath*, vol. 22, no. 1, pp. 90-104, 2023.
- [13] J. Jamaluddin, H. Hidayatulloh, A. Zaini, and S. Sanawi, "The problems of implementing Halal certification through the self-declaration program for MSMEs in Indonesia: A Case Study," *International Journal of Advances in Social and Economics*, vol. 4, no. 1, pp. 30-36, 2022. <https://doi.org/10.33122/ijase.v4i1.221>.
- [14] I. Ismail, N. A. N. Abdullah, I. I. Ibrahim, N. F. M. Nasir, A. N. M. Noor, and N. A. H. N. Abdullah, "The Conceptualisation of Halal Certification Adoption Model Among Small and Medium-Sized Enterprises (SMES) in Malaysia," *AIJBES*, vol. 5, no. 17, pp. 10-17, 2023.
- [15] S. Khan, M. I. Khan, and A. Haleem, "Evaluation of Barriers in the Adoption of Halal Certification: a Fuzzy DEMATEL Approach," *Journal of Modelling in Management*, vol. 14, no. 1, pp. 153-174, 2019. <https://doi.org/10.1108/JM2-03-2018-0031>.
- [16] S. Prabowo, A. Abd Rahman, S. Ab Rahman, and A. A. Samah, "Revealing Factors Hindering Halal Certification in East Kalimantan Indonesia," *Journal of Islamic Marketing*, vol. 6, no. 2, pp. 268-291, 2015. <https://doi.org/10.1108/JIMA-05-2014-0040>.

- [17] S. Z. A. Bakar, S. N. M. Zamani, M. A. B. H. Ahmad, and E. Prasetyaningsih, "Challenges in the implementation of halal certification among small medium enterprises (SMEs)," *Russian Law Journal*, vol. 11, no. 4S, pp. 365-371, 2023.
- [18] C.-C. Sun, "A Performance Evaluation Model by Integrating Fuzzy AHP and Fuzzy TOPSIS Methods," *Expert Systems with Applications*, vol. 37, no. 12, pp. 7745-7754, 2010. <https://doi.org/10.1016/j.eswa.2010.04.066>.
- [19] N. L. Rane and S. Choudhary, "Fuzzy AHP and Fuzzy TOPSIS as an Effective and Powerful Multi-Criteria Decision-Making (MCDM) Method for Subjective Judgements in Selection Process," *International Research Journal of Modernization in Engineering Technology and Science*, vol. 5, no. 4, pp. 3786-3799, 2023.
- [20] A. Fitriani, M. M. Alwi, M. Dawud, and Z. Fanani, "Dynamics of Implementation of Halal Certification for Business Actors," in *Proceeding of 3rd Internasional Conference on Implementing Religious Values on Transdisciplinary Studies for Human Civilization 2023*, pp. 33-42. <https://doi.org/10.24090/icontrees.2023.289>.
- [21] A. F. Putri, "The Urgency of Halal Certification in Halal Cosmetic Brands in Indonesia," *Likuid Jurnal Ekonomi Industri Halal*, vol. 4, no. 1, pp. 32-40, 2024.
- [22] R. D. Luthviati and S. Jenvitchuwong, "Implementation of Halal Product Assurance in the Pharmaceutical Sector in Indonesia," *Journal of Human Rights, Culture and Legal System*, vol. 1, no. 3, pp. 164-179, 2021. <https://doi.org/10.53955/jhcls.v1i3.19>.
- [23] C. Fadila, U. Burhan, and M. Ekawaty, "Analysis of The Role of Halal Fashion in Women's Economic Empowerment," in *Proceedings of the 1st International Conference on Social Science and Technology (INCOSST) 2022*, vol. 1, no. 1, pp. 111-126.
- [24] A. Afendi, "The effect of halal certification, halal awareness and product knowledge on purchase decisions for halal fashion products," *Journal of Digital Marketing and Halal Industry*, vol. 2, no. 2, pp. 145-154, 2020. <https://doi.org/10.21580/jdmhi.2020.2.2.6160>.
- [25] F. K. Mubarak and M. K. Imam, "Halal industry in Indonesia; Challenges and Opportunities," *Journal of Digital Marketing and Halal Industry*, vol. 2, no. 1, pp. 55-64, 2020. <https://doi.org/10.21580/jdmhi.2020.2.1.5856>.
- [26] N.-T. Tran, V.-L. Trinh, and C.-K. Chung, "An Integrated Approach of Fuzzy AHP-TOPSIS for Multi-Criteria Decision-Making in Industrial Robot Selection," *Journal, Type of Article* vol. 12, no. 8, p. 1723, 2024. <https://doi.org/10.3390/pr12081723>.
- [27] F. Han, R. N. Alkhawaji, and M. M. Shafieezadeh, "Evaluating sustainable water management strategies using TOPSIS and fuzzy TOPSIS methods," *Applied Water Science*, vol. 15, no. 1, p. 4, 2025. <https://doi.org/10.1007/s13201-024-02336-7>.
- [28] Q. H. Do, "Evaluating lecturer performance in Vietnam: An application of fuzzy AHP and fuzzy TOPSIS methods," *Heliyon*, vol. 10, no. 11, p. e30772, 2024. <https://doi.org/10.1016/j.heliyon.2024.e30772>.
- [29] A. Özdağoğlu and G. Özdağoğlu, "Comparison of AHP and Fuzzy AHP for the Multi Criteria Decision Making Processes with Linguistic Evaluations," *İstanbul Ticaret Üniversitesi Fen Bilimleri Dergisi*, vol. 6, no. 11, pp. 65-85, 2007.
- [30] Y. Liu, C. M. Eckert, and C. Earl, "A Review of Fuzzy AHP Methods for Decision-Making with Subjective Judgements," *Expert Systems with Applications*, vol. 161, no. 113738, p. 67, 2020. <https://doi.org/10.1016/j.eswa.2020.113738>.

- [31] C. Kahraman, "A Brief Literature Review for Fuzzy AHP," *International Journal of the Analytic Hierarchy Process*, vol. 10, no. 2, pp. 293-297, 2018. <https://doi.org/10.13033/ijahp.v10i2.599>.
- [32] S. Duleba, A. Alkharabsheh, and F. K. Gündoğdu, "Creating a Common Priority Vector in Intuitionistic Fuzzy AHP: a Comparison of Entropy-Based and Distance-Based Models," *Annals of Operations Research*, vol. 318, pp. 163-187, 2022. <https://doi.org/10.1007/s10479-021-04491-5>.
- [33] D.-Y. Chang, "Applications of the extent analysis method on fuzzy AHP," *European Journal of Operational Research*, vol. 95, no. 3, pp. 649-655, 1996. [https://doi.org/10.1016/0377-2217\(95\)00300-2](https://doi.org/10.1016/0377-2217(95)00300-2).
- [34] P. K. Parida, "A General View of TOPSIS Method Involving Multi-Attribute Decision Making Problems," *International Journal of Innovative Technology and Exploring Engineering (IJITEE)*, vol. 9, no. 2, pp. 3205-3214, 2019. <https://doi.org/10.35940/ijitee.B7745.129219>.
- [35] J.-F. Ding, "An Integrated Fuzzy TOPSIS Method for Ranking Alternatives and its Application," *Journal of Marine Science and Technology*, vol. 19, no. 4, p. 2, 2011. <https://doi.org/10.51400/2709-6998.2174>.
- [36] J.-R. Chou, "A Weighted Linear Combination Ranking Technique for Multi-Criteria Decision Analysis," *South African Journal of Economic and Management Sciences*, vol. 16, no. 5, pp. 28-41, 2013.
- [37] S. Nădăban, S. Dzitac, and I. Dzitac, "Fuzzy TOPSIS: a General View," *Procedia Computer Science*, vol. 91, pp. 823-831, 2016. <https://doi.org/10.1016/j.procs.2016.07.088>.
- [38] D. Kannan, R. Khodaverdi, L. Olfat, A. Jafarian, and A. Diabat, "Integrated Fuzzy Multi Criteria Decision Making Method and Multi-Objective Programming Approach for Supplier Selection and Order Allocation in a Green Supply Chain," *Journal of Cleaner production*, vol. 47, pp. 355-367, 2013. <https://doi.org/10.1016/j.jclepro.2013.02.010>.
- [39] H. Oemar, E. Achiraeniwati, A. N. Rukmana, and A. Septiani, "Halal Awareness, Halal Certification Issues, and Challenges for Micro Businesses in Bandung," in *Islam, Media and Education in the Digital Era*: Routledge, pp. 63-69, 2022.
- [40] A. A. Ridlwan and M. K. Anwar, "The Problem of Halal Certification for Food Industry in Indonesia," *International Journal of Civil Engineering and Technology*, vol. 9, no. 8, pp. 1625-1632, 2018.
- [41] Z. bin Md Rodzi *et al.*, "Integrated Single-Valued Neutrosophic Normalized Weighted Bonferroni Mean (SVNNWBM)-DEMATEL for Analyzing the Key Barriers to Halal Certification Adoption in Malaysia," *International Journal of Neutrosophic Science*, vol. 21, no. 3, pp. 106-06, 2023. <https://doi.org/10.54216/IJNS.210310>.
- [42] A. M. N. Widigdo and A. Triyanto, "Knowledge and Compliance: the Increasing Intention of MSME's Halal Certification in Indonesia," *International Journal of Business and Society*, vol. 25, no. 1, pp. 128-147, 2024. <https://doi.org/10.33736/ijbs.6904.2024>.
- [43] N. R. Arifin, R. Muhtadi, and S. Herianingrum, "Small and Medium Enterprise Perception of Halal Certification Post Formalization of Islamic City Branding," *International Journal of Islamic Business Ethics*, vol. 4, no. 1, pp. 601-610, 2019. <http://dx.doi.org/10.30659/ijibe.4.1.601-610>.
- [44] R. Ikawati and A. N. B. Rahman, "The Awareness and Willingness to Apply for Halal Guarantee Certification: a Study of MSMEs Assisted by BAZNAS

- Yogyakarta," *Journal of Halal Science and Research*, vol. 3, no. 2, pp. 70-78, 2022. <https://doi.org/10.12928/jhsr.v3i2.6870>.
- [45] N. Nyata *et al.*, "The Role of Stakeholders in Accelerating Halal Certification for SMEs," *KnE Social Sciences*, vol. 9, no. 18, pp. 169-180, 2024.
- [46] S. Suparti, A. Faris Khoirul, and W. Vega, "The Intention of Halal Certification by Micro Business," *KnE Social Sciences*, vol. 4, no. 9, pp. 141-155, 2020. <https://doi.org/10.18502/kss.v4i9.7322>.
- [47] A. Fitriani, M. M. Alwi, M. Dawud, and Z. Fanani, "Dynamics of Implementation of Halal Certification for Business Actors," in *3rd Internasional Conference on Implementing Religious Values on Transdisciplinary Studies for Human Civilization 2023*, pp. 33-42.
- [48] J. Effendi, "Human Resources Readiness of Small Medium Enterprises (SMEs) for Halal Product in Indonesia," *Global review of islamic economics and business*, vol. 10, no. 2, pp. 083-095, 2023. <https://doi.org/10.14421/grieb.2022.102-08>.
- [49] D. Zulianti and N. Aslami, "Implementation Of Management System On Halal Certification For Medan City Msmes Actors:(Case study at the Medan City Cooperative and MSMEs Office)," *Current Advanced Research on Sharia Finance and Economic Worldwide*, vol. 1, no. 3, pp. 11-16, 2022.
- [50] M. A. Fathoni, F. Marzuki, and R. Parianom, "Socialization of Halal Product Certification at Fatahillah Foundation," *Community Empowerment*, vol. 8, no. 11, pp. 1742-1748, 2023. <https://doi.org/10.31603/ce.9846>.
- [51] Z. M. Rodzi, F. A. M. Amin, M. H. M. Khair, and W. Wannasupchue, "Exploring Barriers to Adoption of Halal Certification among Restaurant Owners in Seremban, Malaysia," *Environment-Behaviour Proceedings Journal*, vol. 8, no. SI14, pp. 3-8, 2023. <https://doi.org/10.21834/e-bpj.v8iSI14.5046>.
- [52] A. Haleem, M. Imran Khan, S. Khan, and A. Hafaz Ngah, "Assessing Barriers to Adopting and Implementing Halal Practices in Logistics Operations," in *IOP Conference Series: Materials Science and Engineering*, 2018, vol. 404, p. 6: IOP Publishing. <https://doi.org/10.1088/1757-899X/404/1/012012>.
- [53] C. Bux, E. Varese, V. Amicarelli, and M. Lombardi, "Halal Food Sustainability Between Certification and Blockchain: a Review," *Sustainability*, vol. 14, no. 4, p. 2152, 2022. <https://doi.org/10.3390/su14042152>.
- [54] E. Muhromin, "Enhancing Halal Certification Literacy Among MSMEs: Barriers, Strategies, and Impacts," *OIKOS*, vol. 17, no. 1, pp. 51-64, 2025.
- [55] M. A. Fathoni, F. Faizi, S. Suprima, F. S. Wiryanto, and S. Suryani, "Exploring halal certification literacy measurement for micro small enterprises (MSEs)," *Review of Islamic Economics and Finance*, vol. 7, no. 2, pp. 1-14, 2024. <https://doi.org/10.17509/rief.v7i2.73607>.
- [56] R. Andespa, Y. Yurni, A. Aldiyanto, and G. Efendi, "Challenges and Strategies in Halal Supply Chain Management for MSEs in West Sumatra: A Participatory Action Research Study," *International Journal of Safety & Security Engineering*, vol. 14, no. 3, pp. 907-921, 2024. <https://doi.org/10.18280/ijssse.140322>.
- [57] A. Prawiro and F. Fathudin, "Challenges in the halal industry ecosystem: analyzing the halal certification process for micro, small, and medium enterprises in lombok, west nusa tenggara," *Mazahib*, vol. 22, no. 2, pp. 431-484, 2023.
- [58] W. F. Amalia and R. Andni, "The influence of education level, halal awareness, and halal certification costs on halal certification decisions with religiosity as a moderating variable: A case study of MSMEs in Kudus Regency," *Journal of Islamic Economics Lariba*, vol. 9, no. 2, pp. 453-478, 2023. <https://doi.org/10.20885/jielariba.vol9.iss2.art10>.

- [59] A. M. Sadad, T. Rahman, R. Umami, and I. Sholeha, "The Efforts of The Bangkalan Regency Government in Accelerating Halal Certification for MSMEs; Analysis of the Norm Escalation Theory-Islamic Good Governance," *Ijtihad*, vol. 18, no. 1, pp. 48-58, 2024. <https://doi.org/10.21111/ijtihad.v18i1.11430>.
- [60] D. H. Firdaus, A. S. Ma'arif, and A. Rouf, "The Role of Islamic Higher Education in Strengthening the Halal Ecosystem in Indonesia," *Peradaban Journal of Religion and Society*, vol. 4, no. 1, pp. 1-14, 2025. <https://doi.org/10.59001/pjrs.v4i1.277>.
- [61] A. Ridho, "Integrating artificial intelligence and blockchain to improve the accuracy of halal certification," *Journal of Halal Review*, vol. 1, no. 1, pp. 12-22, 2025. [https://doi.org/10.70764/gdpu-jhr.2025.1\(1\)-02](https://doi.org/10.70764/gdpu-jhr.2025.1(1)-02).



*This page is blank*