**Analyzing Barriers to Halal Concept Adoption in International Hotel Restaurants Using Fuzzy AHP, Fuzzy MOORA, and QFD**

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**Abstract.** Halal certification is a critical requirement in the food service industry, yet many establishments face significant barriers to achieving compliance. This study aims to systematically identify and prioritize these barriers to provide actionable insights for industry stakeholders. A multi-method approach was employed, integrating Fuzzy Analytic Hierarchy Process (Fuzzy AHP) to rank Severity, Occurrence, and Detection (SOD) factors, followed by Fuzzy Multi-Objective Optimization by Ratio Analysis (Fuzzy MOORA) for barrier prioritization, and Pareto analysis to determine critical issues. The results indicate that the most significant barriers are the integration of bar facilities serving alcoholic beverages, absence of an internal halal supervisor, high costs of kitchen infrastructure renovation, and reliance on non-certified imported ingredients. These barriers exhibit interrelated effects, suggesting that isolated interventions may have limited effectiveness. The findings offer a structured decision-making framework for practitioners and policymakers to focus on high-impact areas, thereby improving halal compliance.

**Keywords :** Halal Certification, Barriers, Fuzzy AHP, Fuzzy MOORA, QFD

# **INTRODUCTION**

The global halal food and hospitality sector has grown rapidly over the past decade, driven by increasing demand from Muslim consumers and interest from non-Muslim customers in quality and ethical standards [1]. In the hospitality industry, halal certification ensures compliance with Islamic dietary laws while promoting hygiene, safety, and ethical sourcing. International hotel restaurants have recognized halal adoption as a strategic move to attract a wider customer base [2]. However, adopting halal standards in such establishments is complex. It requires not only changes in food sourcing and preparation but also adjustments in kitchen layout, storage, and service processes. These changes often demand significant investments in infrastructure, training, and certification fees. As a result, many hotels face difficulties in achieving full halal compliance across multiple locations with diverse supply chains.

Challenges in halal adoption are further complicated by the lack of harmonized global certification standards [3]. Hotels operating in different countries must navigate varying legal requirements and certification processes. In Indonesia, the mandatory halal certification regulation has raised operational costs significantly [4]. The estimated certification cost per menu item increased from USD 314–627 to USD 1,883–4,393, making it difficult for hotels with frequently changing menus. This financial burden is compounded by the need for continuous staff training to maintain compliance [5]. Moreover, customer expectations for halal services vary widely across cultural contexts [6]. These variations create uncertainty in decision-making for hospitality managers, especially when balancing halal requirements with business profitability.

Previous studies have emphasized the importance of applying robust multi-criteria decision-making (MCDM) methods to address halal adoption barriers effectively. The Fuzzy Analytic Hierarchy Process (Fuzzy AHP) is an extension of the classical AHP developed by Saaty (1980), which incorporates fuzzy set theory to handle uncertainty and vagueness in expert evaluations. It is widely applied in prioritizing qualitative factors where human judgment plays a significant role. The Fuzzy Multi-Objective Optimization by Ratio Analysis (Fuzzy MOORA) method, introduced by Brauers and Zavadskas (2006), supports ranking and selecting optimal alternatives when decision criteria are both conflicting and imprecise. This method is computationally straightforward while maintaining high accuracy in decision-making. Quality Function Deployment (QFD), first proposed by Akao (1990), is a customer-driven planning tool that systematically translates customer needs into design and operational requirements. In the hospitality sector, QFD has been successfully used to align service processes with guest expectations [7]. Integrating Fuzzy AHP and Fuzzy MOORA with QFD enables both the identification and prioritization of barriers, as well as the formulation of targeted improvement strategies. Therefore, this study employs such an integrated approach to provide a structured and comprehensive analysis of halal adoption challenges in international hotel restaurants.

# **METHODS**

This study employs an integrated decision-making framework combining Fuzzy Analytic Hierarchy Process (Fuzzy AHP), Fuzzy Multi-Objective Optimization by Ratio Analysis (Fuzzy MOORA), and Quality Function Deployment (QFD) to identify and prioritize barriers to the adoption of the halal concept in international hotel restaurants. The framework is implemented in three main phases: (1) identifying and weighting barriers using Fuzzy AHP, (2) ranking improvement strategies using Fuzzy MOORA, and (3) mapping the prioritized strategies into actionable quality requirements through QFD. Data were collected from a panel of hospitality industry experts, halal certification officers, and academic scholars with experience in halal tourism and food service management.

## **Fuzzy AHP for Weighting Barriers**

The Fuzzy Analytic Hierarchy Process (FAHP) was employed to systematically evaluate and prioritize three critical risk parameters in the Failure Mode and Effects Analysis (FMEA) framework, namely Severity (S), Occurrence (O), and Detection (D). Severity represents the potential impact of a failure on operations or customer satisfaction, Occurrence refers to the likelihood of the failure happening, and Detection indicates the probability of identifying the failure before it causes adverse effects. This method employs Triangular Fuzzy Numbers (TFNs) to represent linguistic judgments. The procedure of fuzzy AHP is given in detail in the following [8]:

A TFN fuzzy value of the pairwise comparison is written as:

|  |  |
| --- | --- |
|  | (1) |

**Step 1**. Construct the fuzzy pairwise comparison matrix.

**Step 2**. Calculate the fuzzy synthetic extent value

|  |  |
| --- | --- |
|  | (2) |

**Step 3**. Determine the degree of possibility. The degree of possibility that Si is greater than or equal to Sk is:

|  |  |
| --- | --- |
|  | (3) |

**Step 4**. Compute the weight vector

|  |  |
| --- | --- |
|  | (4) |

## **Multi-Objective Optimization on the Basis of Ratio Analysis (MOORA) Method**

After obtaining the criterion weights from Fuzzy AHP, the next stage involves ranking the twenty identified barriers. In this stage, the Fuzzy Multi-Objective Optimization on the Basis of Ratio Analysis (Fuzzy MOORA) method is applied. Fuzzy MOORA is selected due to its computational efficiency and its proven capability in handling complex multi-attribute ranking problems [9].

**Step 1**. Construct the fuzzy decision matrix

**Step 2.** Normalize the fuzzy decision values

|  |  |
| --- | --- |
|  | (5) |

**Step 3.** Apply the weight of each criterion from F-AHP

|  |  |
| --- | --- |
|  | (6) |

**Step 3.** Determine the overall performance score. Separate criteria into beneficial (higher is better) and non-beneficial (lower is better).

|  |  |
| --- | --- |
|  | (7) |

**Step 3.** Rank the alternatives. The higher the value the better the performance of the alternative.

## **Quality Function Deployment (QFD) Method**

QFD uses the House of Quality (HoQ) to connect barriers (customer needs) with technical requirements. The procedure of QFD is given in detail in the following [10].

**Step 1**. List customer needs (CNs) from Fuzzy AHP results.

**Step 2**. List technical requirements (TRs) derived from proposed improvement strategies.

**Step 3**. Build the relationship matrix between CN i and TR j with values (9 = strong, 3 = medium, 1 = weak, 0 = none)

**Step 4**. Calculate weighted importance for each TR:

|  |  |
| --- | --- |
|  | (8) |

# **RESULT AND DISCUSSION**

## **Case Study**

The identification of barriers was conducted through a combination of direct field observations and a literature review of previous studies on halal adoption in the hospitality sector. A total of 20 barriers were identified, each coded from H1 to H20, representing operational, managerial, supply chain, infrastructural, and market-related challenges. These barriers reflect the complexity of adopting halal standards within the operational environment of international hotel restaurants, where diverse customer demographics, global supply chains, and international service standards often intersect with local halal regulations. The respective indicators of barriers are shown in **TABLE 1**.

**TABLE 1** Barriers to Halal Concept Adoption in International Hotel Restaurants

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **No.** | **Code** | **Barrier** | **No.** | **Code** | **Barrier** |  |
| 1 | H1 | Competition with more flexible non-halal hotels | 11 | H11 | Supply chain disruptions affecting halal ingredient availability | |
| 2 | H2 | Absence of a halal supervisor | 12 | H12 | Difficulty finding halal-certified suppliers | |
| 3 | H3 | Risk of cross-contamination during food production | 13 | H13 | Limited socialization on certification in hotel management | |
| 4 | H4 | Presence of bar facilities serving alcohol | 14 | H14 | Price fluctuations in halal raw materials | |
| 5 | H5 | Inconsistencies in halal standards between source countries and Indonesia | 15 | H15 | High costs for kitchen infrastructure renovation | |
| 6 | H6 | Lack of separation in receiving and storage areas for halal and non-halal items | 16 | H16 | Fear of losing non-Muslim guests | |
| 7 | H7 | Unclear halal Standard Operating Procedures (SOPs) | 17 | H17 | Lack of a digital halal supply chain tracking system | |
| 8 | H8 | The majority non-Muslim staff are unfamiliar with halal standards | 18 | H18 | Limited access to halal audit technology | |
| 9 | H9 | Misuse of halal labels by third parties | 19 | H19 | Low adoption of halal management systems via applications | |
| 10 | H10 | Reliance on imported ingredients without recognized halal certification | 20 | H20 | Difficulty modifying the existing kitchen layout | |

## **Weight Calculation of Risk Parameters Using FAHP**

The FAHP approach integrates expert judgments using triangular fuzzy numbers to address uncertainty and vagueness in subjective assessments. In this study, expert evaluations were obtained from hospitality industry experts, halal certification officers, and academics, ensuring that the judgments reflected practical experience and contextual knowledge. Pairwise comparisons were conducted for each parameter, and fuzzy synthesis was applied to derive normalized weights, which were subsequently used to rank the risk parameters. This process allowed for a more reliable and nuanced prioritization of risks compared to traditional crisp AHP methods.

**TABLE 2** Weights and rankings of risk parameters using FAHP

|  |  |  |
| --- | --- | --- |
| Kriteria |  | Ranking |
| *Severity* | 0.4 | 1 |
| *Occurance* | 0.257143 | 3 |
| *Detection* | 0.342857 | 2 |

**TABLE 2** presents the calculated weights (W) and rankings of the three risk parameters, Severity (S), Occurrence (O), and Detection (D) as obtained from the Fuzzy Analytic Hierarchy Process (FAHP). The results indicate that Severity holds the highest priority weight (0.400), followed by Detection (0.343) and Occurrence (0.257). The FAHP results reveal that Severity is the most critical parameter in the risk assessment process, implying that risks with higher severity must be prioritized in mitigation strategies. This finding suggests that the hotel's management should focus first on reducing the potential impact of failures before addressing their likelihood or detectability. Detection ranks second, emphasizing the importance of improving monitoring and control mechanisms to identify potential risks early. Finally, Occurrence has the lowest weight, indicating that while the probability of risk happening is relevant, its influence on decision-making is lower compared to the other two factors.

**Ranking of Barriers Using Fuzzy MOORA**

The ranking of the 20 identified barriers to halal adoption in an international hotel restaurant in Malang was determined using the Fuzzy MOORA method. The calculation process in F-MOORA requires the weighted scores of the three critical risk parameters: Severity (S), Occurrence (O), and Detection (D). **TABLE 3** shows the final ranking based on the calculated Best Non-fuzzy Performance (Yi) values, where a higher Yi indicates a more critical barrier.

|  |  |  |  |
| --- | --- | --- | --- |
| **Rank** | **Barrier Description** | **Code** | **Yi Value** |
| 1 | The presence of a bar and alcoholic beverages is integrated with the restaurant. | H4 | 1.419311 |
| 2 | Lack of an internal halal supervisor | H2 | 1.376473 |
| 3 | High renovation costs for kitchen infrastructure to separate halal and non-halal areas | H15 | 1.178102 |
| 4 | Dependence on imported ingredients without halal certification is recognized in Indonesia. | H10 | 1.129547 |
| 5 | Unclear Standard Operating Procedures (SOP) for halal processes | H12 | 1.071006 |
| 6 | Difficulty in obtaining suppliers with halal certification | H7 | 1.047453 |
| 7 | Raw material receiving and storage areas do not separate halal and non-halal ingredients. | H6 | 0.983195 |
| 8 | Risk of cross-contamination during food production | H3 | 0.959641 |
| 9 | Difficulty in adjusting the existing kitchen layout to meet halal standards | H20 | 0.918938 |
| 10 | Lack of socialization regarding halal certification among hotel management | H13 | 0.895384 |
| 11 | Supply chain disruptions are causing uncertainty in the availability of halal ingredients | H11 | 0.849082 |
| 12 | Price fluctuations of halal-certified raw materials compared to regular ingredients | H14 | 0.829797 |
| 13 | The majority of non-Muslim employees lack understanding of halal standards | H8 | 0.806244 |
| 14 | Inconsistencies between foreign halal standards and Indonesian halal standards | H5 | 0.741986 |
| 15 | Low utilization of application-based halal management systems | H19 | 0.677728 |
| 16 | Misuse of halal labels by third parties | H9 | 0.654175 |
| 17 | Competition with non-halal hotels offering greater menu and service flexibility | H1 | 0.645437 |
| 18 | Absence of a digital system for comprehensive halal supply chain tracking | H17 | 0.589917 |
| 19 | Concerns about losing non-Muslim guests due to halal restaurant conversion | H16 | 0.58118 |
| 20 | Limited access to halal audit technology | H18 | 0.493369 |

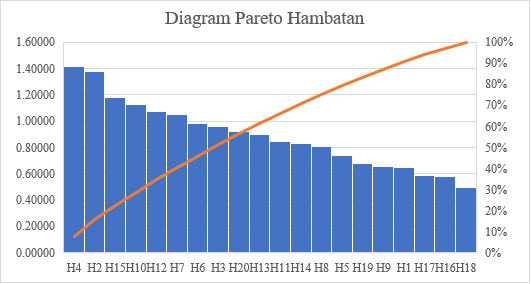
Fuzzy MOORA results show that the presence of a bar and alcoholic beverages integrated with the restaurant (H4) is the most critical barrier to achieving compliance with halal principles in the investigated international hotel in Malang. This finding highlights a significant incompatibility between the hotel’s operational practices and halal certification requirements, as the direct sale and service of alcoholic beverages are strictly prohibited under halal standards. Similar findings were reported by Ab Talib and Wahab [11], who noted that the coexistence of halal-certified facilities and non-halal elements, such as alcohol and pork-based products, creates a major challenge in the hospitality sector, particularly in Muslim-majority countries. Their study emphasized that even if food preparation meets halal requirements, the mere presence of prohibited items within the same service environment can erode consumer trust and hinder certification processes.

In the current study, the Fuzzy MOORA ranking places “H4” at the highest criticality level, followed by other barriers such as limited halal-certified suppliers and the absence of segregated kitchen facilities. This aligns with the findings of Othman and Md Nawi [12], who observed that physical separation of halal and non-halal operations is a prerequisite for compliance, and its absence often leads to non-conformity during audits. Moreover, the high ranking of H4 suggests that, beyond regulatory compliance, there is also a market perception risk. As Rahman, et al. [13] argue, Muslim customers increasingly value transparency in halal hospitality operations, and visible non-halal practices can deter their patronage regardless of the overall quality of service. In this case, the integration of alcoholic beverage services within the main restaurant area not only violates halal standards but also diminishes the hotel’s ability to attract Muslim guests seeking a fully halal experience.

From a managerial perspective, these results imply that immediate corrective actions are needed to either remove alcoholic offerings entirely from the premises or relocate them to an isolated section that is physically and operationally separated from halal dining facilities. This approach is consistent with the recommendations of Qurtubi, et al. [14], who suggested that hotels aiming for halal certification should adopt a "total segregation" policy to maintain integrity and gain consumer trust.

**Determination of Barrier Priorities Using the Pareto Diagram**

The prioritization of barriers was carried out using Pareto analysis based on the ranking results obtained from the Fuzzy MOORA method. As presented in **FIGURE 1**, the analysis aligns with the Pareto principle, which posits that approximately 80% of the overall impact is typically caused by around 20% of the most significant contributing factors. From the total of 20 barriers identified, four were classified as the primary priority barriers to be addressed.



**FIGURE** **1**. Preorientation of Barriers

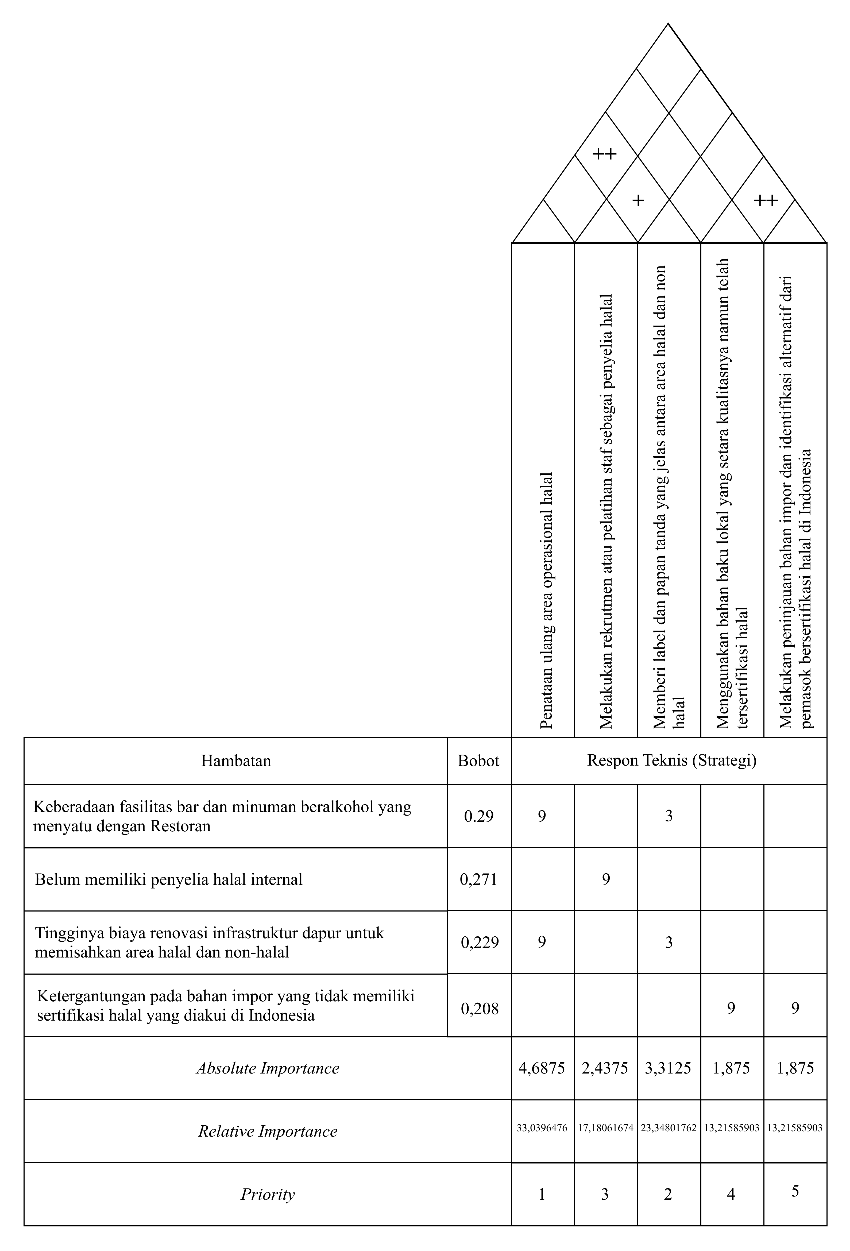
In accordance with the Pareto principle, the four highest-ranked barriers were identified as the main barriers for subsequent strategy formulation through the QFD approach, namely:

1. H4: The presence of a bar and alcoholic beverages is integrated with the restaurant.
2. H2: Absence of an internal halal supervisor.
3. H15: High cost of kitchen infrastructure renovation.
4. H10: Dependence on imported ingredients without halal certification.

These barriers exhibit interrelated characteristics rather than occurring as isolated issues. The substantial renovation costs (H15) represent a financial constraint that contributes to the continued existence of the integrated bar facility (H4). Furthermore, reliance on imported ingredients without halal certification (H10) is compounded by the absence of an internal halal supervisor (H2) capable of verifying suppliers and identifying certified local alternatives. This interconnectedness suggests that addressing these barriers individually would be insufficient; instead, an integrated and comprehensive strategy is required to effectively resolve the underlying problem structure.

**House of Quality (HOQ) Analysis**

The House of Quality (HOQ) matrix was developed to map the four critical barriers (“Whats”) against five proposed technical strategies (“Hows”). **FIGURE 2** illustrates the final HOQ output, including the priority ranking of each strategy based on its calculated Absolute Importance scores.



**FIGURE 2.** House of Quality (HOQ).

The HOQ analysis identified “Reorganizing halal operational areas” as the highest-priority strategy (Absolute Importance Score = 4.69). This strategy obtained the top ranking due to its strong correlation score (value = 9) in addressing two of the most critical barriers: H4 (integrated bar facility) and H15 (high renovation costs). Reorganization is widely recognized in the literature as a fundamental intervention for maintaining halal integrity, as it enables the segregation of halal and non-halal processes and reduces cross-contamination risk. Moreover, restructuring physical layouts has been shown to be a cost-effective long-term solution, particularly when renovation is implemented in stages to reduce financial burden [15]. The second-highest priority is “Implementing clear labeling and signage” (Score = 3.31), which the literature also identifies as a critical element in halal assurance systems. Clear and consistent signage supports both operational compliance and consumer trust by visually reinforcing halal status. It is a low-cost strategy that can be implemented immediately to reduce contamination risks, especially during transitional phases before full physical separation is completed. The technical correlation matrix (HOQ roof) indicates a very strong positive relationship (“++”) between labeling and reorganization, consistent with Su, et al. [16], who found that signage systems significantly enhance the effectiveness of facility layout modifications.

Ranked third, “Recruiting or training staff as halal supervisors” (Score = 2.44) directly addresses barrier H2. The literature emphasizes the pivotal role of trained personnel in halal supply chain management, as they act as custodians of halal integrity across operational stages. Halal supervisors are instrumental in ensuring that physical reorganization and labeling systems are correctly implemented and consistently monitored. This role also extends upstream to supplier verification, supporting barrier H10 resolution through the identification and validation of local halal-certified sources. The positive correlation (“+”) between training and labeling aligns with findings Rahman, et al. [13], who demonstrated that skilled personnel significantly improve compliance outcomes in halal-certified operations. The remaining two strategies, “Utilizing local raw materials” and “Reviewing imported ingredients,” though lower in priority, are consistent with the literature advocating for robust halal sourcing practices. Local sourcing can reduce reliance on imported ingredients, minimizing both certification complexity and potential risk of non-compliance, while ingredient review processes are essential to identify hidden non-halal components.

# **CONCLUSIONS**

This study identified and prioritized key barriers to halal certification within the food service sector using a systematic multi-method approach. The integration of Fuzzy AHP for ranking Severity, Occurrence, and Detection (SOD) factors, followed by Fuzzy MOORA and Pareto analysis, enabled a structured assessment of the most critical issues. The findings revealed four dominant barriers: integrated bar facilities serving alcoholic beverages, the absence of an internal halal supervisor, high kitchen infrastructure renovation costs, and reliance on non-certified imported ingredients. These barriers are not isolated challenges but form an interconnected system that reinforces one another, indicating that addressing them individually would yield limited impact. A holistic strategic approach is therefore necessary, targeting both structural and operational aspects to achieve sustainable halal compliance. The results provide a practical decision-making framework for industry practitioners, policymakers, and certification bodies to focus resources on high-impact barriers, thereby accelerating the adoption of halal standards. Future work can extend this study by exploring the dynamic interactions among barriers using system-based modeling and by validating the proposed prioritization framework across different sectors and geographical contexts. Such advancements would enhance the applicability and robustness of the methodology, ensuring its relevance in diverse operational environments.

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