JURIT
P-ISSN: 2987-7261
E-ISSN: 2987-7253

JURIT
Jurnal Riset Ilmu Teknik

Journal homepage: https://jurnaljepip.com/index.php/jurit
Vol 2, No. 1, pp;49-60, 2024
DOI: 10.59976/jurit.v2i1.64

Performance Analysis Of The Cake Ingredients Supply Chain Integration Of Scor And Fuzzy AHP

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Submitted:04/13/2024; Reviewed: 05/19/2025; Accepted: 05/28/2024

This study aims to analyze the performance of the raw material supply chain in a seasonal food MSME by integrating the Supply Chain Operations Reference (SCOR) model and the Fuzzy Analytical Hierarchy Process (F-AHP) method. The object of the study is ABC MSME, which produces strawberry mochi with a make-to-order system and some make-to-stock. The main problem faced is the delay in the supply of strawberry raw materials which causes a decrease in customer satisfaction and an increase in distribution costs. The analysis was carried out by identifying performance indicators, assigning priority weights using F-AHP, and calculating the final value of supply chain performance. The results showed that the indicators with the largest contribution were product defects from production (17.63), delivery item accuracy by the company (15.67), and delivery quantity accuracy by the supplier (9.41). Meanwhile, the indicator with the lowest contribution was timely delivery performance by the supplier (1.14). The total value of ABC MSME's supply chain management performance reached 71.20, which is categorized as good. This finding emphasizes the importance of improving production quality, distribution accuracy, and coordination with suppliers to improve supply chain reliability and responsiveness. This research provides a theoretical contribution in the development of a seasonal product-based SCM performance evaluation model, as well as a practical contribution in the form of an SCM improvement strategy for similar MSMEs.

Keywords: F-AHP, Performance Measuremen SCOR, Supply Chain Management (SCM)

INTRODUCTION

The development of the food industry in Indonesia shows rapid growth in line with increasing consumer demand and changes in consumption patterns. MSMEs, as one of the drivers of the national economy, have a strategic role in meeting market demand [1]. However, increasingly fierce competition requires MSMEs to have an efficient supply chain system in order to maintain quality and production timeliness [2].

The object of this study is a business that produces sweet foods, specifically strawberry mochi, using a make-to-order production system and a partial make-to-stock system for offline sales.

However, there are often delays in the supply of the main raw material, namely strawberries. Demand data from October 2022 to October 2023 shows that there were 495 pieces of unfulfilled demand. These delays incur additional transportation costs, slow down the production process, and reduce customer satisfaction.

The instability of raw material supply poses a threat to the sustainability of MSMEs. If left unaddressed, this condition can reduce customer loyalty, decrease revenue, and hinder business growth. Supply chain performance analysis is needed to identify weaknesses and determine improvement strategies based on measurable indicators so that MSMEs can improve supply reliability and operational efficiency.

A number of studies have examined the performance of MSME supply chains using the SCOR and AHP approaches, for example in the coffee, bakery, and batik industries. The results show the importance of supply reliability and production quality factors. However, most of these studies focus on non-perishable products or raw materials that are not particularly seasonal, so they are not entirely relevant to the characteristics of strawberry raw materials, which are highly influenced by the season and the agricultural distribution chain.

To date, research combining the SCOR model with the Fuzzy Analytical Hierarchy Process (F-AHP) specifically for food MSMEs using seasonal raw materials remains limited. There have not been many studies exploring specific performance indicators for fresh products such as strawberries, which have high damage rates and require more precise supply planning. This gap opens up opportunities for research to develop more adaptive supply chain performance evaluation methods.

This study integrates the SCOR model as a framework for identifying key supply chain processes (plan, source, make, deliver, return) with the F-AHP method to assign priority weights to each performance indicator. This combination of methods allows for a more comprehensive and accurate analysis in determining the most critical indicators while providing data-driven improvement recommendations.

Based on this background and gaps, this study aims to: (1) identify the indicators that most influence the supply chain performance of ABC MSMEs, (2) quantitatively measure the level of supply chain performance, and (3) formulate performance improvement strategies based on indicator priorities using the integration of SCOR and F-AHP. The research results are expected to serve as a practical reference for similar MSMEs in improving the reliability and competitiveness of their supply chains.

METHOD

Therefore, to solve problems and achieve research goals where problems that occur in companies are related to the supply chain [3]. To solve these problems, supply chain perfor- mance measurements are carried out using the SCOR (Supply Chain Operation Reference) method. According to [4][5] Fuzzy AHP (F-AHP) is a fusion of designs be- tween AHP using fuzzy perception starategy [6]. Fuzzy-AHP design can overcome the limita- tions of AHP design, namely accuracy in the improvement of Multi criteria decision making which has parameters characterized by bias. Foster AHP's Fuzzy strategy by applying the ability of three-sided registration or Tringular Fuzzy Number to replace the scale of 1-9 on paired examination of AHP techniques in making decisions about participation rates. The first stage of data processing in this study is to conduct Data Collection, which iscollected in the form of primary data and secondary data [7]. Primary data is data obtained directly from companies such as questionnaires and conducting interviews with companies [8]. Furthermore, the stages of data processing, in the initial stages of data processing carried out are as follows [9]:

1. Determine the matrix of each level of SCM performance measurement by identifying level 1 matril, namely the SCM process (plan, source, make, dekiver, return), level 2, namely the SCM performance measurement dimension (reliability, responsivness, agility and cost) at level 3, which is an indicator indicator that affects each process [10].
2. Verify Key Performance Indicators (KPIs)
3. Weighting Key Performance Indicators (KPIs) with Fuzzy Analysis Hierarchy Process (F-AHP) method [11], [12]
    a. Comparison matrix tests consistency`
    b. Compiling Triangular Fuzzy Number (TFN) values
    c. Calculating the Fuzzy Synhetic Extent (Si) value
    d. Determine the vector value (v) and the defuzzification ordinate value (d')
    e. Determine vector weight values and fuzzy vector weight normalization
4. Calculate the total value of SCM performance
   The total value of SCM is obtained by calculating each process performance indicator in the SCM process (plan, source, make, deliver, return) obtained from the weighting results [13], [14].
5. Proposed improvement of SCM performance: Proposals are made for performance indicators that require improvement [15].

RESULTS

The relationship between Level 1 (SCOR), attributes at Level 2, key activities at Level 3, and Key Performance Indicators (KPIs) used to measure performance in the supply chain process. This structured explanation provides a comprehensive overview of how planning, procurement, production, delivery, and product returns can be evaluated based on the attributes of reliability and responsiveness, which are important for improving operational efficiency and service quality in supply chain management.

Table 1. Selected Performance Indicators

Level 1 (SCOR)	Level 2 (Attributes)	Level 3 (Activities)	Key Performance Indicators (KPIs)
Plan	Reliability	Identify demand; plan material requirements	Forecast Accuracy; Raw Material Planning Accuracy.
Plan	Responsiveness	Time planning	Planning Cycle Time.
Source	Reliability	Scheduling and execution of material delivery	On-time Delivery by Supplier; Delivery Item Accuracy by Supplier; Delivery Quantity Accuracy by Supplier.

	Responsiveness	Handling defective materials from suppliers	Order Delivered Faultless by Supplier; Supplier Response Time to NCR/returns
Make	Reliability	Production defects	Production Defect Rate; First Pass Yield.
Deliver	Reliability	Fulfillment of delivery as requested	Delivery Quantity Accuracy by Company; Delivery Item Accuracy by Company; On-time Delivery to Customer; Perfect Order Fulfillment
Return	Reliability	Return of defective products from customers	Customer Return Rate; Return Process Cycle Time.

The SCOR table displays the relationship between the five main supply chain processes—Plan, Source, Make, Deliver, and Return—and two performance attributes: Reliability and Responsiveness. Each process is mapped to specific activities and relevant Key Performance Indicators (KPIs), such as Forecast Accuracy for planning, On-time Delivery by Supplier for procurement, and Production Defect Rate for manufacturing. This mapping demonstrates that reliability is a primary focus: nearly all processes have KPIs that emphasize accuracy and consistency, from material planning accuracy to customer order fulfillment.

Meanwhile, the Responsiveness attribute appears only in the Plan and Source processes, indicating the need for increased response speed in the production and distribution stages. Consequently, companies can use this table as a reference for balancing reliability and speed, for example, by extending the responsiveness KPI to the Deliver or Make process. By monitoring defined KPIs, organizations can identify critical areas for improvement, optimize planning, and strengthen the overall competitiveness of the supply chain.

Attribute Weighting

Weighting in the process is done by comparing paired criteria Plan, Source, Make, Deliver and Return. The results of process weighting can be described in the following Figure 1.

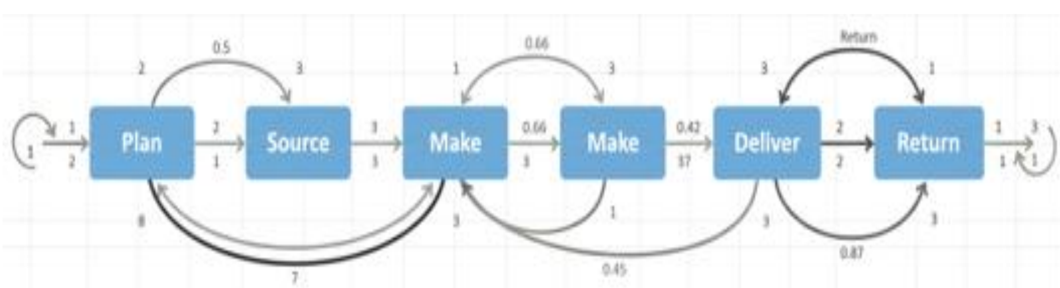

Figure 1. Recapitulation Pairwise Comparison Process

The figure 1 shows the SCOR supply chain process flow, associated with weights or probability values for each relationship between stages (Plan, Source, Make, Deliver, Return). Each arrow represents a material or information flow, while the numbers along the arrow—such as 0.5, 0.66, 0.42, 0.87—can be interpreted as the probability, frequency, or ratio of transitions from one process to another.

Analytically, it is clear that Plan serves as a starting point with numerous relationships to other processes, including internal feedback loops indicating repetitive planning activities. Source has a large backflow to Plan (values of 7 and 8), indicating high interaction or the need for plan adjustments due to material procurement. The Make process has multiple relationships with a value of 0.66, indicating a production cycle that can span more than one stage or batch. Deliver is closely linked to Return (value 0.87), indicating a significant level of return, necessitating effective reverse logistics management. Overall, this diagram emphasizes the importance of dynamic coordination: Plan is the control center, Source is heavily influenced by the accuracy of the plan, and Deliver–Return highlights the need for efficiency in the shipping and returns handling processes.

Calculating the Consistency Index and Performance Attribute Ratio Consistency

The following table presents the results of a pairwise comparison assessment of five key supply chain processes: Plan, Source, Make, Deliver, and Return. Each value indicates the relative importance of each process in supporting the overall performance of the supply chain. The "Total" column represents the sum of the weights in each row, while the "Eigenvector" describes the normalized priority weights for each process.

Table 2. Calculation of Eigen Vaktor and Eigen Value in Process

	Plan	Source	Make	Deliver	Return	Total	EigenVaktor
Plan	0.04	0.04	0.04	0.03	0.04	0.22	0.04
Source	0.09	0.09	0.09	0.07	0.09	0.45	0.09
Make	0.14	0.29	0.14	0.11	0.14	0.82	0.16
Deliver	0.33	0.28	0.42	0.25	0.33	1.64	0.32
Return	0.39	0.28	0.28	0.51	0.38	1.85	0.37

Preparation of Triangular Fuzzy Number (TFN) Values from the Comparison Results of Paired Matrices

Supply chain performance analysis was conducted using the Supply Chain Operations Reference (SCOR) approach, which encompasses five key processes: Plan, Source, Make, Deliver, and Return. The assessment was conducted using three levels of weighting (Lower, Middle, and Upper) to assess the interrelationships between processes. The following table presents the results of the interrelationship matrix calculation, which represents the relative influence of each process within the supply chain system.

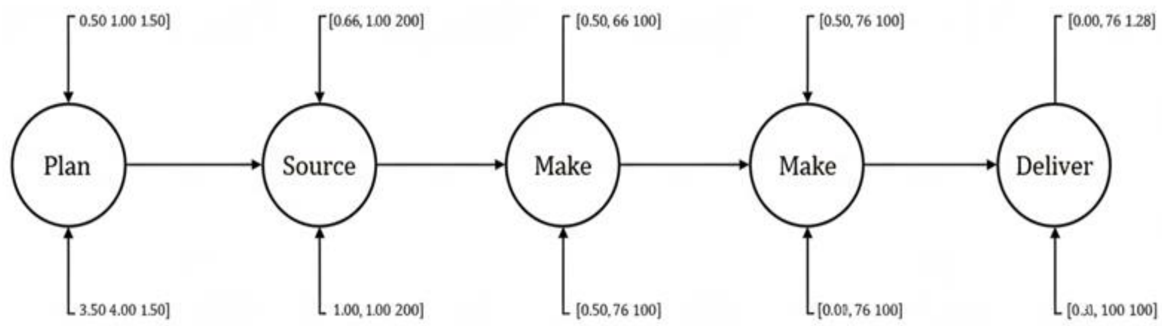

Figure2. Triangular Fuzzy Number (TFN) Values

The Return process shows the highest correlation value in most categories, especially in the Upper weight with a range of up to 4.50, indicating a significant influence on the sustainability of the supply chain as a whole. The Deliver process also plays an important role, indicated by a relatively high value compared to other processes, especially in relation to the Plan and Make processes. Meanwhile, the Plan process has a relatively moderate value, indicating a strategic but not dominant role in the context of overall integration. These findings confirm that optimizing the Return and Deliver processes can be a primary focus for improving supply chain efficiency and resilience.

Fuzzy Synthesis (Si)

Fuzzy Synthetic extent is used in determining the value of fuzzy synthesis so that the value of the weight vector of each activity is obtained. The calculation stage is carried out by summing the TFN values in advance from the weighting in the process based on a predeter- mined TFN matrix.

Calculating the total value of TFN in pairs comparison on the weight of performance measurement criteria, here is a recapitulation of the TFN value from the weight of supply chain performance measurement criteria.

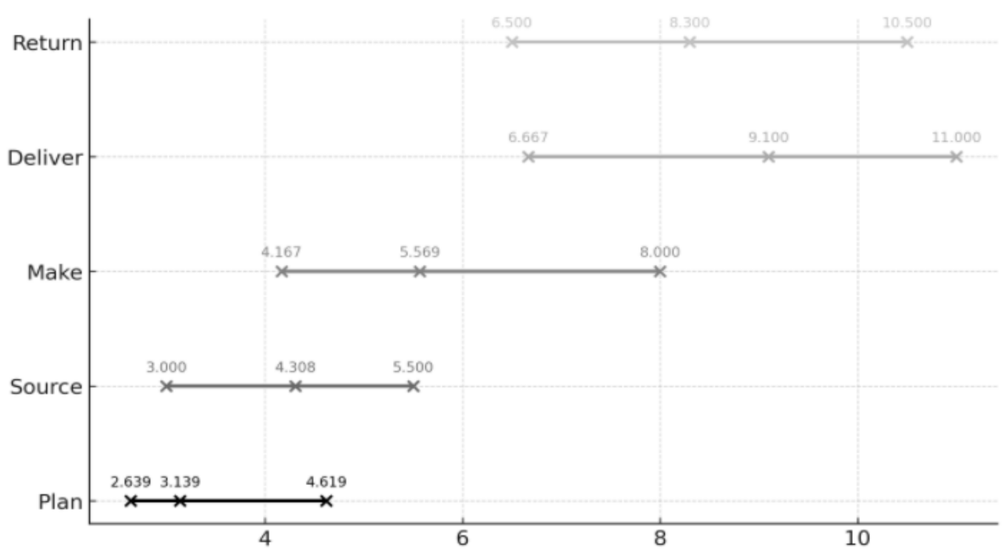

Figure 3. Fuzzy Synthetic Extent Values of Process Criteria

The Plan process has the lowest scores (Lower = 2.639, Middle = 3.139, Upper = 4.619), indicating a relatively small contribution compared to other processes. The Source process is slightly higher (3.000–5.500), while make shows a significant increase (4.167–8.000), indicating greater complexity in production activities. The Deliver (6.667–11.000) and Return (6.500–10.500) processes have the highest scores, indicating the dominance of distribution and return activities in the overall system. In general, this trend indicates that downstream activities (Deliver and Return) carry greater weight in the fuzzy assessment than upstream activities (Plan and Source), so improvement and efficiency efforts should be prioritized at the distribution and return stages to improve performance.

The same calculation is carried out on criteria and sub-criteria so as to get a recapitulation of the calculation of priority fuzzy synthesis (Si) values, here is table 7 of the calculation of fuzzy synthesis (Si) values.

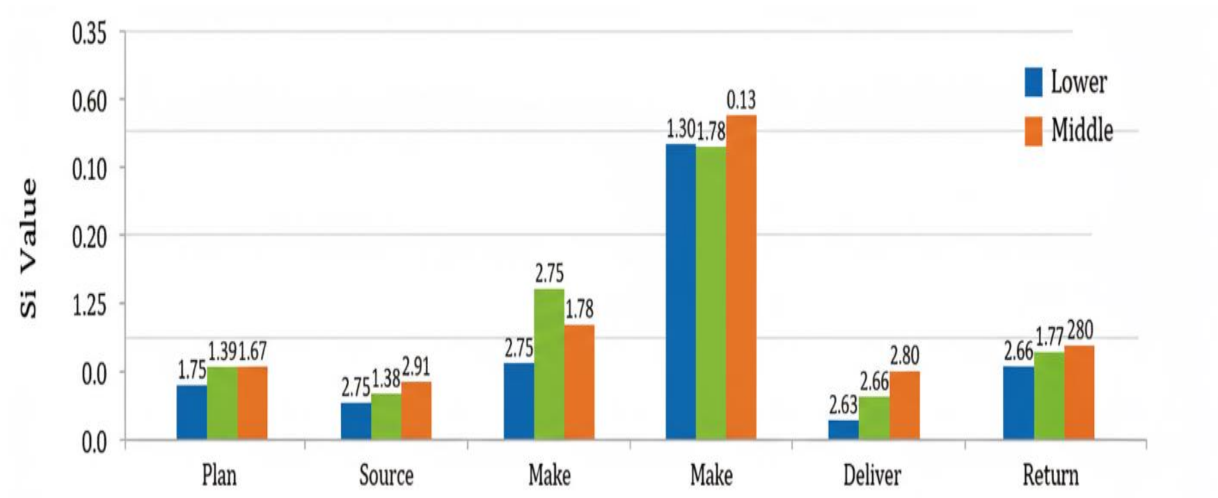

Figure 4. Recapitulation of Fuzzy (Si) Process Synthesis Values

Performance Indicator Weighting Results

In the process of weighting indicators, it aims to determine the importance of each per- formance indicator. Because each performance indicator has a different level of importance. Weighting was carried out using the Fuzzy AHP method, and data collection through ques- tionnaires. The weight of the criteria must be obtained on condition of consistency CR<0.1. If inconsistent indicators are obtained, refilling will be carried out on the questionnaire until they get a consistent weight. Performance weights are the results of calculations of level 1, level 2, level 3 where the calculation results are obtained eigenvalues (partial weights). The following are the results of weighting performance indicators with Fuzzy AHP in table 3 be- low.

Table 3. Indicator Weighting Results

Process	Weigt Level 1	Attribute	Weigt Level 2	Performance Indicators	Weight Level 3
Plan	0.35	Reliability	0.88	Forecast Accuary	0.13
				Raw Material Planning Accuary	0.87
		Responsivness	0.14	Planning Cycle Time	1

Source	0.18	Reliability	0.83	Timely Delivery Performance By Supplier	0.10
				Delivery Item Accuary By The Supplier	0.26
				Delivery Quantity Accuary By Supplier	0.63
		Responsivness	0.17	Order Delivered Faultless By Supplier	1
Make	0.18	Reliability	1	Product Defect From Production	1
Deliver	0.18	Reliability	1	Delivery Quantity Accuary By The Company	0.12
				Delivery item Accuary by the company	0.871
Return	0.08	Reliability	0.67	Return Rate From Customer	1
		Responsivness	0.331	Product Replacement Time	1

The table illustrates the supply chain performance weighting structure, divided into five main processes: Plan, Source, Make, Deliver, and Return, with an emphasis on two key performance attributes: Reliability and Responsiveness. The results show that almost all processes are dominated by the Reliability dimension, for example, in Plan (0.88), with the most dominant indicator being Raw Material Planning Accuracy (0.87), and in Source (0.83), where the Delivery Quantity Accuracy by Supplier indicator has the highest weight (0.63). Similarly, in Make and Deliver, full weight is given to Reliability, with a focus on minimizing defective products and accurate delivery by the company. This confirms that supply chain success depends heavily on consistency and accuracy in planning, procurement, production, and distribution.

Meanwhile, Responsiveness plays a significant role in the Return process, emphasizing Return Rate from Customers and Product Replacement Time with a full weight (1). These findings demonstrate that in addition to reliability, flexibility and speed in responding to complaints and product returns are also important factors in maintaining customer satisfaction. Thus, this analysis confirms that supply chain performance improvement strategies need to emphasize strengthening the reliability of core processes, while integrating responsiveness aspects at the post-sales service stage to achieve a balance between operational efficiency and customer satisfaction.

Supply Chain Management Performance Value

The calculation of the final value of UMKM supply chain management performance deiperis obtained by means of the final value of performance multiplied by the final weight of Fuzzy AHP from each performance indicator resulting from the final weight namely the multiplication of the weight of level 1,2,3.

Table 4. Performance Value of Supply Chain Management

Performance Indicators	**Snorm De Boer**	**Final Weigt**	**SCM Final Value**	**Rangking**
Forecast Accuary	91.50	0.040	3.66	7
Raw Material Planning Accuary	91.18	0.042	3.83	5

Planning Cycle Time	76.92	0.049	3.77	6
Timely Delivery Performance By Supplier	81.21	0.014	1.14	12
Delivery Item Accuary By The Supplier	90.94	0.038	3.46	8
Delivery Quantity Accuary By Supplier	100	0.094	9.41	3
Order Delivered Faultless By Supplier	82.80	0.030	2.48	10
Product Defect From Production	97.93	0.180	17.63	1
Delivery Quantity Accuary By The Company	100	0.022	2.16	11
Delivery item Accuary by the company	100	0.157	15.67	2
Return Rate From Customer	100	0.054	5.36	4
Product Replacement Time	100	0.026	2.64	9

The indicator with the highest contribution to the achievement of Supply Chain Management (SCM) is Product Defect from Production with a final score of 17.63 (ranked 1), followed by Delivery Item Accuracy by the Company (15.67; ranked 2) and Delivery Quantity Accuracy by Supplier (9.41; ranked 3). This indicates that aspects of production quality and delivery accuracy, both by the company and suppliers, are dominant factors in SCM effectiveness. Conversely, the indicator with the lowest contribution is Timely Delivery Performance by Supplier with a score of 1.14 (ranked 12), indicating that there are still significant obstacles to supplier punctuality. Meanwhile, planning indicators such as Planning Cycle Time and Raw Material Planning Accuracy have medium scores (ranked 5–6), emphasizing the importance of coordination in material planning and production scheduling. Overall, these results confirm that improving internal product quality and delivery accuracy are top priorities, while improvements in supplier punctuality aspects require strategic attention in the company's supply chain management.

DISCUSSION

The results of this study indicate that the indicators with the highest weighting in MSME supply chain performance are product defects from production (17.63) and delivery item accuracy by the company (15.67). This confirms that production quality and on-time internal delivery are key to SCM effectiveness [16]. This finding aligns with a study by [7], which emphasized the importance of consistent product quality as a key determinant of fresh food supply chain sustainability. On the other hand, the low score for timely delivery performance by suppliers (1.14) indicates weak upstream coordination, similar to the findings of [17] in the bakery industry, which faced seasonal raw material delays.

The integration of the SCOR and Fuzzy AHP methods in this study proved effective in mapping improvement priorities, particularly in the make, deliver, and return processes. This aligns with research by [18], which showed that using a fuzzy approach in decision-making improves the accuracy of assessing uncertainty in the agro-industry supply chain [19]. Furthermore, a study by [20] in the batik sector also proved that the combination of the SCOR model with a fuzzy-based method provides advantages in determining the weight of the most critical indicators [21].

From a managerial perspective, the high weighting of the customer return rate indicator (5.36) emphasizes the importance of product returns management. This finding aligns with research by [22], which found that effective reverse logistics significantly contributes to customer loyalty. Research by [23] also underscores that a rapid response to returns can improve the brand image of MSMEs.

Furthermore, this study confirms the importance of reliability over responsiveness in most supply chain processes. This finding aligns with the study [24], which showed that reliability is a dominant factor in the perishable food industry. However, the responsiveness dimension remains critical, particularly in the returns process, as identified by [25] in their study of the organic vegetable supply chain.

The moderate planning performance in the raw material planning accuracy (3.83) and planning cycle time (3.77) indicators indicates the need for demand data integration. A study by [26] confirmed that real-data-based planning can mitigate the bullwhip effect. Similarly, research by Hernández et al. (2023) shows that digitalization of supply chain planning improves the accuracy of seasonal raw material requirement projections.

These findings also provide theoretical contributions to the SCM literature for seasonal product-based MSMEs. Compared with studies [16] on the coffee industry and Lin et al. (2022) on the fisheries industry, this research reinforces the view that perishable and seasonal raw materials require more adaptive indicators. Practically, the results of this study support the strategy of improving production quality and distribution accuracy, as recommended [27] in their bakery SCM study.

This research demonstrates that the SCOR–Fuzzy AHP integration is effective in identifying weaknesses and providing strategic recommendations for seasonal food-based MSMEs. Comparing these results with previous literature, it can be concluded that SCM success is not solely determined by upstream (supplier) efficiency, but more importantly by the quality of internal processes and downstream (delivery and return) management.

CONCLUSION

This study concludes that the integration of the SCOR model and the Fuzzy AHP method can provide a comprehensive picture of the supply chain performance of seasonal product-based MSMEs. The SCM performance score of 71.20 indicates that the system is in the good category, but there are still aspects that need to be improved, especially supply delays from suppliers. The indicators with the greatest influence are production quality and distribution accuracy, which means that internal quality control and delivery accuracy are key factors for SCM success. Meanwhile, the low performance of supplier on-time delivery indicates the need for collaborative strategies with suppliers to improve supply chain reliability. This study expands the literature on the application of SCOR and Fuzzy AHP in the context of MSMEs with seasonal raw materials that have a high level of uncertainty. Practically, the results of the study provide recommendations for MSMEs to focus on improvements in production quality, distribution accuracy, and product return management, as well as developing more adaptive partnerships with suppliers. Thus, MSMEs can increase their competitiveness and business sustainability through a more reliable and responsive supply chain system.

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