Performance analysis of supply chain on rice organic agroindustry in Jember District, Indonesia

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Abstract. The annual demand for organic rice tends to increase due to attention to a healthy lifestyle. This trend offers businesses a massive opportunity to develop, including those in Jember District East Java. Product expansion without suboptimal productivity in the organic rice agroindustry has made it impossible to meet the required production and consumer demand. Therefore, evaluating supply chain performance and strategies to improve it is necessary. This study aims to analyse the structure and performance of organic rice supply chain activities in Jember District. The study used Supply Chain Operation Reference (SCOR) to evaluate each process in the supply chain. The method aided in grouping the performance of each process into several metrics described with specific attributes and presented in the form of Key Performance Indicators (KPI). In addition, each metric was weighted using the Analytical Hierarchy Process (AHP). The results showed that the supply chain performance of the organic rice agroindustry was 65.97, classified in the "average" category. The strategies to improve these performance indicators are elaborated based on identified problems and discussions with several experts in the organic rice agroindustry.

1 Introduction

A healthy lifestyle has developed and become institutionalised in people's lives. People become increasingly aware and selective in consuming food. The healthy lifestyle flourishing in the community requires food ingredients to have several characteristics, such as being safe for consumption, environmentally friendly, and highly nutritious. Likewise, the demand for organic rice as a staple food has peaked along with the rising trend of a healthy lifestyle.

The rapidly growing demand for organic products has attracted farmers, including those in Jember District, as one of the rice barns in East Java, to develop an organic farming system for rice plants. The demand for organic rice as healthy food increases every year, leading to a great opportunity for farmers to cultivate organic agriculture. One of the organic rice agroindustry developments with an intensification system in rice plants is centred in Rowotengah Village of Sumberbaru Sub-district and Rowosari Village of Sumberjambe Sub-district.

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In 2022, the total demand was 400 tons per year. Meanwhile, farmers were only able to produce 80% of the demand. This was due to low productivity and the unstable distribution of grain and rice [1]. Therefore, the shortages of grain and rice stocks can be solved by analysing each organic rice supply chain in Jember District.

This research requires support from the results of previous studies related to organic rice in Jember District. As in previous studies, the development of the existence of organic rice or rice agro-industry shows that organic rice farming in Jember District has a sustainability status of"Sufficiently Sustainable" with a total value of 71,754 [3] Meanwhile, research on strategies for developing organic rice farming includes monitoring and evaluating the implementation of SOPs to maintain quality organic rice products and introduce quality organic rice products, developing organic rice seed production, increasing the capacity of production storage warehouses and improving managerial aspects [4]. Another study concluded that by using SCM, the condition of the organic rice supply chain in Indonesia could be said to be not good enough to win the competition, the existence of irregular financial flows and the flow of information caused losses for one party [5]. Meanwhile, the condition of the organic rice supply chain in Bandung and Tasikmalaya Districts was not optimal since all farmers' harvests were not brought to the rice milling industry due to limited market access and capital available [6].

Research using the SCOR application in the rice industry, initially hampered by changes in the number of orders for raw materials resulting in backlogs, now produces a total performance value in the supply chain, which can be classified into the average category in the monitoring system [7]. Measuring the performance of the organic vegetable supply chain shows that the responsiveness and flexibility attributes are in the best performance. However, the cost attributes still do not reach the best performance and need to be improved [8]. Other studies combined the SCOR method with AHP results; measurement of performance attributes obtains values included in the average group, which previously had constraints, namely a lack of productivity in the product's capacity to develop. In the Make, Return and Deliver processes, productivity still needs to be increased [9].

This research aims to measure supply chain management performance in the organic rice agro-industry in Jember District. Applying the supply chain method that provides supply chain mapping for organic rice agroindustry will help review the entire organic rice agroindustry business process. The supply chain integrates planning, implementation, coordination, and control of all business processes to produce and deliver products efficiently to meet market needs [10]. A better understanding of the rice supply chain is pivotal to identifying the relationship between product flows, financial flows, and information flows from farmers to consumers of the organic rice agroindustry. Furthermore, this will gain insights into the driving factors of the business performance of the organic rice agroindustry. In this direction, the present study employed the SCOR method to scrutinise the supply chain of organic rice.

SCOR method can help analyse and monitor supply chain activities based on existing data and identify areas that require improvement. SCOR consists of five different management processes, namely (1) plan – process dealing with demand and supply management, (2) source - managing material inventory, acceptance, supplier selection, procurement strategy, and performance management, (3) make – process in transforming product to the finished state through the management or production schedule, production and engineering/customisation activities, (4) deliver – process dealing with the management of finished goods inventory, requests for product and order information, product distribution, and final installation at the consumer's location, (5) return - all activities related to returning a product to suppliers or receiving the product from supplier [11].

The purpose of this modelling is to get a comprehensive understanding of the supply chain, simplify the analysis, and gain a detailed picture of each supply chain performance

related to the organic rice agroindustry, therefore helping to gain a more accurate understanding of related supply chain performances. Performance improvement can be achieved by integrating supply chain elements to compare actual and targeted performance. Performance measurement aims to determine the level of achievement over time to achieve pre-determined targets effectively and efficiently.

In contrast to other research, this research was conducted without using a weighting method. Weighting is carried out by filling out a questionnaire by rice or organic rice stakeholders. The results of this weighting become the priority weights for each level in SCOR. In this way, the level of supply chain management in the organic rice agro-industry in Jember District and recommendations for improvements can be made to the poor attributes. If it is in a good category, it can be a reference for local governments to continue developing a sustainable organic rice agro-industry to compete with other regions. This research can be useful for other agro-industries, especially regarding knowledge about the benefits of supply chain management for its business processes.

2 Methodology

This research was carried out from October to December 2022 in Rowotengah Village of Sumberbaru Sub-district. The area was chosen since Jember District was known as one of the largest rice-producing barns at the provincial level. In addition, this village had a farmer group, the *Barokah* farmer group, which received assistance from the 2015 System of Rice Intensification program. This group had the highest productivity of organic rice at the district level. All research data were analysed at the Faculty of Agricultural Technology, University of Jember.

This research applied descriptive and analytic methods. The descriptive method aims to create a picture of a situation or event as the basis for further data collection. In contrast, the analytical method was employed for analysis and divided into compiling, analysing, and interpreting the data [4]. The study analysed primary data from direct interviews and questionnaires related to product quantity, product quality, organic rice cultivation, agroindustry performance, and document accuracy. In addition, secondary data were sourced from the literature review. The research procedure is following: (1) preliminary survey as the first step to finding out the problems in producing organic rice as a part of the agroindustry business, (2) literature review, (3) problem identification, (4) problem formulation which identified research topics and problems were used to formulate the research problems and focus, (5) data collection through the observation and interviews and questionnaires to validate the Key Performance Indicators and the weighting of each indicator, (6) Identification of supply chain activities, (7) identification of key performance indicators (KPI). Each KPI was grouped based on 5 core processes in the SCOR method, namely *Plan, Source, Make, Deliver,* and *Return,* (8) KPI validation. This stage was carried out through expert validation, (9) KPI weighting with AHP was based on levels 1 to 3 within the SCOR method, (10) calculation of the actual performance score of KPIs, (11) scoring system by calculating Objective Matrix (OMAX) scores coupled with score evaluation, (12) calculation of agroindustry performance score to determine the supply chain performance, (13) analysis and discussion, and (14) formulating the conclusions and suggestions.

Data for measuring the supply chain performance was analysed using the SCOR method. Based on the guidelines compiled by the SCC (Supply Chain Council), the analysis consisted of the following stages: (1) identifying the supply chain by identifying the linkages between supply chains, (2) mapping the supply chain to level 3, (3) measuring supply chain performance using pairwise comparison based on questionnaires and triangulating the analysis results with interviews, and (4) analysing performance metrics with low-performance levels (below 50) by linking them to level 2 or level 3 metrics to propose the

improvement based on the best practices. The following tables describe the performance indicators based on the SCOR method.

Table 1. Indicator of each level.

Core process (Level 1)	Dimensions (Level 2)	KPI code	Performance metrics (Level 3)	Unit
Plan (P)	Reliability	1	The match between the actual harvest and the predicted harvest	%
		2	The fulfilment of unhulled rice orders	%
		3	The accuracy of unhulled rice raw material inventory	%
		4	The accuracy of raw material inventory of rice and dry unhulled rice	%
	Flexibility	5	Unexpected alternatives (e.g., broken machine)	%
Source (S)	Reliability	6	Fertiliser requirement	kg/litre
		7	The amount of subsidised fertiliser received	kg/litre
		8	Pest and weed medicine needed for one cycle	g/ml
		9	The percentage of defective unhulled rice received/ unhulled rice quality.	%
		10	The percentage of damaged packaging materials	%
		11	The percentage of orders that the supplier can fulfil	%
		12	The percentage of defects received/ rice quality	%
		13	The percentage of damaged packaging materials	%
		14	The percentage of orders that the supplier can fulfil	%
	Flexibility	15	The availability of kiosk supplier	kiosk
		16	The availability of suppliers from farmers	person
		17	The availability of suppliers from collectors	agency
	Cost	18	The total cost of agricultural input	IDR
		19	The ordering costs for farmers	IDR
		20	The ordering fees for collectors	IDR
	Asset	21	Suitable machine	machine
Make (M)	Reliability	22	The suitability of crop yields from forecast (5 cycles)	%
		23	Workforce reliability	%
		24	The decreased percentage of rice yield after processing	%
		25	Workforce reliability	%
		26	The percentage of defective rice products	%
		27	Packing accuracy	%
	Responsiveness	28	Rice harvest cycle time	day
		29	Product processing time	day
	Cost	30	Rice planting cost	IDR
		31	Production cost	IDR
		32	Production and maintenance costs	IDR
Deliver (D)	Reliability	33	The percentage requests that c collectors can fulfil	%
		34	The number of requests that the distributor can fulfil	%

Table 2. Level monitoring performance indicators.

Monitoring level	Performance indicator
< 40	Poor
40 – 50	Marginal
50 – 70	Average
70 – 90	Good
> 90	Excellent

Source: [12]

3 Results and discussion

3.1 Identification of supply chain activities in organic rice agroindustry

Supply chain activities began with organic rice farmers purchasing raw materials from several official kiosks, such as Bumi Jaya store in the Tanggul area, Tani Maju, and Santoso in Jember District. The raw materials (fertilisers and chemicals) were supplied from kiosks (ECO SIDA, BDM Supplements, POC Bio7, and others). Farmers in Rowosari Village made their raw materials from animal and plant waste. The supply chain of the organic rice agroindustry is presented in Figure 1.

Planting occurs when the seedlings have two leaves at 12 days old after sowing. Rice takes approximately 100 days to be ready for harvest. The harvested unhulled rice will be distributed to the grain processing site (rice mill). After the grain is received and weighed, it will be dried for 3-5 days. The dried grain will be ground to separate the husk and rice. For 100 kg of grain after milling, 60 kg of rice is obtained. On average, a milling machine can process 500 kg – 1 ton/hour of grain. After milling, the rice is packaged using sacks. The distribution of organic rice in Jember District only goes through orders because organic rice is limited by production capacity. Ordering systems and partners are used upon product distribution. The distribution is carried out in several grocery stores in the district, such as Golden Market, Roxy, and Bulog, and places outside the region, such as Central Java and Jakarta.
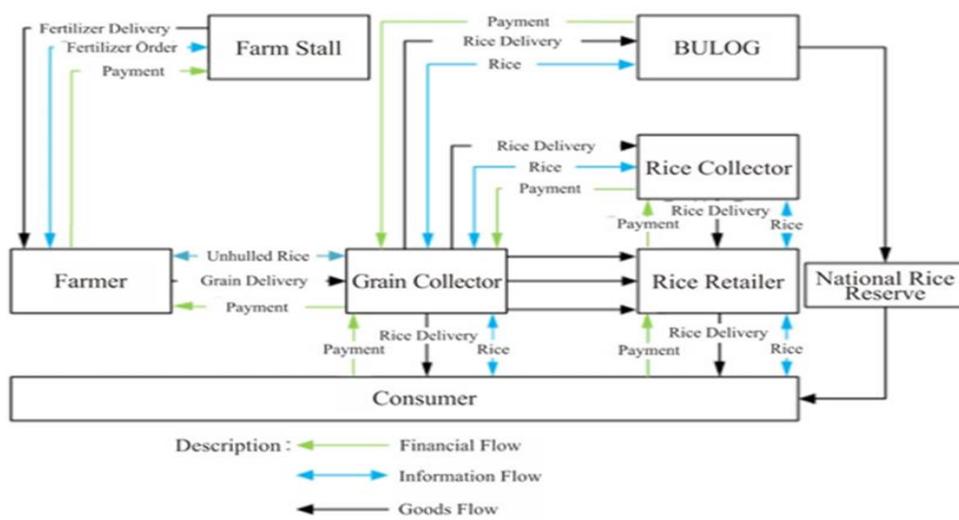

Fig. 1. The supply chain of the organic rice agroindustry.

3.2 Supply chain mapping based on SCOR model

In the hierarchy structure of supply chain performance, a pairwise comparison is used to determine the weight of the KPI. The hierarchy of supply chain performance is displayed in the following figure.
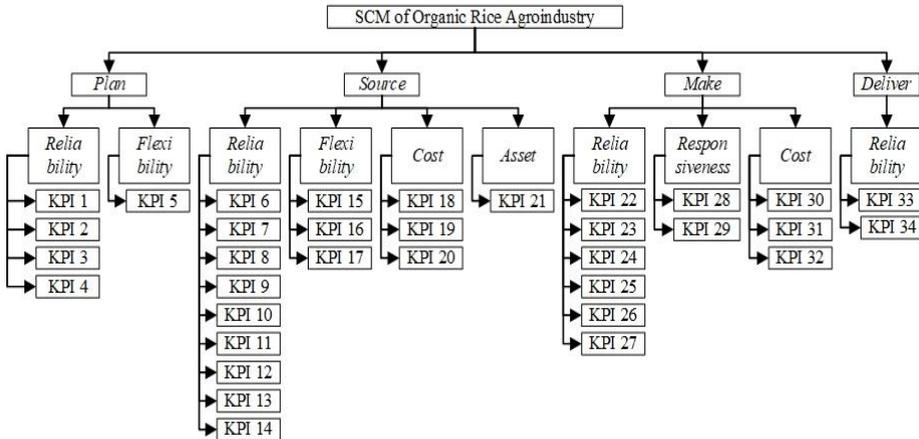

Fig. 2. The hierarchy structure in the SCOR model.

The researcher used the AHP (Analytical Hierarchy Process) method with expert choice software to weigh those KPIs. The weighting aims to know the burden or the level of importance of each KPI; the higher the weight score, the more influential the performance. The weighting is determined through a pairwise comparison of the questionnaire results at each level of supply chain performance filled out by each expert. Level 1 includes planning, sourcing, manufacturing, shipping, and returns. Level 2 provides reliability, responsiveness, flexibility, cost, and assets. Level 3 includes supply chain performance indicators. Consistency ratio (CR) less than 0.1 is the threshold for approving weight assessment, while CR above 0.1 requires a reappraisal of comparison results. The AHP results show that all CR values are consistent because the value is ≤ 0.1. These calculations determine the weight of each metric, which will be used to calculate the final supply chain performance.

3.3 Calculating the final scores of supply chain performance

The calculation served as the basis for determining the performance level of each KPI based on performance level and weight (level of importance). A high KPI score corresponds to essential indicators. A low score marks the necessity to review supply chain performance for required improvements.

3.3.1 The calculation of supply chain performance metrics (Level 3)

The supply chain management performance score is calculated by multiplying each dimension's score and weight. The calculation is carried out bottom-up, starting from calculating scores and weights at level 3, as seen in Table 3.

Based on the table, the results of measuring the performance of organic rice supply chains at source in the reliability attributes have achieved the superior performance position, 96.36. In this business, input and post-harvest handling, including the packaging, are the main factors for better output in the organic rice agroindustry. However, some KPIs have low scores, such as cost (33.62). It indicates that the production cost was still high due to

increasing input prices (seed, fertiliser, labour, and others). Supply chain management performance can be maximised by improving the performance metrics with a score below 70.

Table 3. The performance index and performance value in the SCOR model.

Level 1	Dimension (level 2)	Performance metrics (level 3)	Score (SNORM)	Weight	Performance index	Performance value
Plan (P)	Reliability	KPI 1	86.67	0.190	16.47	81.02
		KPI 2	92.00	0.414	38.09	
		KPI 3	66.67	0.186	12.40	
		KPI 4	66.67	0.211	14.07	
	Flexibility	KPI 5	70.00	1.000	70.00	70.00
Source (S)	Reliability	KPI 6	64.29	0.206	13.24	96.36
		KPI 7	25.00	0.067	1.68	
		KPI 8	80.00	0.062	4.96	
		KPI 9	75.00	0.096	7.20	
		KPI 10	75.00	0.043	3.23	
		KPI 11	61.90	0.173	10.71	
		KPI 12	87.50	0.119	10.41	
		KPI 13	84.00	0.370	31.08	
		KPI 14	70.00	0.198	13.86	
	Flexibility	KPI 15	100.00	0.403	40.30	70.15
		KPI 16	50.00	0.292	14.60	
		KPI 17	50.00	0.305	15.25	
	Cost	KPI 18	25.00	0.567	14.18	33.62
		KPI 19	50.00	0.216	10.80	
		KPI 20	40.00	0.216	8.64	
	Asset	KPI 21	71.43	1.000	71.43	71.43
Make (M)	Reliability	KPI 22	77.78	0.276	21.47	82.73
		KPI 23	80.00	0.034	2.72	
		KPI 24	92.31	0.328	30.28	
		KPI 25	83.33	0.034	2.83	
		KPI 26	75.00	0.245	18.38	
		KPI 27	85.00	0.083	7.06	
	Responsiveness	KPI 28	25.00	0.645	16.13	42.75
		KPI 29	75.00	0.355	26.63	
	Cost	KPI 30	70.00	0.471	32.97	75.44
		KPI 31	76.67	0.275	21.08	
		KPI 32	84.21	0.254	21.39	
Deliver (D)	Reliability	KPI 33	66.67	0.558	37.20	63.72
		KPI 34	60.00	0.442	26.52	

3.3.2 Supply chain process calculation (level 2)

The calculation results of performance metrics are accumulated to analyse the core processes at level 2. The calculation is done by multiplying the score and weight at level 2. The results are shown in Table 4.

Table 4. The index performance at level 2 and performance value at level 1 in the SCOR model.

Level 1	Dimension (Level 2)	Score	Weight	Performance index	Performance value
Plan (P)	Reliability	81.02	0.757	61.33	78.34
	Flexibility	70.00	0.243	17.01	
Source (S)	Reliability	96.36	0.288	27.75	60.65
	Flexibility	70.15	0.084	5.89	
	Cost	33.62	0.474	15.93	
	Asset	71.43	0.155	11.07	
Make (M)	Reliability	82.73	0.194	16.05	70.09
	Responsiveness	42.75	0.207	8.85	
	Cost	75.44	0.599	45.19	
Deliver (D)	Reliability	63.72	1	63.72	63.72

The highest total score of 78.34 is marked in the planning process. This process is considered the most important in the organic rice agroindustry because it determines the entire supply chain flow. Planning can help to measure performance and improve supply chain performance while reducing risks in the future. In contrast, the lowest final score of 60.65 is identified in the *Source* process because some attributes did not perform, especially for cost attributes. It shows that the cost attribute did not reach good performance across operations, adversely impacting productivity and affecting the calculation of supply chain performance.

3.3.3 Total calculation of supply chain performance

Based on the process performance measurement at level-1 supply chain management, the organic rice agroindustry achieves a final performance score of 65.97. This figure falls in the Average category with a score range between 50-70. The category indicates that supply chain performance in the organic rice agroindustry has not yet reached the desired target because several KPIs perform below the average. By implication, each core process struggles with distinctive shortcomings.

Table 5. The performance value of the supply chain.

Level 1	Performance value at level 1	Weight	Value
Plan (P)	78.34	0.183	14.34
Source (S)	58.52	0.408	24.75
Make (M)	38.04	0.141	9.81
Deliver (D)	63.72	0.268	17.08
Total			65.97
			Average

It should be noted in Table 5 that the core process of the source has a performance level of 58.52. This core process calls for considerable improvement and development because it has the highest importance level of 0.408. The core process of *Make* is shown to have a smaller score of 38.04 and a weight of 0.141, which is the most minor figure compared to other core processes. Improvements are necessary for each performance with a final performance score below 70 based on the SCOR and AHP methods calculation. The results of those calculations are presented in Table 5.

As shown in Table 6, 12 KPIs need to be improved, especially those in the *Poor* category, i.e., KPIs 7, 18, and 28. Further, Table 7 summarises the issues leading to the suboptimal performance of supply chain management and the experts' recommendations for improvements.

Table 6. Performance indicators needing improvement.

Core process	Code	KPI	Score	Performance indicators
Plan	3	The accuracy of unhulled rice raw material inventory	66.67	Average
Source	6	Fertiliser requirement	64.29	Average
	7	The amount of subsidised fertiliser received	25.00	Poor
	11	The percentage of the number of orders that the supplier can fulfil	61.90	Average
	16	The availability of suppliers from farmers	50.00	Average
	17	The availability of suppliers from collectors	50.00	Average
	18	The total cost of agricultural input	25.00	Poor
	19	The ordering costs for farmers	50.00	Average
	20	The ordering fees for collectors	40.00	Marginal
Make	28	Rice harvest cycle time	25.00	Poor
Deliver	33	The number of requests that collectors can meet	66.67	Average
	34	The number of requests that can be fulfilled by the distributor	60.00	Average

Table 7. The analysis results of performance indicators and recommended strategies.

KPI code	KPI description	Problem	Experts' recommendations for improvement
3	The accuracy of unhulled rice raw material inventory	• This problem arises due to excessive demand. • Limited land and the lack of organic farmers lead to the unfulfilled demand.	Production and inventory management program was needed to encourage farmers to be more productive An information system has to be built accurately.
6	Fertiliser requirement	Due to the increasing demand, optimised production and planting are very important. This triggers increased fertiliser consumption, yet the inappropriate amount of fertilisers can inhibit rice growth and the development of rice panicles, thus affecting final yield.	Organising the management of organic fertilisers to improve the quality of organic rice agroindustry
7	The amount of subsidised fertiliser	The absence of quality organic fertiliser from the government	A special training for farmers to produce organic fertiliser
11	The percentage of orders that the supplier can fulfil	The limited variations in organic fertilisers and pesticides lead to difficulties in dealing with uncertain weather.	• Organic farming programs to support and encourage communities to benefit from organic-based businesses • Designing special programs with supportive partners
16	The availability of suppliers from farmers	The lack of organic farmers results in low productivity.	• Designing solid organic farmer group

KPI code	KPI description	Problem	Experts' recommendations for improvement
17	The availability of suppliers from collectors	The lack of suppliers limits productivity.	Contract farming system with the third party
18	The total cost of agricultural input	Increased input costs due to pandemic conditions, such as the costs of transportation and services.	Improving expense management and cost allocation through organised planning
19	The ordering costs for farmers	Rice prices rise due to low yields of organic rice	Conducting product reviews so that inputs and outputs remain balanced
20	The ordering fees for collectors	Rice prices rise due to low yields of organic rice	Conducting product reviews so that inputs and outputs remain balanced
28	Rice harvest cycle time	Due to the volatile weather and environmental conditions, the harvest cycle time becomes longer by about ± 100 days	• Re-selection of rice seeds that have a short cycle time and are suitable for the environment • Providing experimental land to improve the quality of organic rice through research and development
33	The number of requests that can be fulfilled by collectors	The stock of raw materials needed for production is often lacking due to the delayed delivery of raw materials by suppliers, therefore obstructing the entire production.	The availability of raw materials is the most important thing in production. The supply of raw materials needs to be planned properly to ensure sustainable stock. Therefore, companies need to have reliable suppliers so that raw materials can be made available on time, in the right quality and quantity.
34	The number of requests that can be fulfilled by the distributor	The stock of raw materials needed for production is often lacking due to the delayed delivery of raw materials by suppliers, therefore obstructing the entire production.	The availability of raw materials is the most important thing in production. The supply of raw materials needs to be planned properly to ensure sustainable stock. Therefore, companies need to have reliable suppliers so that raw materials can be made available on time, in the right quality and quantity.

4 Conclusions and policy recommendations

The research results have highlighted the roles of supply chain actors in organic rice agroindustries. These actors include farmers' kiosks as suppliers, manufacturers of rice mills, distributors, and consumers. There are three flows in the supply chain: the flow of information, which plays a role in planning, the flow of finance as funding, and the flow of goods.

Based on the analysis, it is known that the highest final supply chain performance value is found at source at 24.75. The overall supply chain performance is 65.97, which is classified as average. It can be concluded that there is currently an organic rice agro-industry in Jember District. Its performance has not worked optimally, and there are still shortcomings, especially in planning, making, and delivering.

The need to improve supply chain performance in the organic rice agro-industry can be done through comprehensive monitoring and control routines and processes, starting from post-harvest, inventory, and institutional management. Forming a management group that focuses on improving the supply chain process of the organic rice agroindustry is considered a crucial strategy in the future. It is hoped that the availability of supporting facilities such as

warehouses and information systems will increase the productivity of organic rice in Jember District. For further research, the strategy for increasing organic rice agro-industry businesses using the Analytical Network Process (ANP) Benefit, Opportunity, Cost, and Risk (BOCR) model is expected to be executed for agro-industry sustainability in Jember District. Further, research can be expanded to other regions or other organic commodities that have the potential to be developed.

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