

In a competitive business environment, companies must carefully evaluate a range of complex factors to select suppliers that align with operational requirements and market demands. This study employs the Analytic Network Process (ANP) to identify and prioritize critical criteria for supplier selection, including halal certification, quality, sustainability, cost, delivery, flexibility, responsiveness, and technical capabilities. Data were collected through semi-structured interviews with supply chain managers and questionnaire-based surveys, integrating qualitative and quantitative insights. The ANP model was used to analyze the interdependence between these criteria, revealing that quality ranks highest (0.331), followed by halal certification (0.231) and cost (0.157). These findings highlight the priority given to maintaining high product quality and strict adherence to halal standards over short-term cost considerations. Supporting factors such as delivery, flexibility, responsiveness, technical capabilities, and sustainability were also evaluated for their roles in maintaining an efficient supply chain and meeting international logistics requirements. The structured ANP framework provides practical insights for halal instant food manufacturers, enabling them to optimize supply chain management and align with regulatory standards, market demands, and sustainability objectives. This approach enhances export capabilities and strengthens the competitive position of halal food producers in the global market

Keywords: Analytic Network Process (ANP), halal certification, instant food, supplier selection, supply chain management, sustainability, export markets

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1. Introduction

The halal food industry has experienced significant growth in recent years, driven by increasing demand from Muslim populations worldwide and non-Muslim consumers interested in halal products for their safety, ethical standards, and high-quality assurance. The global halal food market is projected to surpass 2 trillion USD by 2027, with Southeast Asia, the Middle East, and North Africa as major contributors to this growth (World Halal Forum, 2021). As a result, manufacturers of halal instant food products are increasingly seeking to expand their market reach through exports, necessitating a robust and reliable supply chain to ensure the quality and authenticity of their products.

In particular, the instant noodle industry in Indonesia exemplifies the challenges and opportunities faced by halal food producers aiming for export markets. Indonesia is the world's second-largest consumer of instant noodles, with over 12 billion servings consumed annually (World Instant Noodles Association, 2023). As the majority of its population is Muslim, halal certification plays a critical role in securing both domestic and international consumer trust. Additionally, Indonesia's instant noodle exports are rising, contributing to the country's economic development. According to Indonesia's Central Bureau of Statistics, the country's instant noodle exports reached 274.91 million USD in 2022,

SUPPLIER SELECTION FOR THE HALAL INSTANT FOOD AND EXPORT-ORIENTED INDUSTRY: A CASE STUDY USING ANP

Chauliah Fatma Putri

Corresponding author

Master of Industrial Engineering

Department of Industrial Engineering*

E-mail: chauliah@widyagama.ac.id

Iwan Nugroho

Doctor of Agribusiness, Professor

Department of Agribusiness*

Rangga Pahlevi Putra

Master of Computer Engineering

Department of Informatics Engineering*

*Universitas Widyagama Malang

Taman Borobudur Indah str., 3,

Malang, Indonesia, 65142

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marking a significant 11.42 % increase compared to the previous year.

Instant foods such as instant noodles have become widely consumed in the world. In fact, it is one of the basic needs in some areas of the world. Despite this potential, the supply chain for halal instant food products is complex. Companies must ensure that their suppliers meet stringent halal standards while also addressing other factors such as cost, sustainability, and technical capability [1]. The intricacies of international supply chains, particularly for halal-certified products, underscore the need for a strategic supplier selection process that prioritizes quality, flexibility, and compliance with both halal regulations and international trade requirements.

Previous research has highlighted the importance of quality in maintaining an effective supply chain [2–5], as well as food safety quality [6]. Research on halal food and halal certificates has also been widely developed. Research on supplier selection that considers sustainability is limited to public institutions [7] and food manufacturing in general [8, 9]. There is research on halal food production and export for SME. However, there is still very limited research conducted on halal supplier selection for export-oriented industries, especially in the instant food sector.

Therefore, research on supplier selection of halal and export-oriented instant food manufacturers considering some of these important criteria is relevant.

2. Literature review and problem statement

Related papers show that the global demand for instant processed foods is increasing rapidly, particularly for export, which requires strict compliance with food safety regulations. In producing high-quality halal instant foods for export, selecting suppliers that meet halal standards [10], comparative advantage [11], and sustainability is crucial [8, 9] given the high standards that must be met for competitive international markets. Thus, Food Safety Standard (FSS) is increasingly on the international agenda. This is relevant given that companies must select suppliers that not only meet product quality standards, but can also support operational sustainability and brand reputation, especially in a global context.

However, an unresolved question relates to the lack of consistency in implementing halal certification and food safety in various regions, especially for exported halal products. This challenge is related to the different levels of consumer awareness of HACCP certification and willingness to pay more for certified products in different countries [12]. The reason could be the objective difficulties associated with differences in standards among export destination countries, which require manufacturers to consider cost factors and the complexity of international trade regulations. Halal and food safety certifications, such as HACCP [6], add another layer of complexity to supply chain management [3, 4], especially in markets where similar standards are not yet in place.

An expensive part of the plan is meeting the requirements of multiple certification standards such as HACCP and TQM [2, 3]. This increases operational costs and can make it difficult for producers to remain competitive, given that export markets have uniquely diverse requirements, especially for halal products targeting global Muslim consumers.

An option to overcome the relevant difficulties could be to apply a Multi-Criteria Decision-Making (MCDM) method, such as the Analytic Network Process (ANP) that allows companies to consider multiple interdependent criteria [13]. This approach has proven effective in halal food supply chain research where factors such as cost, delivery, and halal compliance play a closely interrelated role. The application to the specific context of halal instant food supply chains for export-oriented businesses is limited. The additional complexities of international trade and halal regulations add to the challenges that have not been widely studied.

Despite extensive research on supplier selection in the food industry, gaps remain in addressing halal instant food suppliers, particularly for export businesses. While general criteria like cost, quality, and delivery are considered, halal instant food suppliers must also meet specific requirements such as halal certification, sustainability, and compliance with international standards like HACCP.

The halal instant food sector in Indonesia is growing rapidly due to increasing demand. However, the complexity of halal certification, sustainability, and quality control poses challenges for export expansion. Addressing these challenges requires a comprehensive approach to supplier selection, ensuring alignment with international standards and market expectations.

3. The aim and objectives of the study

The study aims to select suppliers for halal instant food products, especially for export-oriented businesses, integrating criteria like halal certification, cost, quality, sustainability, and technical capability with a focus on the halal instant food sector.

To achieve this aim, the following objectives are accomplished:

- to identify and prioritize key supplier selection criteria relevant to the halal instant food industry, based on existing literature and industry practices;
- to apply the Analytic Network Process (ANP) method to assess the interrelationships between these criteria;

4. Materials and methods

4.1. Object and hypothesis of the study

This research was conducted on export-oriented halal instant food companies in Indonesia. The main hypothesis of this research is that criteria including cost, delivery, flexibility, halal certification, responsibility, technical capability, and sustainability can lead to effective supplier selection. The assumptions made in this study are that instant food companies apply halal certification, export their products, and apply sustainability. The research concentrated on Indonesia's halal instant food manufacturers, which may not account for regional variations in supplier dynamics and halal standards globally. Semi-structured interviews were conducted with a limited group of supply chain managers.

This study employs a mixed-methods approach, integrating both qualitative and quantitative data to develop a comprehensive supplier selection model for halal instant food products, with a focus on export-oriented companies. The Analytic Network Process (ANP) method is used to model the complex interrelationships between supplier selection criteria, ensuring the model reflects the priorities of the halal food industry.

4.2. Data collection

The qualitative phase involves conducting semi-structured interviews with key stakeholders from the supply chain departments of leading halal instant food manufacturers in Indonesia. Participants include purchasing managers and suppliers responsible for sourcing raw materials and ensuring halal compliance. The purposive sampling method is used to select participants with direct involvement in the halal supply chain, ensuring relevant and insightful data. Interviews focus on key supplier selection criteria such as cost, delivery, flexibility, halal certification, and sustainability.

In the quantitative phase, a questionnaire survey is conducted using pairwise comparisons for ANP analysis. Participants rank supplier selection criteria, determining their relative importance, which is essential for establishing the criteria's weighted priorities.

Before the research is carried out, it is necessary to understand the flow of procurement processes that occur in the company. Fig. 1 shows the start of the submission process as a supplier until the supplier can be decided to be selected by the company as a supplier who truly meets the conditions and requirements determined by the company.

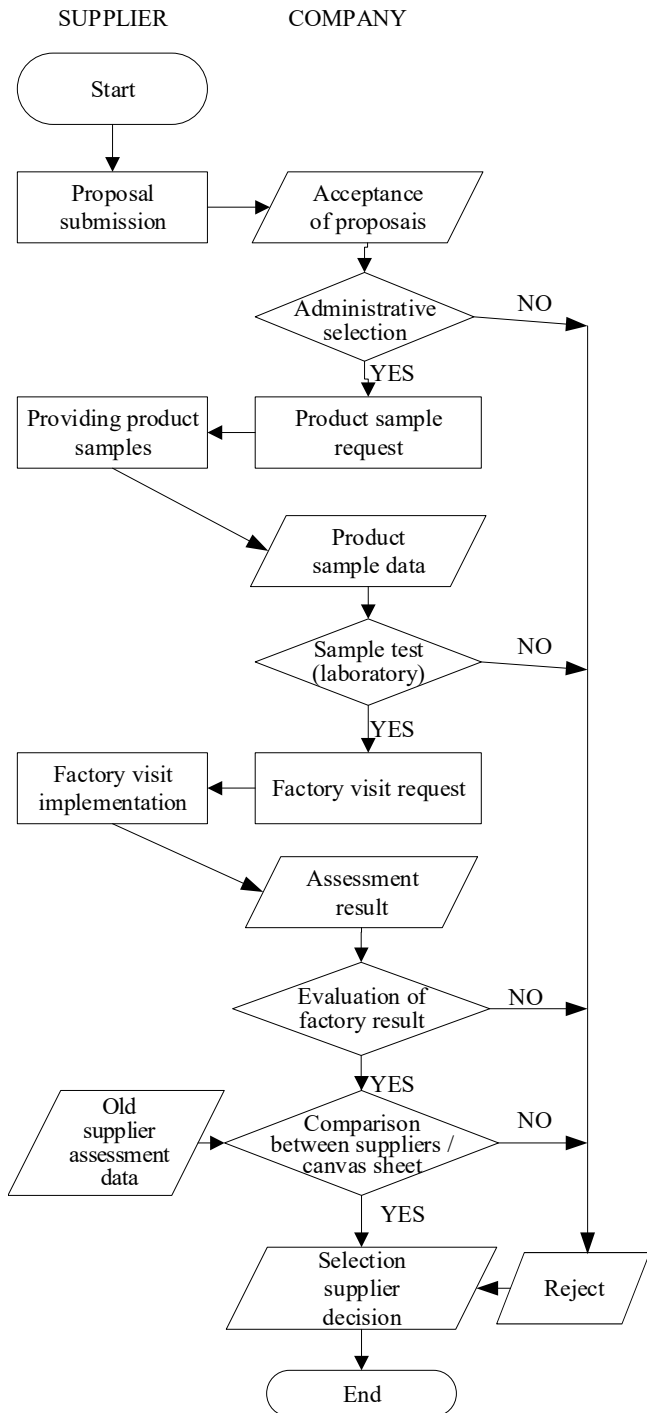


Fig. 1. Flow chart of supplier selection process for halal instant food

The supplier selection process begins with identifying potential suppliers who meet the qualifications for producing halal instant food products for export. The first step is pre-qualification, where suppliers are assessed based on key criteria such as halal certification, technical capability, and compliance with food safety standards (e. g., HACCP and ISO 9001).

After pre-qualification, suppliers undergo evaluation using the Analytic Network Process (ANP). This step involves assessing them on multiple criteria, including:

- cost – ensuring competitive pricing without sacrificing quality [2, 7, 14];

- delivery – evaluating the ability to meet delivery timelines and handle international shipping risks [10, 15, 16];
- flexibility – determining adaptability to changing market demands [16, 17];
- halal certification – ensuring strict adherence to global halal standards [10, 18];
- quality – assessing the consistency of product quality [2, 4] and compliance with safety standards, including HACCP certification [3, 12] and Food Safety Standard [6, 19];
- sustainability – measuring commitment to environmentally friendly practices [8, 9, 20, 21];
- responsiveness – ability to quickly address issues and changes [1, 9];
- technical capability – ensuring suppliers have the necessary expertise to meet product specifications [16, 19].

Based on these evaluations, suppliers are ranked, and the most suitable ones are selected. Contracts are negotiated, followed by continuous monitoring and performance reviews.

4. 3. Analytic network process (ANP)

The ANP method is selected due to its ability to handle interdependent relationships among multiple criteria, which is common in supply chain decision-making. When it comes to analysis, ANP is more adaptable and dynamic than conventional approaches to decision-making. To make decisions, ANP grouped the supplier selection criteria into clusters and determined how they related to one another [13]. The ANP analysis, performed using Super Decisions software, computes priorities and interdependencies between criteria, ensuring a comprehensive approach to halal food supplier selection.

4. 4. Sampling and study area

The study targets Indonesia’s leading halal instant food manufacturers, focusing on suppliers of key components like flour, spices, ingredients, seasoning, and oil, essential for certified halal food production and export activities.

5. Results of research identification of criteria, sub-criteria, and selection of suppliers

5. 1. Identification and prioritization of supplier selection criteria

These supplier selection criteria and sub-criteria can be explained in the structure in Fig. 2 below.

Fig. 2 above explains that in selecting suppliers of instant halal food producers for export orientation, it is necessary to pay attention to 8 criteria consisting of cost, delivery, flexibility, halal certification, responsiveness, technical capabilities, quality, and sustainability. Each criterion needs to be detailed by sub-criteria that represent a detailed explanation of the criteria. For example, the cost criterion can be explained by 3 sub-criteria. The delivery criterion is explained by 7 sub-criteria. Likewise, the criteria for flexibility, halal certification, responsiveness, technical capability, and sustainability can each be explained by 5 sub-criteria. While the quality criteria are explained by 9 sub-criteria.

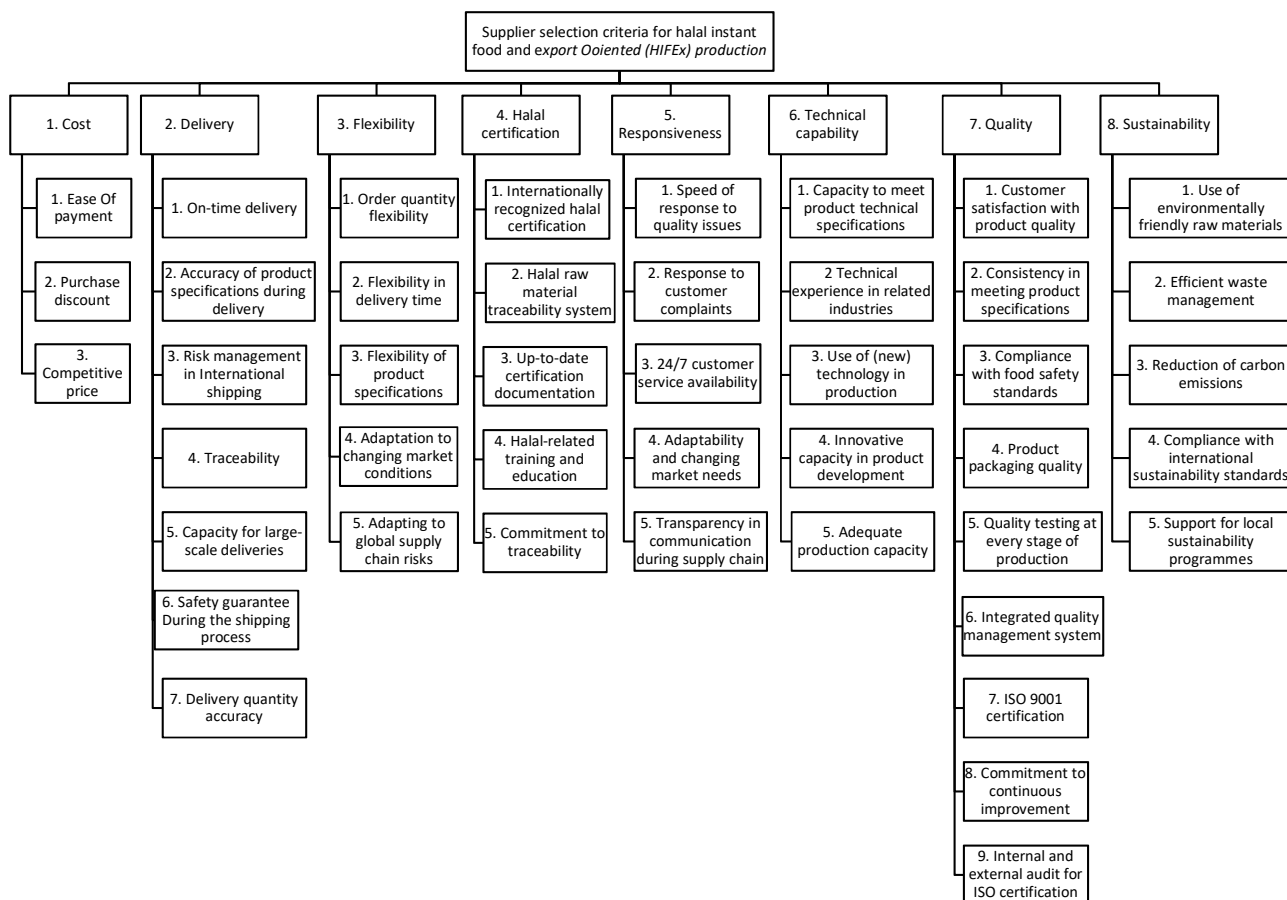


Fig. 2. Structure of criteria and sub-criteria for selection of HIFEx manufacturer suppliers

5. 2. Application of analytic network process (ANP) method

The ANP method analyzes supplier selection against criteria and sub-criteria not only quantitatively, but also qualitatively. Although this method is a development of the analytical hierarchy process (AHP) which has also been widely developed as Fuzzy Theory [22] or a combination with other methods such as COPRAS Hybrid [23], but ANP has other advantages. From the quantitative and qualitative analysis from ANP, findings were obtained. Furthermore, the results of the comparison of prospective supplier companies will be obtained, so that the company is selected as the most appropriate supplier. At the end of this ANP application, the validation of the model obtained is presented.

1. Quantitative analysis.

ANP results. Using the pairwise comparison data from the questionnaire survey, the analytic network process (ANP) was applied to evaluate the relative importance of the identified criteria. The analysis was conducted using Super Decisions software, which generated priority scores for each criterion, considering their interdependencies. The results of the drawing of the structure of criteria and sub-criteria in the selection of suppliers of Halal Instant Food and Export-Oriented (HIFEX) producers can be seen in Fig. 3.

In Table 1, the results of analysis with ANP at a high level of inconsistency (0.02942) are given. The ranking of supplier selection criteria: quality, halal certification, cost, delivery, flexibility, responsiveness, technical capability, and sustainability.

Quality ranked the highest (0.331), highlighting the importance of quality in avoiding rejection and financial losses in export markets. Halal certification comes next (0.231),

in line with findings that emphasize the importance of halal certification to meet domestic and international market demands. Interestingly, cost, which is often a top priority in many industries, was ranked third (0.157). Sustainability was ranked eighth (0.023), indicating the increasing importance of environmental considerations in the halal food supply chain.

Table 1

The overall ranking of criteria

Name	Normalized	Idealized
Cost	0.157235038	0.47456462
Delivery	0.10590333	0.319635969
Flexibility	0.070935607	0.214096869
Halal certification	0.230660008	0.69617485
Quality	0.331324822	1
Responsiveness	0.047681116	0.143910486
Sustainability	0.023562492	0.071115987
Technical capability	0.032697587	0.098687406
Inconsistency		0.02942

Interdependencies Between Criteria. The ANP analysis also revealed significant interdependencies between the criteria. For instance, halal certification was closely linked to quality and sustainability. This relationship can be explained by the fact that halal compliance requires rigorous quality control measures, such as ensuring that no cross-contamination with non-halal substances occurs. Similarly, sustainable practices often align with halal principles, which emphasize ethical and environmentally responsible food production.

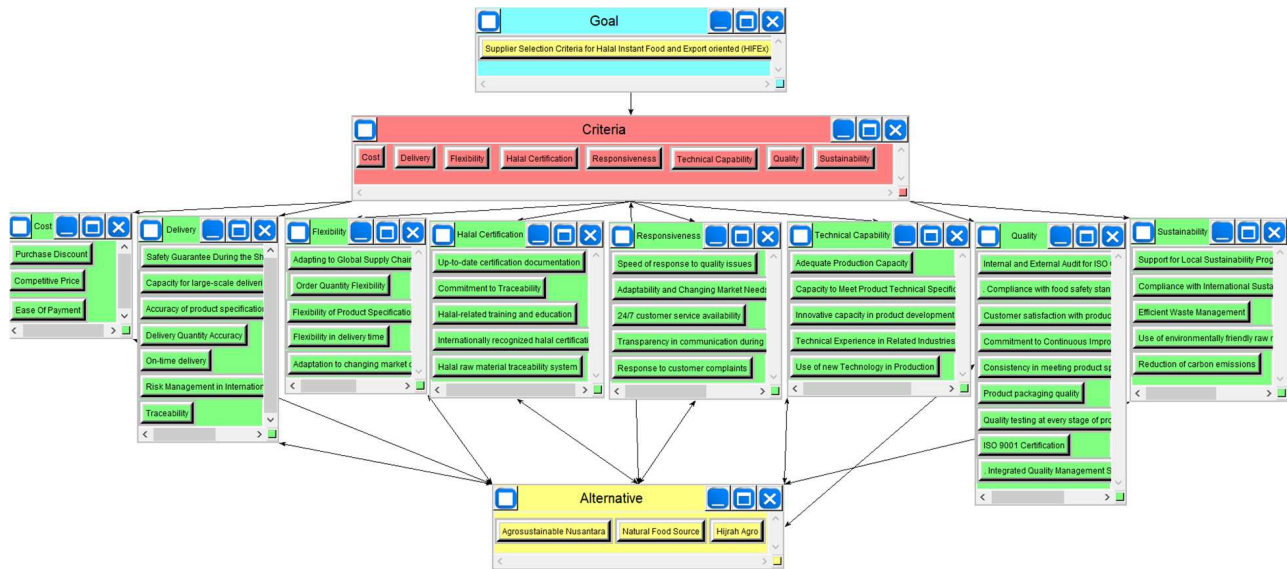


Fig. 3. Analytical network process (ANP) structure of criteria and sub-criteria for selection of HIFEx manufacturer suppliers

Technical capability was found to influence both quality and delivery. Suppliers with advanced technical capabilities are better equipped to meet stringent quality standards and ensure efficient, on-time delivery. However, the relatively lower ranking of technical capability (0.032) suggests that while it is important, it is seen more as a supporting criterion rather than a primary one.

2. Qualitative Findings.

Key supplier selection criteria. The qualitative phase, based on interviews with supply chain managers from leading halal instant food manufacturers in Indonesia, identified critical supplier selection criteria. These include cost, delivery, flexibility, halal certification, technical capability, quality, responsiveness, and sustainability, aligning with prior research.

Halal certification emerged as paramount, with respondents emphasizing robust traceability systems to ensure compliance throughout the supply chain. While quality is often a primary concern in general supply chain contexts, sustainability is increasingly critical. Suppliers adhering to environmental standards, reducing carbon emissions, and managing waste responsibly are preferred.

Technical capability, particularly in meeting export-quality standards and innovating, intersects significantly with quality assurance, including adherence to HACCP and ISO 9001. Cost and delivery remain fundamental, with competitive pricing and timely delivery vital for international trade.

The ANP analysis highlights that responsiveness is essential in the export-oriented sector for adapting to market demands, regulatory updates, or disruptions. Suppliers with strong communication and problem-solving capabilities provide a competitive edge. Responsiveness also ensures compliance with new halal standards and efficient documentation handling.

These findings emphasize interdependencies among criteria, with responsiveness and quality playing pivotal roles in ensuring timely deliveries and maintaining export market reputations.

3. Comparison between companies. The study also examined how different companies in the halal instant food sector prioritize these criteria. The three major companies included in the study were Agrosustainable Nusantara, Hijrah Agro, and Natural Food Source. This is shown in Fig. 4 below, which is a snapshot of the Super Decision software output.

The final results of the analysis of the selection of selected suppliers are Hijrah Agro, then Natural Food Source, and finally Agrosustainable Nusantara. In its application, 1 or 2 suppliers can be selected, or even all three, but with different order proportions.

While the priority analysis of each criteria of each company can be seen in Table 2 below.

Table 2

Priority of criteria in each company

Criteria	Agrosustainable Nusantara	Hijrah Agro	Natural food source
Cost	0.15724	0.17236	0.15719
Delivery	0.1059	0.15321	0.12014
Flexibility	0.07094	0.09052	0.0707
Halal certification	0.23066	0.18188	0.246
Quality	0.33132	0.20741	0.31481
Responsiveness	0.04768	0.07738	0.04139
Sustainability	0.02356	0.05189	0.01683
Technical capability	0.0327	0.06535	0.03294

Here are the overall synthesized priorities for the alternatives. You synthesized from the network Super Decisions Main Window: Supplier Selection Criteria for HIFEx 1.sdmod

Name	Graphic	Ideals	Normals	Raw
Agrosustainable Nusantara		0.878635	0.312733	0.153167
Hijrah Agro		1.000000	0.355931	0.174323
Natural Food Source		0.930901	0.331336	0.162278

Fig. 4. The Overall synthesized priorities for the alternatives of supplier selection

Agrosustainable Nusantara prioritizes quality and halal certification, aligning with its commitment to responsible production and exports to strict halal markets. Hijrah Agro emphasizes halal certification and quality for Middle Eastern consumers. Natural Food Source focuses on cost and delivery for Southeast Asia, while maintaining high importance on halal compliance.

Table 3 below is the result of the sub-criteria priority analysis of the quality criteria for each company.

Table 3

Priority of quality sub-criteria in each company

Sub-criteria quality	Agrosustainable Nusantara	Hijrah Agro	Natural food source
Commitment to continuous improvement	0.05405	0.02472	0.03515
Compliance with food safety standards	0.314	0.31211	0.31241
Consistency in meeting product specifications	0.15725	0.22234	0.15579
Customer satisfaction with product quality	0.10877	0.15547	0.22264
Integrated quality management system	0.02482	0.05066	0.02535
Internal and external	0.01839	0.01834	0.01837
ISO 9001 certification	0.21291	0.07385	0.0742
Product packaging quality	0.07464	0.10751	0.10519
Quality testing at every stage of production	0.03517	0.035	0.0509

For the quality criteria, all three companies are equally superior in the compliance with food safety standards sub-criteria, and even in almost every sub-criterion has the same ability priority assessment.

Table 4 below is the result of the sub-criteria priority analysis of the halal certification criteria for each company.

Table 4

Priority of halal certification sub-criteria in each company

Sub-criteria halal certification	Agrosustainable Nusantara	Hijrah Agro	Natural food source
Commitment to traceability	0.18349	0.17818	0.14466
Halal raw material traceability system	0.22863	0.25664	0.29133
Halal-related training and education	0.09716	0.09015	0.05703
Internationally recognized halal certification	0.43178	0.41551	0.42088
Up-to-date certification documentation	0.05894	0.05952	0.0861

For halal certification criteria, the three companies are equally superior in internationally recognized halal certification.

Meanwhile, Table 5 below is the result of the sub-criteria priority analysis of the cost criteria for each company.

In the delivery criteria, Hijrah Agro and Natural Food excel in terms of On-time delivery. meanwhile, Agrosustainable Nusantara excels in delivery quantity accuracy.

Table 7 below is the result of the sub-criteria priority analysis of the flexibility criteria for each company.

Table 5

Priority of cost sub-criterion in each company

Sub-criteria cost	Agrosustainable Nusantara	Hijrah Agro	Natural food source
Competitive price	0.29696	0.38737	0.59363
Ease of payment	0.53961	0.1692	0.15706
Purchase discount	0.16342	0.44343	0.24931

In the cost theory, the three companies have different advantages. Natural Food Source has an advantage in competitive price. Agrosustainable Nusantara excels in ease of payment. Meanwhile, Hijrah Agro excels in purchase discount.

The following, Table 6 is the result of the sub-criteria priority analysis of the delivery criteria for each company.

Table 6

Priority of delivery sub-criterion in each company

Sub-criteria delivery	Agrosustainable Nusantara	Hijrah Agro	Natural food source
Accuracy of product specifications during delivery	0.15865	0.15865	0.10496
Capacity for large scale deliveries	0.04477	0.03117	0.03145
Delivery quantity accuracy	0.35428	0.23993	0.24437
On-time delivery	0.23993	0.35428	0.33671
Risk management in international shipping	0.03117	0.04477	0.04522
Safety guarantee during the shipping process	0.10362	0.10362	0.16897
Traceability	0.06756	0.06756	0.06833

Table 7

Priority of flexibility sub-criterion in each company

Sub-criteria flexibility	Agrosustainable Nusantara	Hijrah Agro	Natural food source
Adaptation to changing market conditions	0.06119	0.16287	0.08591
Adapting to global supply chain risks	0.08943	0.06257	0.05994
Flexibility in delivery time	0.15709	0.36993	0.46142
Flexibility of product specifications	0.29837	0.30588	0.14438
Order quantity flexibility	0.39391	0.09875	0.24836

In the flexibility criterion, Natural Food excels in terms of flexibility, as well as Hijrah Agro but still below it. Meanwhile, Agrosustainable Nusantara excels in order quantity flexibility.

Table 8 below is the result of the sub-criteria priority analysis of the responsiveness criteria for each company.

For the responsiveness criteria, the three companies are equally superior in speed of response to quality issues, and response to customer complaints. In fact, almost every sub-criterion has the same ability priority assessment.

Next, Table 9 below is the result of the sub-criteria priority analysis of the technical capability criteria for each company.

Hijrah Agro and Natural Food Source companies are equally superior in terms of Adequate production capacity. Meanwhile, Agrosustainable Nusantara has an advantage in capacity to meet product technical specifications.

Table 8
Priority of responsiveness sub-criterion in each company

Sub-criteria responsiveness	Agrosustainable Nusantara	Hijrah Agro	Natural food source
24/7 customer service availability	0.11587	0.06222	0.07195
Adaptability and changing market needs	0.06238	0.09823	0.08609
Response to customer complaints	0.27567	0.23102	0.30708
Speed of response to quality issues	0.37628	0.42306	0.37081
Transparency in communication during supply chain	0.16979	0.18548	0.16407

Table 9
Priority of technical capability sub-criterion in each company

Sub-criteria technical capability	Agrosustainable Nusantara	Hijrah Agro	Natural food source
Adequate production capacity	0.30818	0.45502	0.4196
Capacity to meet product technical specifications	0.37144	0.23411	0.26352
Innovative capacity in product development	0.06303	0.08671	0.07098
Technical experience in related industries	0.14302	0.16791	0.16107
Use of new technology in production	0.11433	0.5625	0.08477

Finally, Table 10 is the result of the sub-criteria priority analysis of the sustainability criteria for each company.

Table 10
Priority of sustainability sub-criterion in each company

Sub-criteria sustainability	Agrosustainable Nusantara	Hijrah Agro	Natural food source
Compliance with international sustainability standards	0.43121	0.16442	0.43987
Efficient waste management	0.09182	0.42641	0.15565
Reduction of carbon emissions	0.06126	0.05478	0.05796
Support for local sustainability programmes	0.25832	0.08934	0.0907
Use of environmentally friendly raw materials	0.15739	0.26504	0.25583

Based on sustainability criteria, Agrisustainable Nusantara excels in the sub-criteria compliance with International sustainability standards and support for local sustainability programmes. Natural Food Sources also excel in compliance with international sustainability standards and use of environmentally friendly raw materials while Hijrah Agro excel in the efficient waste management and use of environmentally friendly raw Materials.

4. Model validation. To validate the supplier selection model, expert judgment and empirical testing were conducted. Industry experts were consulted to review the model's criteria and their interrelationships. The experts agreed that the identified criteria were appropriate and reflective of the key considerations in selecting suppliers for halal instant food products. Additionally, the model was applied

to real-world supplier selection scenarios in the companies studied, and the results indicated that the ANP model successfully helped these companies make more informed, balanced decisions in their supply chain management.

6. Discussion on the results of supplier selection criteria and sub-criteria prioritization

This study developed a supplier selection model for halal instant food products, using ANP to identify and prioritize key criteria, with a focus on export-oriented businesses:

1. The role of quality in the halal supply chain.

Quality emerged as the most critical factor in supplier selection, with a priority score of 0.331 (Table 1). This finding is in line with studies by [1] that maintaining consistent product quality is crucial in food supply chains, especially for exports [19], with HACCP [3] and ISO 9001 [4] ensuring safety and compliance with international standards. The link between quality and halal certification (Fig. 3) ensures both technical compliance and adherence to halal standards.

Halal certification requires strict quality control to prevent cross-contamination with non-halal substances. As illustrated in Fig. 3 and Table 1, halal certification was ranked second (0.230), confirming that the two factors-quality and halal certification are the most significant in the supplier selection process for halal instant food manufacturers.

2. Halal certification as the priority.

The results clearly demonstrated that halal certification is the critical criterion in supplier selection for halal instant food producers, with a priority score of 0.231 (Table 1). This is consistent with previous studies, which emphasize the importance of halal compliance in the food industry [24]. The link between halal certification and quality, shown in Fig. 3, confirms that essential for export markets, to ensure compliance and authenticity, particularly in Saudi Arabia and Malaysia.

Halal certification reflects increasing global consumer demand for halal products [25]. As the halal food market continues to grow globally, non-Muslim consumers are also increasingly opting for halal products due to their perceived ethical and health benefits. Halal certification is both a religious requirement and a quality standard, including for teenagers.

3. Cost vs. halal compliance and quality.

Although cost is typically a top priority, it ranked third (0.157) in this study, indicating halal compliance and quality are more important for halal instant food manufacturers [19]. Halal food companies prioritize certified suppliers, even at a premium cost.

Cost remains important, with interdependencies between cost, delivery, and sustainability, where sustainable practices can reduce long-term operational expenses and offer competitive pricing.

4. The importance of delivery, flexibility, responsiveness, and technical capability.

Delivery ranked fourth (0.106), emphasizing its importance for timely, reliable export shipments (Table 1). Interdependencies between delivery, quality, and halal certification (Fig. 3) highlight that delays can compromise product integrity [26], especially for perishable halal instant food [10, 16, 24].

The relatively lower ranking of flexibility (0.048) and responsiveness (0.071) indicates that while these factors are

important, they are secondary considerations compared to quality and halal certification. Technical capability ranked seventh (0.0327), ensuring suppliers meet export market requirements, including packaging, labeling, and safety standards [11, 27, 28].

5. Sustainability as a growing concern.

The study found that sustainability is becoming an increasingly important criterion, ranking eighth with a priority score of 0.024 (Table 1). Global food companies face pressure to adopt sustainable practices and reduce environmental impact [28]. Halal principles promote sustainability through ethical treatment, resource responsibility, and waste reduction [8, 9, 20, 21].

The growing emphasis on sustainability aligns with SDG 12, requiring halal food producers to meet both halal and sustainability standards for competitiveness [11, 27]. ANP analysis shows sustainability, cost, and quality are interdependent, with sustainability enhancing long-term savings and quality.

6. Practical implications of the model.

This supplier selection model helps halal food manufacturers prioritize certification, quality, and sustainability for export market success (Table 1). The ANP method (Fig. 3) offers a structured approach to evaluating suppliers based on interrelated strategic criteria.

The model emphasizes the interdependencies between criteria like quality and halal certification, as well as cost and delivery. These insights guide companies in selecting suppliers who foster long-term trust and profitability [27, 29]. Delivery ranked fourth in the ANP results, highlighting its importance in supplier selection for halal instant food. Timely delivery is vital to avoid disruptions and financial losses in export markets [11, 21, 27]. Previous studies highlight the importance of delivery in global supply chains, especially for perishable goods like food products [24], where late deliveries can result in spoilage and non-compliance with contractual obligations. Previous studies emphasize delivery's importance for perishable goods, preventing spoilage and contract violations.

Responsiveness ranked sixth in the ANP analysis, indicating it's valuable but not as critical as halal certification, quality, and sustainability. It involves adapting to changes and handling issues like delays or complaints. Studies [12] help companies minimize disruptions and manage market demand fluctuations.

Although ranked lower, responsiveness supports strong supplier-buyer relationships [30]. Suppliers who adapt quickly to changing halal standards or export requirements are valuable partners. Suppliers must quickly address halal compliance issues to prevent delays or recalls. Responsive communication builds trust by addressing shipment and logistical issues.

In summary, delivery and responsiveness, though lower-ranked, remain crucial factors for success. Delivery ensures that products arrive on time and in the required condition, a key factor in maintaining product integrity in the export market. Responsiveness allows suppliers to adapt to unforeseen circumstances, providing flexibility. Both delivery and responsiveness significantly enhance the overall halal instant food supply chain.

The supplier selection model in this study provides a robust framework for identifying suppliers aligned with halal procurement and sustainability goals. Key criteria such as quality, halal certification, cost, delivery, flexibility,

responsiveness, technical capability, and sustainability are prioritized, with quality and halal certification emphasized to ensure supply chain integrity and compliance with international standards.

By considering interdependencies, the model supports selecting suppliers committed to eco-friendly practices and sustainable production. It enhances supply chain efficiency, particularly for export-oriented companies, and should be regularly updated to adapt to evolving regulations and market demands.

The study's limitations include its geographic focus on Indonesia and emphasis on the halal instant food sector, which may limit generalizability to other regions or industries. It simplifies real-world complexities through predefined criteria in the analytic network process (ANP) model and relies on subjective qualitative data from a limited group of stakeholders.

Future research could expand to other regions and halal food sectors to identify broader patterns and challenges, enhancing the model's global applicability. Incorporating dynamic decision-making frameworks, advanced technologies like blockchain for traceability, and a stronger focus on sustainability could address evolving market demands and regulatory requirements. These developments are crucial as they align with global trends in halal certification, ethical practices, and efficient supply chain management, ensuring the model remains relevant and adaptable in a rapidly changing industry.

7. Conclusions

1. A supplier selection model for export-oriented halal instant food manufacturers has been successfully identified to select suppliers with a competitive advantage and appropriate in meeting applicable requirements and conditions. Supplier selection criteria and sub-criteria for export-oriented halal instant food manufacturers have been identified as having 8 main criteria with 44 sub-criteria that are important to consider. The study successfully developed a supplier selection model for export-oriented halal instant food manufacturers using the Analytic Network Process (ANP). The model identifies and prioritizes eight key criteria: quality, halal certification, cost, delivery, flexibility, responsiveness, technical capability, and sustainability. By integrating these factors, the study addresses unique challenges in the halal food sector, particularly the need for quality control and religious compliance. This tailored approach bridges the gap between operational efficiency and adherence to halal standards, providing a structured framework for optimizing supplier selection.

2. Using the ANP method, the interrelationship between criteria can be assessed and the results of the prioritization of consecutive criteria based on the level of importance are product quality and service, halal certification, cost, delivery, flexibility, responsiveness, technical capabilities, and sustainability. The results emphasize the importance of quality (0.331) and halal certification (0.231), which outrank cost (0.157), reflecting the industry's commitment to long-term value and market trust. Comparative evaluations of suppliers revealed varying strengths, such as cost efficiency or sustainability, demonstrating the need for a balanced approach based on specific market demands. The model's low inconsistency (0.02942) validates its re-

liability, making it a strategic tool for navigating complex supply chain requirements and enhancing competitiveness in global export markets.

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Conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this paper. The research was conducted independently, and no financial, commercial, or personal relationships have influenced the results or conclusions presented in this study. All data and findings are based on objective analysis and are free from any bias that could affect the integrity of the research.

Data availability

The manuscript has no associated data.

Use of artificial intelligence

The authors confirm they did not use artificial intelligence technologies when creating the current work.

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