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A Structured Decision-Making Approach for Supplier Performance Evaluation in the Restaurant Sector

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ABSTRACT

In the contemporary, highly competitive restaurant sector, securing high-quality food raw materials is pivotal to achieving sustained business success. An organised and systematic supplier selection process is fundamental for ensuring operational efficiency, cost control, and consistent service standards. The present study introduces a structured framework designed to assess and rank restaurant raw material suppliers by integrating subjective evaluations across multiple criteria. The proposed methodology follows a two-phase process. The first phase entails the identification of essential supplier evaluation criteria, utilising rank-based weighting methods to determine their relative significance from the perspective of restaurateurs in Thailand. In the second phase, the fuzzy technique for order preference by similarity to the ideal solution (fuzzy TOPSIS) is applied to assess and rank potential suppliers based on their aggregate performance. A practical case study is presented involving an independent full-service restaurant in Thailand that was required to select from four candidate suppliers. This case is used to demonstrate the effectiveness of the framework. Furthermore, a sensitivity analysis is conducted to examine the impact of different weighting approaches on the final supplier rankings. The results highlight eight key evaluation criteria: quality level, product cost, responsiveness speed, communication systems, delivery performance, lead time, fill rate, and process flexibility. Findings from the sensitivity analysis indicate that supplier rankings vary according to the weighting methodology applied, underscoring the necessity for adaptable decision-making models. Such flexibility is crucial as the relative importance of these criteria can shift in response to market dynamics or specific operational priorities. For restaurant operators, adopting a systematic approach is vital to address the inherent complexity and uncertainty of supplier assessments. Incorporating multiple weighting techniques can strengthen the robustness of selection processes. This study offers practical guidance for enhancing procurement strategies and competitive advantage, while also providing suppliers with valuable insights into industry requirements and expectations.

1. Introduction

Shifts in societal lifestyles have contributed to the rapid expansion of the restaurant sector, as

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an increasing proportion of individuals choose to dine out, host gatherings, and celebrate both personal and business occasions [80]. Consequently, restaurants have gained considerable popularity by offering convenience to their clientele. In addition, customer preferences are increasingly centred on speed and accessibility [35]. The rise of food delivery services and collaborations between restaurants and online platforms has further facilitated access to diverse dining options [5; 45; 67; 84]. This heightened demand has driven sustained industry growth, with leading businesses expanding multinational chains to cater to a broader and more diverse consumer base [36; 78]. However, the proliferation of restaurants has intensified competition and accelerated changes in consumer preferences [3; 16; 26]. Rising operational costs, including higher energy prices, legally mandated increases in minimum wages, and escalating raw material prices linked to global conflicts and increased logistics expenses, have further exacerbated these challenges [28; 69]. Under these circumstances, restaurant operators must adapt swiftly to maintain their competitive advantage.

Securing raw materials for food preparation, which form the basis of final menu items, is a fundamental element of restaurant operations. These establishments must procure a variety of products from multiple suppliers, including meat, vegetables, and packaging materials, each offering different prices and quality standards. Such inputs directly influence the taste, quality, cost, and profitability of the final product [52]. Therefore, selecting appropriate suppliers to provide high-quality materials at competitive prices is vital for achieving success in an increasingly competitive market [79]. Supplier selection constitutes a critical strategic decision that has a substantial effect on a restaurant's operational performance. Despite this importance, the process is often complex and demands careful evaluation [10]. Many operators rely on intuition and previous experiences rather than structured assessments, which may not always lead to the most suitable choice. While the restaurant industry generally operates with lower capital requirements and on a smaller scale than many other sectors, the adoption of systematic, rational supplier selection approaches is crucial. Such strategies function as decision-support tools that help achieve operational excellence and maintain competitive positioning.

Typically, supplier selection involves two stages: identifying the relevant evaluation criteria and selecting the most suitable suppliers according to these factors [15]. Like other industries, restaurants must take into account a combination of objective and subjective considerations. Although quality and cost remain central and widely adopted factors, operators often have additional concerns that necessitate the inclusion of other evaluation dimensions [55; 79]. Effective supplier evaluation often requires addressing both quantitative and qualitative criteria [65]. Given that many of these criteria are qualitative, assigning precise numerical values can be challenging. Decision-making in this context is frequently affected by uncertainty and subjectivity, as linguistic evaluations may lead to incomplete or inaccurate representations of reality [57; 63]. The complexity of decision-making increases with the number of criteria and potential suppliers under consideration [86]. This underlines the need for operators to adopt objective, structured evaluation methods, reducing reliance on subjective judgments [42]. Implementing a robust supplier evaluation framework can enhance competitiveness through improved service quality and procurement efficiency [7; 55]. Despite its significance, supplier selection in the restaurant sector, particularly among independent full-service establishments, remains insufficiently explored in academic research. While selection criteria have been studied across numerous industries, and certain factors are applicable across sectors, others are unique to specific business environments [40]. There is limited scholarly investigation into the factors influencing raw material supplier choice within the restaurant sector, especially concerning the inherent uncertainty, ambiguity, and vagueness of decision-makers' judgments.

Addressing this research gap holds considerable importance. First, independent full-service restaurants face distinctive challenges in supplier selection owing to their operational structures, quality requirements, and customer expectations [27; 80]. These businesses often operate with tighter profit margins and less negotiating power compared to large chains, making strategic supplier selection even more critical for profitability and long-term sustainability [54]. Second, as competition intensifies and investment in the restaurant industry grows, understanding and applying structured supplier selection methodologies becomes essential for procurement efficiency and cost management. Intuition-driven approaches are inadequate in today's complex and fast-changing business environment [9]. Consequently, there is an increasing need for decision-making frameworks that accommodate the subjective nature of certain evaluation criteria while ensuring consistency and efficiency in supplier selection [21]. Third, existing multi-criteria decision-making (MCDM) techniques have not been sufficiently tested or validated in the specific context of restaurant supplier selection. Combining rank-based weighting methods with the fuzzy technique for order preference by similarity to the ideal solution (fuzzy TOPSIS) offers a novel approach to address the unique challenges of supplier selection in independent full-service restaurants, where qualitative and subjective evaluations are prevalent.

This study seeks to close this gap by systematically presenting a process for assessing and selecting raw material suppliers for independent full-service restaurants. It aims to establish a comprehensive framework that incorporates the subjective judgments of decision-makers across multiple criteria for several potential suppliers. Through an analytical approach capable of effectively handling such subjectivity, the study delivers insights that can enhance supplier selection practices. It further contributes empirical evidence on how variations in criteria weights affect final supplier rankings, thereby improving understanding of the implications of different weighting techniques. This knowledge can help restaurants optimise resource allocation and strengthen procurement processes. The results also provide suppliers with insights into restaurant requirements, enabling them to refine their offerings and improve their competitive standing.

The objectives of the study are threefold: (1) to identify and prioritise the key criteria influencing supplier evaluation and selection in independent full-service restaurants, (2) to propose a method that facilitates supplier selection while addressing the uncertainty and subjectivity inherent in decision criteria, and (3) to validate the proposed approach through a case study and examine the sensitivity of rankings to different weighting methods. Rank-based weighting techniques are employed to determine the relative significance of the criteria, and fuzzy TOPSIS, a recognised tool for selection problems in academic and practical domains, is applied to assess supplier performance. A case study involving a restaurant in Thailand serves to illustrate the approach. To the best of current knowledge, this integration of rank-based weighting and fuzzy TOPSIS has not been previously applied to the selection of raw material suppliers in the restaurant sector. Since weighting methods can produce different rankings for the same alternatives, the study also compares results from four rank-based weighting techniques to assess ranking stability and validate the approach.

The paper is organised into six sections. Section 2 presents a literature review on raw material supplier selection in the restaurant industry. Section 3 outlines the research methodology, explaining the rank-based weighting methods and fuzzy TOPSIS. Section 4 identifies the main selection criteria for the restaurant sector and details the determination of their relative importance. Section 5 demonstrates the practical application of the framework via a case study of an independent full-service restaurant in Thailand and includes a sensitivity analysis exploring how different weighting methods influence rankings. The final section discusses managerial and practical implications, offers recommendations for improving supplier selection, and highlights the strategic value of systematic evaluation. It concludes by summarising the study's contributions, acknowledging its limitations, and suggesting avenues for future research.

2. Literature Review

Selecting appropriate raw material suppliers constitutes a strategic decision for restaurants, as it influences food quality, operational efficiency, cost control, and customer satisfaction [32]. Research within the restaurant sector, although still developing, has identified various methodologies and evaluation criteria for supplier selection [76]. For example, one study applied the AHPSort method to assess food and equipment suppliers in the United Kingdom, using eight criteria: quality, cost, delivery time, flexibility, line of credit, product range, distance, and relationship quality [38]. Another investigation employed a hybrid approach integrating analytic hierarchy process (AHP) and TOPSIS for shrimp supplier selection in Indonesia, focusing on quality, price, service, and delivery as the main factors [76]. Similarly, an analytical network process (ANP) combined with mixed integer programming (MIP) has been utilised to optimise supplier selection for sushi restaurants, considering price, delivery, flexibility, and quality [68].

Other studies have incorporated methods such as the Delphi technique followed by fuzzy AHP to determine and weight supplier evaluation criteria, highlighting factors including product variety, product quality, product yield, price, service, delivery time, and payment terms [31]. In the context of casual dining establishments in the United States, five main criteria—financial/technical, product, service, cost/price, and quality—have been identified, further subdivided into 26 sub-criteria [20]. Further analysis within the restaurant industry has revealed a broader set of 23 selection criteria, with cost, product quality, service technology, and finance ranking among the most influential [72]. Studies comparing supplier selection practices across Spain, France, and Morocco have classified 12 evaluation criteria into production quality, economic efficiency, social responsibility, and distribution [48]. Additional frameworks developed for chain restaurants have grouped 15 evaluation criteria into quality, price, supply capability, service level, and credibility, applying AHP to determine their relative weights [88].

Insights from related industries have also contributed to this domain. Research on eco-friendly supplier selection in the food sector using fuzzy grey relational analysis (GRA) identified 15 criteria across qualitative, delivery and service, financial, and environmental categories [12]. Investigations into seafood supplier selection have highlighted quality assurance and logistics as the most influential factors, followed by competitive ability, information technology, and crisis management [21]. In addressing uncertainty in perishable goods supply chains, stochastic mixed-integer programming models have been proposed that account for perishability, upstream and downstream disruptions, and age-dependent demand [8]. Within the food processing sector, critical criteria have been defined as cost, quality, service, delivery, and management for small and medium-sized enterprises [60]. Hybrid methodologies combining PROMETHEE and binary linear programming have also been used to evaluate green suppliers, categorising 15 sub-criteria into cost, quality, delivery, environmental impact, and technological capability [34].

Fuzzy logic-based and optimisation-oriented approaches have been applied in supermarket and beverage manufacturing contexts. Interval-valued intuitive fuzzy sets (IVIFSs) have been employed to assess food suppliers based on 15 criteria grouped into production environment, production equipment, personnel, raw materials, methodology, and management [46]. Genetic algorithms integrated with TOPSIS have been used to optimise supplier selection, incorporating organic material sourcing, consumer behaviour, and technological choices [49]. Similarly, AHP and quality function deployment (QFD) have been combined to weight supplier evaluation criteria for dairy enterprises, considering delivery time, quality, financial stability, corporate social responsibility, and environmental management [73]. Multi-method approaches including fuzzy multi-attributive border approximation area comparison (MABAC), fuzzy measurement alternatives and ranking according to the compromise solution (MARCOS), and fuzzy compromise ranking of alternatives from distance to ideal solution (CRADIS) have also been applied to green supplier evaluation [58], while AHP combined with ordered weighted averaging (OWA) and mathematical modelling has been implemented in agro-food sector partner selection [6]. TOPSIS, VIKOR, and GRA methods have been employed to assess food processing suppliers with emphasis on environmental management systems [11], and GRA-TOPSIS with interval-valued intuitionistic uncertain linguistic sets (IVIULSs) have been used in agri-food supplier evaluation [66].

Sustainability-focused procurement research is expanding in scope. PROMETHEE has been utilised to select green suppliers in organic food supply chains, considering both environmental management and green packaging alongside traditional cost and quality factors [1]. AHP-based models have been developed for catering supplier evaluation, incorporating food safety and company image [30]. Studies have identified specific operational considerations such as cold storage capacity and raw material handling in snack manufacturing contexts [41]. Hybrid game-theoretic frameworks integrating fuzzy AHP, TOPSIS, and ELECTRE have been used to evaluate organic food suppliers, incorporating certified organic status and corporate social responsibility [43]. Similar approaches in catering supplier selection have introduced crisis management and green production as key factors [37]. More recent contributions apply sustainability-driven methods such as fuzzy AHP with CoCoSo [75] and the MARCOS-D method [87] to evaluate sustainable food suppliers in contexts ranging from wine production to general food manufacturing. Research in the hospitality sector has revealed multi-dimensional supplier selection frameworks covering raw materials, services, financing, nutrients, environmental impact, and human factors [79]. Pythagorean CRITIC and MARCOS methods have further advanced sustainability evaluation by integrating social, economic, and environmental dimensions [82].

Despite these advances, notable gaps remain in the literature. First, comparative evaluations of multiple weighting methods within the same decision-making framework are scarce, particularly for independent restaurant operations. Second, many studies rely on generic supplier selection criteria rather than adapting them to the specific operational requirements of independent restaurants, which face distinct challenges compared to chain operations or general food processing. Third, the incorporation of uncertainty-handling tools such as fuzzy logic remains limited in restaurant-specific applications. Finally, most frameworks are tailored to large-scale enterprises, with little consideration for the constraints and decision-making processes characteristic of smaller, independently managed establishments. This study addresses these limitations by:

1. Identifying and ranking supplier evaluation criteria tailored to independent full-service restaurants, reflecting their operational realities.
2. Incorporating fuzzy logic to manage uncertainty in supplier performance assessment, ensuring methodological robustness.
3. Comparing alternative weighting methods to analyse their impact on supplier rankings and the stability of decision outcomes.
4. Proposing a decision-making framework that is accessible, resource-efficient, and applicable in real-world restaurant procurement contexts.

Through these contributions, the study enhances the literature on restaurant procurement and provides practitioners with a practical, systematic approach to supplier selection that can improve both supply chain efficiency and competitive positioning.

3. Methodology

3.1 Determination of Criteria Weights Using Rank Ordering Methods

Rank-ordering approaches are among the most straightforward methods for determining criterion weights in MCDM applications. In these techniques, decision-makers arrange the criteria in order of importance, assigning rank 1 to the most significant and progressively higher numbers to less important criteria. The assigned ranks are then converted into quantitative weights for use in decision analysis. The literature outlines several well-established rank-based weighting methods, with the most frequently utilised being the rank sum (RS), rank reciprocal (RR), and rank order centroid (ROC) techniques [13; 61; 81]. Although they share the same objective, each method applies a distinct mathematical process to convert ordinal rankings into cardinal weights.

For a decision problem with n criteria, where w_i denotes the weight of the i^{th} criterion and r_i signifies its rank position, the RS, RR, and ROC methods are mathematically defined as follows:

$$w_i^{\mathrm{RS}} = \frac{n-r_i+1}{\sum_{j=1}^{n}(n-j+1)} \quad (1)$$

$$w_i^{\mathrm{RR}} = \frac{1/r_i}{\sum_{j=1}^{n}(1/j)} \quad (2)$$

$$w_i^{\mathrm{ROC}} = 1/n \sum_{j=i}^{n} \frac{1}{j} \quad (3)$$

Furthermore, a method known as the SR weight approach has been proposed, which integrates the weight functions of RS and RR techniques [23]. The calculation procedure for this method is outlined as follows:

$$w_i^{\mathrm{SR}} = \frac{1/r_i + \frac{n-r_i+1}{n}}{\sum_{j=1}^{n}(1/j + \frac{n-j+1}{n})} \quad (4)$$

One important characteristic about all rank-based weighting methods is that the weights always add up to one ($\sum_{i=1}^{n} w_i = 1$), which ensures that decision analysis applications are properly normalised.

3.2 Performance Evaluation of Restaurant Raw Material Suppliers Using Fuzzy TOPSIS

The fuzzy TOPSIS method is an extension of the classical TOPSIS technique, which is designed to handle vagueness and ambiguity in decision-making processes. This is achieved by integrating fuzzy logic, which better captures the imprecision inherent in human judgment.

Step 1: Construct the Fuzzy Decision Matrix

Given a set of alternative suppliers $A = A_1, A_2, \dots, A_m$ and evaluation criteria $C = C_1, C_2, \dots, C_n$, the performance of each supplier relative to each criterion is represented by fuzzy numbers $\tilde{x}_{ij}$, where $i = 1,2, \dots, m$ and $j = 1,2, \dots, n$. Then, the fuzzy decision matrix $\tilde{X}$ where $\tilde{X} = \left[\tilde{x}_{ij}\right]_{m \times n}$ is constructed. Each $\tilde{x}_{ij}$ can be represented as a triangular fuzzy number (TFN) $\tilde{x}_{ij} = (a_{ij}, b_{ij}, c_{ij})$, where a_{ij}, b_{ij}, and c_{ij} denote the lower, middle, and upper limits of the fuzzy number, respectively.

Step 2: Normalize the Fuzzy Decision Matrix

The fuzzy decision matrix is normalized as matrix $\tilde{R} = \left[\tilde{r}_{ij}\right]_{m \times n}$ to facilitate comparison. For a TFN $\tilde{x}_{ij} = (a_{ij}, b_{ij}, c_{ij})$, normalization is performed as:

$$\tilde{r}_{ij} = \begin{cases} \left(\frac{a_{ij}}{c_j^*}, \frac{b_{ij}}{c_j^*}, \frac{c_{ij}}{c_j^*}\right) & \text{where } c_j^* = \max_i c_{ij} \text{ for benefit criteria, and} \\ \left(\frac{a_j^-}{c_{ij}}, \frac{a_j^-}{b_{ij}}, \frac{a_j^-}{a_{ij}}\right) & \text{where } a_j^- = \min_i a_{ij} \text{ for cost criteria.} \end{cases} \quad (5)$$

Step 3: Calculate the Weighted Normalised Fuzzy Decision Matrix

The normalized fuzzy decision matrix is multiplied by the criteria importance weights w_j to construct the weighted normalized fuzzy matrix $\tilde{V} = \left[\tilde{v}_{ij}\right]_{m\times n}$ where:

$$\tilde{v}_{ij} = \tilde{r}_{ij} \cdot w_j. \tag{6}$$

Step 4: Identify the Fuzzy Positive and Negative Ideal Solutions

The fuzzy positive ideal solution (FPIS) $\tilde{A}^*$ and fuzzy negative ideal solution (FNIS) $\tilde{A}^-$ are defined as:

$$\tilde{A}^* = (\tilde{v}_1^*, \tilde{v}_2^*, \dots, \tilde{v}_n^*) \qquad \text{where } \tilde{v}_j^* = \max_i\{v_{ij3}\}, \text{ and} \tag{7}$$

$$\tilde{A}^- = (\tilde{v}_1^-, \tilde{v}_2^-, \dots, \tilde{v}_n^-) \qquad \text{where } \tilde{v}_j^- = \min_i\{v_{ij1}\}. \tag{8}$$

Step 5: Calculate Distances from FPIS and FNIS

The distances of each supplier from FPIS and FNIS are computed as:

$$d_i^* = \sum_{j=1}^{n} d_v\left(\tilde{v}_{ij}, \tilde{v}_j^*\right) \tag{9}$$

$$d_i^- = \sum_{j=1}^{n} d_v\left(\tilde{v}_{ij}, \tilde{v}_j^-\right) \tag{10}$$

Where the distance measurement d_v between two TFNs $\tilde{A} = (l_A, m_A, u_A)$ and $\tilde{B} = (l_B, m_B, u_B)$ is calculated as:

$$d_v\left(\tilde{A}, \tilde{B}\right) = \sqrt{\frac{1}{3}\left[(l_A - l_B)^2 + (m_A - m_B)^2 - (u_A - u_B)^2\right]}. \tag{11}$$

Step 6: Compute the Relative Closeness Coefficient

The relative closeness coefficient (CC_i) of each supplier is calculated as:

$$CC_i = \frac{d_i^-}{d_i^* + d_i^-}. \tag{12}$$

Step 7: Rank the Suppliers

Suppliers are ranked according to their CC_i values, with the highest value indicating the best supplier.

The fuzzy TOPSIS method incorporates fuzzy logic to provide a robust framework for managing uncertainty and subjectivity, making it highly suitable for complex decision-making contexts [56]. This approach has been applied in various supplier selection studies across different sectors, including the pharmaceutical [50], internet [59], agriculture [17], automotive [32], and steel industries [39]. Several studies have integrated TOPSIS with rank-based weighting techniques to address selection problems. For instance, fuzzy TOPSIS was employed for supplier selection in a manufacturing firm, with RS, RR, and ROC methods used for criterion weighting [19]. Another study compared RS, RR, ROC, and rank exponent (RE) methods for weighting criteria in the context of e-learning, followed by the application of TOPSIS to determine the most effective e-learning strategy for a Malaysian university [51]. Additionally, RS ratios, TOPSIS, and fuzzy TOPSIS were utilised to evaluate hospital medical service capacities [85]. ROC weighting combined with TOPSIS was applied to select exemplary students [64], while another study used ROC weighting and TOPSIS to rank applicants for admission to state universities [70].

4. Criteria Affecting the Assessment and Choice of Restaurant Raw Material Suppliers

This analysis focuses on identifying the primary criteria considered by restaurant operators in the selection of raw material suppliers. A consolidated list of 14 potential criteria, determined based on their operational relevance to the restaurant sector, is presented in Table 1.

Table 1
Potential Criteria for Evaluating Restaurant Raw Material Suppliers

Criteria	Definition
1. Product Cost	Costs directly associated with a product.
2. Operation Cost	Ongoing expenses incurred in daily business operations.
3. Terms of Payment	Documentation detailing how and when customers pay for goods/services.
4. Quality Level	Degree of excellence and durability of products under normal operating conditions.
5. Quality Certificate	Certification of a company's quality management system.
6. Fast Responsiveness	Ability to quickly react to important or urgent situations.
7. Process Flexibility	Adaptability to changes in supply or demand.
8. Communication System	Systems for exchanging information between transmitter and receiver.
9. Lead Time	Time taken from the start to completion of a process.
10. Fill Rate	Percentage of customer orders fulfilled without stockouts.
11. Delivery Performance	Ability to effectively deliver services or goods to end customers.
12. Financial Status	Condition of a company's finances, including performance and operations.
13. Reputation and Financial Position	Public perception and operational status of the company.
14. Environmental Management System	Processes to reduce environmental impact and increase efficiency.

To identify the most critical criteria for supplier evaluation, each of the factors listed in Table 1 was assessed using a five-point Likert scale, where 5 corresponded to extremely important, 4 to very important, 3 to moderately important, 2 to slightly important, and 1 to not at all essential. The mean scores were subsequently calculated for all criteria, with those achieving a threshold above 4.21 considered highly pertinent to restaurant operations in the selection and assessment of raw material suppliers. These criteria were retained for further analysis, and the definitive set of selected factors is detailed in Table 2.

Table 2 presents the eight principal criteria that influence the evaluation and selection of raw material suppliers within restaurant operations, encompassing both qualitative and quantitative dimensions. While conventional supplier selection predominantly emphasises quality, price, and delivery due to their direct impact on operational efficiency and profitability [74], additional factors are particularly pertinent in the restaurant context. Timely responsiveness of suppliers is critical, enabling restaurants to adjust orders in response to peak periods or unforeseen shortages [47].

Table 2
Final List of Criteria

Code	Criteria	Average Score	Remarks
C1	Quality Level	4.6957	Retained
C2	Product Cost	4.6522	Retained
C3	Fast Responsiveness	4.6087	Retained
C4	Communication System	4.5652	Retained
C5	Delivery Performance	4.5217	Retained
C6	Lead Time	4.4783	Retained
C7	Fill Rate	4.4348	Retained
C8	Process Flexibility	4.2609	Retained
–	Terms of Payment	4.1304	Removed
–	Operation Cost	4.0000	Removed
–	Reputation and Financial Position	3.7826	Removed
–	Financial Status	3.6957	Removed
–	Environment Management System	3.4783	Removed
–	Quality Certificate	3.4348	Removed

Efficient communication systems are necessary for managing orders, resolving issues, and implementing modifications effectively. Lead time significantly affects inventory management, as shorter lead times facilitate frequent procurement of fresh ingredients and minimise the requirement for extensive storage. The fill rate reflects a supplier's capacity to fulfil orders completely and accurately, which is essential for seamless kitchen operations. Furthermore, the ability of a supplier to accommodate changes in order volume, frequency, or special requests is vital for establishments experiencing variable demand. Following the definition of these criteria, their relative importance was evaluated, recognising that each criterion may carry a distinct level of significance. In this study, criterion weights were derived using multiple rank-ordering techniques. Specifically, the RS, RR, ROC, and SR methods, as expressed in Equations (1)–(4), were employed to calculate the weights for the selected criteria (C1–C8). The resulting weights for each criterion, as determined by all four methods, are summarised in Table 3.

Table 3
Criteria Weights using RS, RR, ROC, and SR Methods

Criteria	w_i^{RS}	w_i^{RR}	w_i^{ROC}	w_i^{SR}
C1: Quality Level	0.2222	0.3679	0.3397	0.2771
C2: Product Cost	0.1944	0.1840	0.2147	0.1905
C3: Fast Responsiveness	0.1667	0.1226	0.1522	0.1501
C4: Communication System	0.1389	0.0920	0.1106	0.1212
C5: Delivery Performance	0.1111	0.0736	0.0793	0.0970
C6: Lead Time	0.0833	0.0613	0.0543	0.0750
C7: Fill Rate	0.0556	0.0526	0.0335	0.0544
C8: Process Flexibility	0.0278	0.0460	0.0156	0.0346

In the analysis of weighted criteria for selecting raw material suppliers, quality level consistently emerges as the most significant factor across all weighting methods, underscoring its central role in restaurant operations. The primacy of quality reflects its direct influence on food safety, consistency, and customer satisfaction [62], aligning with the operational demands of food service, where ingredient quality directly affects the final product presented to patrons [77]. Product cost ranks second in importance, reflecting the necessity for restaurants to balance quality with cost management in order to maintain profitability. This prioritisation illustrates the economic constraints faced by restaurants, where narrow profit margins coexist with the critical requirement to avoid compromising quality. Previous research in restaurant contexts [38; 68; 88] and studies on supplier selection within the food industry [1; 6; 60] similarly identify quality and cost as the most influential criteria. Fast responsiveness and communication systems occupy the third and fourth positions in relative importance, highlighting the significance of supplier relationships and effective information flow in an environment characterised by dynamic demand, perishable inventory, and time-sensitive operations. Rapid response and robust communication are essential for addressing urgent requirements and maintaining uninterrupted operations [33]. The remaining criteria, ranked sequentially, include delivery performance, lead time, fill rate, and process flexibility.

The prioritisation of weighted criteria in the restaurant sector differs from general supplier selection practices in several notable respects. Firstly, while conventional supplier selection often emphasises price and delivery, restaurants assign greater importance to quality. This difference reflects the unique nature of restaurant operations, where ingredient quality directly affects taste, safety, and customer experience in ways that are immediately perceptible compared to other industries [29; 53]. Secondly, criteria such as fast responsiveness and communication systems assume heightened importance in restaurants, contrasting with other sectors where these factors are typically secondary. This prioritisation acknowledges the operational realities of restaurants, including menu adjustments, special events, and fluctuating customer volumes, which necessitate prompt and accurate communication with suppliers [22]. Thirdly, although timely delivery remains significant, the moderate weight allocated to lead time suggests that restaurants may implement inventory strategies tailored to ingredients with varying shelf lives, thereby reducing the relative importance of lead time compared with non-perishable goods industries [14]. Finally, process flexibility is less emphasised in restaurant contexts than in manufacturing sectors, indicating that restaurants, while valuing some adaptability from suppliers, often operate with more standardised ordering procedures than manufacturing operations that frequently require customised components or services [25].

These findings underscore the necessity of developing context-specific criteria for supplier selection rather than applying generic frameworks across different industries. The distinct operational characteristics of restaurants—including perishable inventory, direct quality implications for customer experience, and fluctuating demand patterns—require specialised criteria for supplier evaluation. The weighted criteria identified in this study will serve as the basis for assessing the performance of raw material suppliers within the restaurant sector.

5. Selection of Restaurant Raw Material Suppliers

This section presents a case study on supplier selection for an independent full-service restaurant in Khon Kaen, Thailand. Four prospective meat and poultry suppliers, designated A1 through A4, were assessed using the fuzzy TOPSIS methodology against the eight critical criteria (C1–C8). The following subsections detail the application of the fuzzy TOPSIS approach to this case study. Initially, each supplier's performance was evaluated relative to the criteria using linguistic scales, which were represented as triangular fuzzy numbers (TFNs). These scales, adapted from prior studies [85], are summarised in Table 4. The linguistic evaluation enabled the effective incorporation of subjective judgments, facilitating a more accurate assessment of supplier performance in the restaurant context.

Table 4
Linguistic Scales for Supplier Evaluation

Linguistic Scales	TFN
Very Poor (VP)	(0, 1, 3)
Poor (P)	(1, 3, 5)
Fair (F)	(3, 5, 7)
Good (G)	(5, 7, 9)
Very Good (VG)	(7, 9, 10)

Using these scales, the fuzzy decision matrix $\tilde{X} = \left[\tilde{x}_{ij}\right]_{4\times 8}$ was constructed, as shown in Table 5.

Table 5
The Fuzzy Decision Matrix from the Evaluation of the Four Suppliers

Criteria	Supplier			
	A1	A2	A3	A4
C1	(7, 9, 10)	(3, 5, 7)	(7, 9, 10)	(3, 5, 7)
C2	(1, 3, 5)	(5, 7, 9)	(1, 3, 5)	(5, 7, 9)
C3	(3, 5, 7)	(5, 7, 9)	(3, 5, 7)	(7, 9, 10)
C4	(7, 9, 10)	(5, 7, 9)	(5, 7, 9)	(5, 7, 9)
C5	(3, 5, 7)	(5, 7, 9)	(0, 1, 3)	(3, 5, 7)
C6	(1, 3, 5)	(5, 7, 9)	(7, 9, 10)	(3, 5, 7)
C7	(0, 1, 3)	(3, 5, 7)	(5, 7, 9)	(3, 5, 7)
C8	(0, 1, 3)	(5, 7, 9)	(5, 7, 9)	(3, 5, 7)

The fuzzy decision matrix was then normalized using Equation (5). The normalized fuzzy decision matrix $\tilde{R} = \left[\tilde{r}_{ij}\right]_{4\times 8}$ is presented in Table 6.

Table 6
The Normalized Fuzzy Decision Matrix

Criteria	Supplier			
	A1	A2	A3	A4
C1	(0.7,0.9,1)	(0.3,0.5,0.7)	(0.7,0.9,1)	(0.3,0.5,0.7)
C2	(0.111,0.333,0.556)	(0.556,0.778,1)	(0.556,0.778,1)	(0.556,0.778,1)
C3	(0.3,0.5,0.7)	(0.5,0.7,0.9)	(0.3,0.5,0.7)	(0.5,0.7,0.9)
C4	(0.7,0.9,1)	(0.5,0.7,0.9)	(0.5,0.7,0.9)	(0.5,0.7,0.9)
C5	(0.333,0.556,0.778)	(0.556,0.778,1)	(0,0.111,0.333)	(0.5,0.7,0.9)
C6	(0.1,0.3,0.5)	(0.5,0.7,0.9)	(0.7,0.9,0.1)	(0.3,0.5,0.7)
C7	(0,0.111,0.333)	(0.333,0.556,0.778)	(0.556,0.778,1)	(0.333,0.556,0.778)
C8	(0,0.111,0.333)	(0.556,0.778,1)	(0.556,0.778,1)	(0.33,0.556,0.778)

To construct the weighted normalized fuzzy decision matrix $\tilde{V} = [\tilde{v}_{ij}]_{4\times 8}$ in accordance with Equation (6), the relative weights obtained using the RS method, as provided in Table 3, were applied in this case study. The resulting weighted matrix is presented in Table 7.

Table 7
The Weighted Normalized Fuzzy Decision Matrix

Criteria	Supplier			
	A1	A2	A3	A4
C1	(0.156,0.2,0.222)	(0.067,0.111,0.156)	(0.156,0.2,0.222)	(0.067,0.111,0.156)
C2	(0.022,0.065,0.108)	(0.108,0.151,0.194)	(0.022,0.065,0.108)	(0.108,0.151,0.194)
C3	(0.05,0.083,0.117)	(0.083,0.117,0.15)	(0.05,0.083,0.117)	(0.117,0.15,0.167)
C4	(0.097,0.125,0.139)	(0.069,0.097,0.125)	(0.069,0.097,0.125)	(0.069,0.097,0.125)
C5	(0.037,0.062,0.086)	(0.062,0.086,0.111)	(0,0.012,0.037)	(0.037,0.062,0.086)
C6	(0.008,0.025,0.042)	(0.042,0.058,0.075)	(0.058,0.075,0.083)	(0.025,0.042,0.058)
C7	(0,0.006,0.019)	(0.019,0.031,0.043)	(0.031,0.043,0.056)	(0.019,0.031,0.043)
C8	(0,0.003,0.009)	(0.015,0.022,0.028)	(0.015,0.022,0.028)	(0.009,0.015,0.022)

Subsequently, the FPIS and FNIS were calculated using Equations (7) and (8) to represent the positive and negative ideal solutions for the eight criteria. The corresponding values are presented as follows:

$\tilde{A}^{*}$=
[(0.156,0.2,0.222),(0.108,0.151,0.194),(0.117,0.15,0.167),(0.097,0.125,0.139),(0.062,0.086,0.111),(0.058,0.075,0.083),(0.031,0.043,0.056,),(0.015,0.022,0.028)]

$\tilde{A}^{-}$=
[(0.067,0.111,0.156),(0.022,0.065,0.108),(0.05,0.083,0.117),(0.069,0.097,0.125),(0,0.012,0.037),(0.008,0.025,0.042),(0,0.006,0.019),(0,0.003,0.009)]

The separation measures of each supplier from the FPIS and FNIS were subsequently computed using Equation (11). The calculated distances are summarised in Table 8.

Table 8.
The Distance between the Performance of Each Supplier and the FPIS and FNIS of Each Criterion

Criteria	$d_v(\tilde{v}_{ij}, \tilde{v}_i^{*})$				$d_v(\tilde{v}_{ij}, \tilde{v}_i^{-})$			
	A1	A2	A3	A4	A1	A2	A3	A4
C1	0	0.082	0	0.082	0.082	0	0.082	0
C2	0.086	0	0.086	0	0	0.086	0	0.086
C3	0.062	0.029	0.062	0	0	0.033	0	0.062
C4	0	0.024	0.024	0.024	0.024	0	0	0
C5	0.025	0	0.07	0.025	0.046	0.07	0	0.046
C6	0.047	0.014	0	0.031	0	0.033	0.047	0.017
C7	0.035	0.012	0	0.012	0	0.023	0.035	0.023
C8	0.018	0	0	0.006	0	0.018	0.018	0.011

The total distances (d_i^{*} and d_i^{-}) of each supplier from the FPIS and the FNIS were calculated utilizing Equations (9) and (10). The closeness coefficient (CC_i) for each supplier, which indicates overall performance, was finally computed using Equation (12). The computational outcomes, including the final ranking of suppliers, are presented in Table 9.

Table 9
The Aggregated Distances and the Closeness Coefficient CC_i of the Four Suppliers

Supplier	d_i^{*}	d_i^{-}	CC_i	Ranking
A1	0.2728	0.1518	0.3576	4
A2	0.1619	0.2637	0.6196	1
A3	0.2423	0.1822	0.4292	3
A4	0.1802	0.2446	0.5758	2

The results demonstrate that supplier A2 achieved the highest overall performance across the eight criteria, followed sequentially by A4, A3, and A1. To evaluate the robustness of the supplier rankings, a sensitivity analysis was conducted by recalculating the fuzzy TOPSIS using alternative weights derived from the RR, ROC, and SR methods as indicated in Table 3. The resulting rankings from these alternative weighting approaches, in comparison with the original RS-based rankings, are summarised in Table 10 and illustrated in Figure 1.

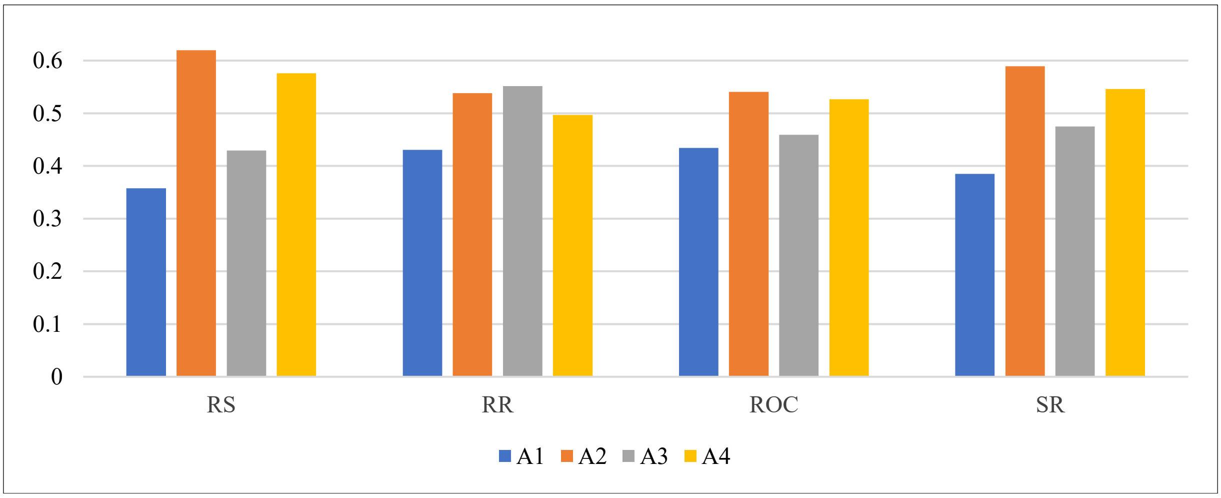

Fig.1: Comparative Ranking of Suppliers Based on the Four Weighting Methods

Table 10
Rankings Based on Different Weighting Methods

Supplier	RS		RR		ROC		SR	
	CC_i	Rank	CC_i	Rank	CC_i	Rank	CC_i	Rank
A1	0.3576	4	0.4309	4	0.4340	4	0.3852	4
A2	0.6196	1	0.5384	2	0.5407	1	0.5891	1
A3	0.4292	3	0.5516	1	0.4590	3	0.4751	3
A4	0.5758	2	0.4967	3	0.5269	2	0.5461	2

Across the various weighting methods employed, supplier A2 consistently ranks highest in three methods: RS, ROC, and SR. This strong performance indicates that supplier A2 maintained a satisfactory balance in overall performance across all eight evaluation criteria. The overall ranking pattern generally follows A2 > A4 > A3 > A1, with one notable exception. Supplier A3 presents an intriguing case. While ranking third under most weighting methods, supplier A3 achieves the top position under the RR approach. This deviation can be attributed to A3's outstanding performance in quality level (C1), which is given the highest weight in all methods but is particularly emphasised in RR. Suppliers with exceptional performance in the most critical criteria might rank differently across weighting methods depending on how significantly those criteria are weighted [83]. Nevertheless, A3's overall ranking persists at third in alternative methodologies, signifying that its efficacy is confined to specific criteria rather than uniformly applicable across all criteria.

The sensitivity in supplier rankings based on weighting methodologies offers significant insights into the impact of criteria weights on supplier selection. RR allocates the most relative weight to the paramount criterion (C1: quality level), exhibiting the most pronounced fall between the first and second criteria. This approach advantages suppliers with outstanding performance in the dominant criterion, explaining A3's superior ranking despite only moderate performance in other domains [61]. On the other hand, ROC establishes the most significant weight disparity between the highest and lowest criteria while keeping the mid-tier criteria fairly evenly distributed [4]. This equitable approach benefits suppliers such as A2, who have a robust overall performance [2]. The RS and SR techniques allocate weights more evenly across all criteria, thereby diminishing the predominance of any individual criterion [23; 24]. These methods generally prioritise suppliers that exhibit consistent performance across all evaluation criteria rather than exceptionalism in only one or two key criteria.

The observed variations in supplier rankings highlight the important impact of criteria weightings and the necessity to integrate flexible modifications in decision-making processes [18]. This means that supplier evaluation frameworks need to be flexible and responsive. The case study illustrates that the fuzzy TOPSIS method is effective for assessing restaurant suppliers under uncertain conditions. This approach takes into account that humans often make decisions under uncertainty while also providing a systematic framework for multi-criteria analysis [44]. The decision framework combines both rank ordering methods and fuzzy TOPSIS to highlight the importance of tailoring the weightings of the criteria to fit business goals while ensuring robust and reliable supplier evaluations [71]. Thus, it is important to develop adaptive supplier selection frameworks specific to each industry, especially in food service, where quality, responsiveness, and communication are of particular significance compared to other sectors.

6. Conclusion

The restaurant sector faces operational challenges in procurement, where selecting suitable suppliers is critical. Many operators rely on experience, making decision-making complex as selection criteria increase. This study provides a practical framework for assessing suppliers, addressing a gap in systematic research. Eight key criteria were identified for independent full-service restaurants: quality level, product cost, fast responsiveness, communication system, delivery performance, lead time, fill rate, and process flexibility. Rank-based weighting techniques confirmed quality as the most critical factor. Fuzzy TOPSIS was applied to evaluate suppliers, capturing uncertainty and subjectivity in decisions and demonstrating practical applicability for operators managing multiple operational responsibilities. The case study validated the framework and highlighted the influence of criteria-weighting methods on outcomes. Sensitivity analysis showed that rankings depend not only on supplier performance but also on how criteria are weighted. Supplier A2, with consistent performance across criteria, ranked highest overall, while supplier A3 excelled in quality under specific weighting approaches. The findings emphasise the need for flexible, systematic frameworks that allow dynamic adjustment of criteria weights to reflect changing market conditions, seasonal demands, or supply disruptions. Regularly updating criteria and re-evaluating supplier performance ensures reliable rankings. Hybrid supplier strategies, prioritising both high-quality and balanced-performance suppliers, can enhance operational efficiency and sustainability. While fuzzy TOPSIS effectively reduces subjective judgment, it does not incorporate precise numerical data. Future research could integrate exact and fuzzy information and explore alternative weighting methods such as AHP, DEMATEL, or SWARA. Combining subjective and objective approaches may further refine supplier evaluation, enabling comparisons between independent restaurants and chains to account for differences in operational scale and business models.

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Data Availability Statement

The datasets used and analysed during the current study available from the corresponding author on reasonable request.

Conflicts of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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