

Measurement and Improvement of Fresh Milk Supply Chain Performance (Case Study of XYZ Farmers Group, Bogor Regency)

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ABSTRACT

The challenges in the small-scale dairy industry often stem from outdated business management practices and a lack of comprehensive performance evaluation. This study adopts a structural approach by analyzing the performance of the fresh milk supply chain within Farmers Group XYZ, located in Bogor Regency. We employed the SCOR and AHP methods for our performance analysis. Data were garnered through questionnaires, interviews, and observations. The findings reveal that the overall performance of the fresh milk supply chain was moderate, with performance scores of 84.25% for feed suppliers, 77.47% for Farmers Group XYZ, and 82.05% for consumers. Notably, areas requiring enhancement include reliability, responsiveness, and cost-efficiency. Consequently, we have developed strategic recommendations aimed at augmenting supply chain effectiveness. These include enhancing the transportation system to ensure timely deliveries (Reliability), shortening order fulfillment times and improving the flexibility to adapt to demand fluctuations (Responsiveness), and optimizing logistics and storage to reduce costs (Cost). Implementing these strategies will bolster collaboration and fortify relationships among suppliers, producers, and consumers, contributing to a more robust dairy industry.

Keywords: AHP, Fresh Milk, SCOR, Supply Chain Performance

ABSTRAK

Tantangan dalam industri susu skala kecil berasal dari praktik manajemen bisnis yang masih tradisional dan kurangnya evaluasi kinerja yang komprehensif. Studi ini mengadopsi pendekatan struktural dengan menganalisis kinerja rantai pasokan susu segar di Kelompok Peternak XYZ, yang berlokasi di Kabupaten Bogor. Penelitian ini menggunakan metode SCOR dan AHP untuk analisis kinerja. Data dikumpulkan melalui kuesioner, wawancara, dan observasi. Temuan menunjukkan bahwa kinerja rantai pasokan susu segar secara keseluruhan tergolong sedang, dengan skor kinerja 84.25% untuk pemasok pakan, 77.47% untuk Kelompok Peternak XYZ, dan 82.05% untuk konsumen. Secara khusus, area yang perlu ditingkatkan meliputi keandalan, daya tanggap, dan efisiensi biaya. Oleh karena itu, kami telah mengembangkan rekomendasi strategis yang bertujuan untuk meningkatkan efektivitas rantai pasokan. Hal ini mencakup peningkatan sistem transportasi untuk memastikan pengiriman yang tepat waktu (Keandalan), memperpendek waktu pemenuhan pesanan dan meningkatkan fleksibilitas untuk beradaptasi dengan fluktuasi permintaan (Daya Tanggap), dan mengoptimalkan logistik dan penyimpanan untuk mengurangi biaya (Biaya). Menerapkan strategi-strategi ini akan meningkatkan kolaborasi dan memperkuat hubungan di antara para pemasok, produsen, dan konsumen, sehingga berkontribusi pada industri susu yang lebih kuat.

Kata kunci: AHP, Susu segar, SCOR, Kinerja Rantai Pasok

INTRODUCTION

Milk is a livestock product that plays an important role in fulfilling body protein requirements and improving community nutrition. However, domestic milk production only meets 29.4% of the total domestic milk demand (Statistik 2020). The challenges facing the national dairy industry are closely linked to the suboptimal productivity of dairy cows raised by farmers and processed by the Milk Processing Industry. Therefore, the government must import milk to meet domestic milk needs. These issues are primarily attributed to inefficient smallholder farm management practices, inadequate production levels, and the absence of an effective supply chain network (Damayanti *et al.* 2014).

A large number of smallholder farms has become a major player in the agribusiness supply chain structure and has great opportunities for the expansion of the supply chain (Saptana & Daryanto 2013). However, they face limitations and require significant improvements in supply chain performance, which currently lacks measurable metrics and relies on traditional methods. These challenges were evident in Farmers Group XYZ in Bogor District, where, besides low production, the group struggled to meet the rising demand for fresh milk. Furthermore, this farmers' group's performance metrics were not adequately defined, quantified, or evaluated, impeding the development of effective improvement strategies.

Business interactions between actors in the fresh milk supply chain constitute a system that aligns each actor according to their respective roles. Through system analysis, it becomes apparent whether each actor performs a similar role, operates in an organized manner, or functions independently. The interactions among actors can generate complex dynamics with varied performances; thus, a structural analysis is imperative. This process involves analyzing the decision-making framework and assessing collective performance. Such collective performance measurement is crucial for identifying inefficiencies and non-valuable waste throughout the supply chain (Chopra and Meindl 2008).

Among the various approaches to performance measurement, the Supply Chain Operation Reference Model (SCOR) stands out as the most effective method for assessing supply chain performance (Estampe *et al.* 2013). The SCOR method is a systematic method that combines elements of business engineering, benchmarking, and supply chain best practices. These elements are linked in a unique framework as a reference for measuring and improving supply chain management performance (Council 2012). Consequently, SCOR provides a performance measurement tool that can dynamically illustrate the implementation of improvements and is seamlessly integrated into the process stages.

Furthermore, achieving improved performance requires continuous improvement efforts by eliminating waste at all stages of milk production, particularly in problematic performance activities or performance metrics. All business processes are monitored, and problems in each activity in the supply chain are analyzed to minimize waste and problems and improve quality (Nagy and

Stukovszky 2023). Consequently, this study aims to assess the performance of the fresh milk supply chain and devise strategies to enhance its effectiveness.

MATERIAL AND METHODS

Material

The research was conducted at XYZ Farmers Group, Bogor Regency. This study gathered two types of data: primary and secondary. Primary data were collected directly through interviews and questionnaires completed by business and expert respondents. Secondary data consisted of references from the literature.

Methods

The data collection process was organized into the following stages:

1. Descriptive analysis: Conducted through field and literature studies and observations to identify initial challenges in the fresh milk supply chain at the XYZ Farmers Group.
2. Data collection: This stage employed purposive sampling for conducting interviews and distributing questionnaires among critical actors, including feed suppliers, business units, and consumers.
3. Expert opinions: These were gathered from practitioners and academics knowledgeable about the fresh milk supply chain. Experts were chosen using purposive sampling and possessed at least three years of experience in their respective fields.

Research Framework

The objectives of this study are to measure the performance of the fresh milk supply chain, identify areas for improvement and find strategies to improve the fresh milk supply chain. To achieve these objectives, the following steps are required.

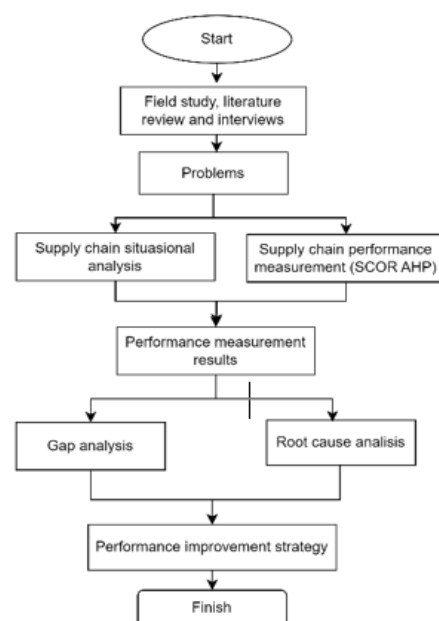


Figure 1. Research Stages

Data Analysis

Data analysis and processing included situational analysis of the supply chain, supply chain performance analysis and performance improvement strategy study. All of these analyses are processed using different methods and will produce different outputs. The data processing methods are as shown in the Table 1.

Table 1. Data Processing Method

No	Stage	Methods	Output
1.	Supply chain situational analysis	Decision-Making Framework Analysis	Supply chain structure, business process
2.	Supply chain performance measurement	1. SCOR-AHP 2. Gap analysis	Supply chain performance
3.	Review of performance improvement strategies	1. Problem analysis 2. Root cause analysis	Strategies to improve supply chain performance

Situational Analysis of the Fresh Milk Supply Chain

Situational analysis is initiated by identifying and measuring key performance issues. This approach allows for a detailed examination of the stages of managing the flow of goods, finances, and information. The process starts with an analysis of objectives and the challenges encountered, which supports decision-making and its implementation in the fresh milk supply chain (Chopra and Meindl 2008).

Performance Measurement Using SCOR AHP

The SCOR framework provides a comprehensive analysis of performance at four distinct process levels: Level 1 categorizes process types such as planning, sourcing, manufacturing, shipping, returning, and activation; Level 2 details the operational strategy; Level 3 delineates process elements which include performance attributes like reliability, responsiveness, agility, cost, and asset management; and Level 4, which encompasses specific performance activities such as delivery performance, order fulfillment cycles, top supply chain adjustments, among others (Council 2012). The SCOR model emphasizes supply chain agility, assets, costs, reliability, and responsiveness as critical attributes for evaluating performance. Consequently, assessing the significance of these performance metrics involves a complex multi-criteria decision-making process, reflecting various perspectives, dimensions, and criteria (Djatna *et al.* 2020).

The Analytical Hierarchy Process (AHP) is utilized to calculate critical weights. Beyond aiding in the visualization of the supply chain structure, the integration of AHP with SCOR through a quantitative rating scale facilitates the generation of weighted values and significance levels at each process level, validated via expert judgment. The performance measurement proceeded through the following steps:

- Determination and Measurement of Performance Metrics**
 Performance metrics, guided by the SCOR model and associated performance attributes, were derived from data collected via questionnaire forms, interviews, and observations involving key supply chain stakeholders: feed suppliers, group leaders, members, and fresh milk consumers. The performance metric value was ascertained by comparing the actual values measured against the targets set by each stakeholder.
- Hierarchy Development**
 The SCOR hierarchy outlines processes and focuses on activities within the supply chain, visualized at each process level. The objective is to elaborate on the process architecture—detailing how each process interacts, its execution, and its configuration within the supply chain. Applying AHP at each level is essential to ascertain the importance of weightings.
- Prioritization**
 Prioritization was established during the data collection phase through an expert questionnaire that included a pairwise comparison scale to quantify the importance level among elements in attribute weights. Performance metrics from these attributes were calculated using the formula:

$$\text{Total performance} = \sum_{i=1}^n (\text{attribute score } i \times \text{attribute weight } i) \quad (1)$$

The outcomes of this performance measurement were classified according to predetermined performance standards, as shown in Table 2.

Table 2. Category Criteria Score

Criteria Score	Category
95 - 100	Excellent
90 - 94	Above average
80 - 89	Average
70 - 79	Below average
60 - 69	Poor
< 60	Unacceptable

Source: (Monczka *et al.* 2016)

RESULTS AND DISCUSSION

Fresh Milk Supply Chain Structure

The structure of the fresh milk supply chain in the group involves upstream concentrate feed suppliers, the group as fresh milk production units, and downstream consumers, as illustrated in the subsequent Figure 2.

Fresh milk produced by 20 farmers (group members) was collected daily in a central cooling unit near the leader’s barn, with collections occurring twice daily—once in the morning and once in the evening. The group leader coordinates handling and control for collecting fresh milk at the central cooling unit, preparing it for consumer delivery, including 3 SMEs in Cibinong District and Pondok Pesantren. Feed suppliers provide feed with quality

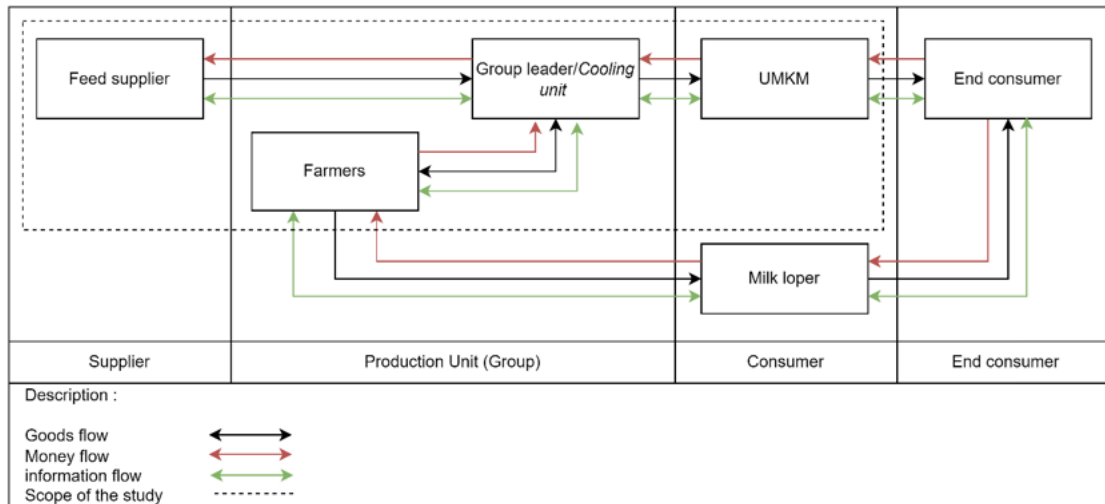


Figure 2. Fresh milk supply chain structure

standards, quantity, and availability at all times. Suppliers must meet these qualifications to ensure the availability of feed, which determines the quality and quantity of milk that will be produced. Based on 3, the management of the cooling unit is key to the sustainability of this fresh milk business, where the group has used a cooling unit equipped with digital temperature control, but still uses manual observation to control. Because of its perishable characteristics and the certainty of daily fresh milk uptake, dairy farmers depend on the existence of cooling units, which are the location and other resources owned by the leader. Thus, the group leader has the ability to market and distribute fresh milk in an organized manner.

As depicted in Figure 3, members can deposit their milk at the group's cooling unit or sell it directly to milk traders who offer higher prices without the additional requirement of milk delivery. Although the group leader possesses the necessary resources to organize marketing and distribution and ensure steady uptake of fresh milk, the lack of a formal commitment between the leader and the members complicates the leader's ability to collect milk, especially if demand continues to rise consistently.

Institutionally, the XYZ Farmers Group lacks a written agreement concerning the group's financial management. Consequently, the absence of a formal governance structure

allows members the autonomy to manage their products, which can lead to fragmentation within the group.

Measurement of Supply Chain Performance

Performance measurement is conducted within the scope of activities by three critical actors in the fresh milk business: feed suppliers, production units, and milk processing SMEs as consumers. The integration established through relationships between these actors is evident from the achievement of interconnected performance metrics, with the results displayed in Figure 4.

Total Performance. The cumulative performance score for the three actors, including feed suppliers, livestock groups, and SMEs consumers, is 81.25, categorized as average, as displayed in Table 3.

Performance metrics that require improvement include upper supply chain adjustment with a score of 53.33%, upper supply chain flexibility with a score of 65.56%, lower supply chain adjustment 68.25%, responsiveness 72.50%, and total cost 76.15%. The results of the performance measurements for each actor are as follows:

Feed Supplier. Performance measurements for feed suppliers in the fresh milk supply chain at XYZ Farmers Group, Bogor Regency, are documented in Table 4.

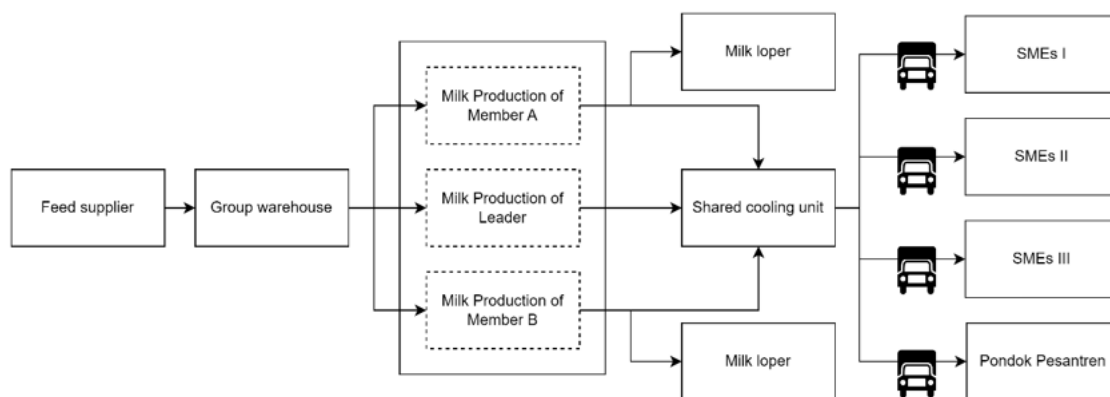


Figure 3. Logistics activities in the fresh milk production process

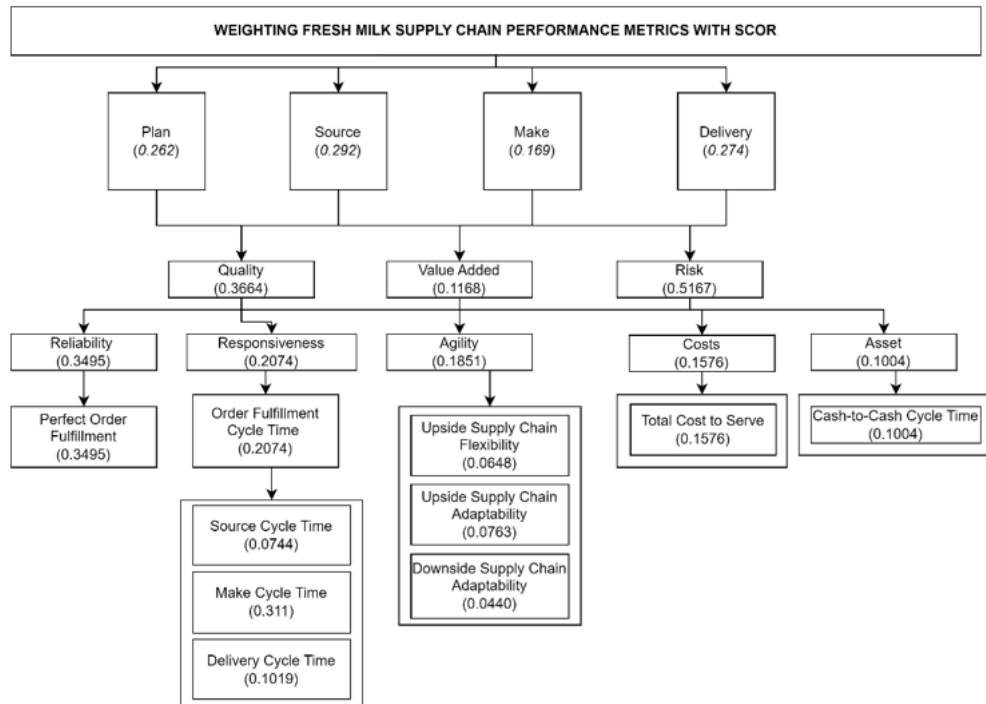


Figure 4. Hierarchy and Weighting Results of Fresh Milk Supply Chain Performance Metrics

Table 3. Total Score of Fresh Milk Supply Chain Performance

Performance Attribute	Metrics Performance	Weight	Score (%)	Value
Reliability	Perfect order fulfillment	0.35	90.28	31.56
Responsiveness	Source cycle time	0.07	72.50	5.40
	Make cycle time	0.03	84.72	2.63
	Delivery cycle time	0.10	88.70	9.04
Agility	Upside supply chain flexibility	0.06	65.56	4.25
	Upside supply chain adaptability	0.08	53.33	4.07
	Downside supply chain adaptability	0.04	68.25	3.00
Costs	Total cost to serve	0.16	76.15	12.00
Asset	Cash-to-cash cycle time	0.10	92.75	9.31
Total				81.25
Category			Average	

Table 4. Feed Supplier Performance Score

Performance Attribute	Metrics Performance	Weight	Score (%)	Value
Reliability	Perfect order fulfillment	0.35	87.50	30.59
Responsiveness	Source cycle time	0.07	75.00	5.58
	Make cycle time	0.03	100.00	3.11
	Delivery cycle time	0.10	95.83	9.77
Agility	Upside supply chain flexibility	0.06	100.00	6.48
	Upside supply chain adaptability	0.08	60.00	4.58
	Downside supply chain adaptability	0.04	71.43	3.14
Costs	Total cost to serve	0.16	83.46	13.15
Asset	Cash-to-cash cycle time	0.10	78.26	7.85
Total				84.25
Category			Average	

Feed suppliers have an individual performance calculation value of 84.25, falling into the average category. Areas needing enhancement include upper supply chain adjustments scoring 60%, lower supply chain adjustments at 71.42%, an order fulfillment cycle of 75%, and a return on capital cycle of 78.26%. These scores reflect feed producers' challenges in ensuring a consistent supply of raw feed materials affected by variable weather and climate conditions.

XYZ Farmers Group. The performance measurements for the XYZ Farmers Group are detailed in Table 5.

The XYZ Group has a performance score of 77.47, classified as below average. Metrics in the lower category include upper supply chain flexibility at 46.67%, upper supply chain adjustment at 50%, lower supply chain cost adjustment at 50%, total cost at 65%, order fulfillment cycle at 62.5%, manufacturing cycle at 66.67%, and delivery performance at 77.78%. These scores highlight the group's

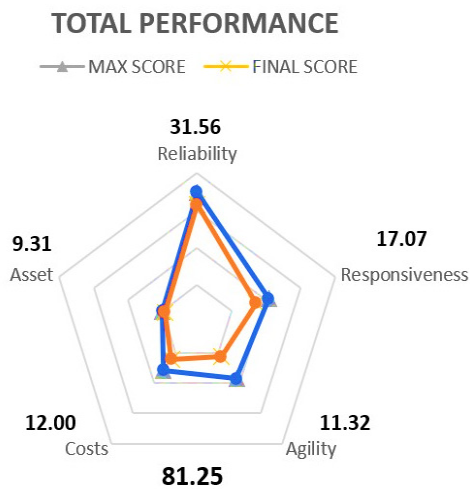


Figure 5. Total Performance Score

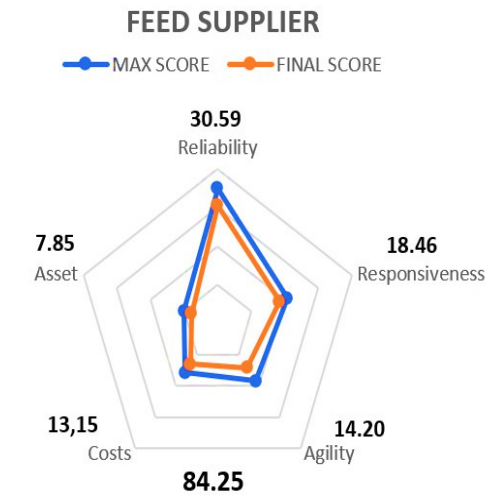


Figure 6. Feed Supplier Performance Score

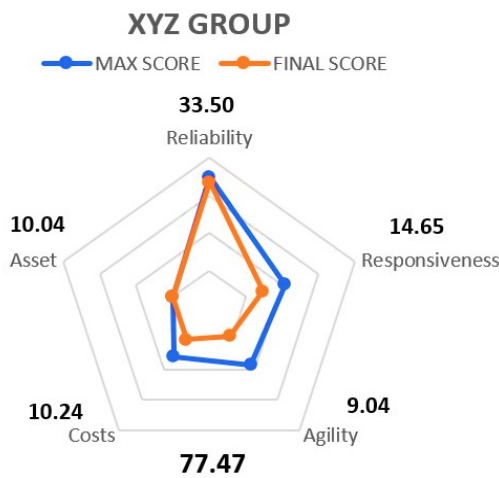


Figure 7. XYZ Group Performance Score

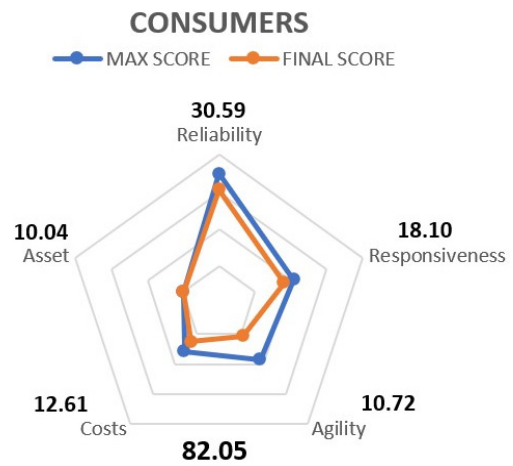


Figure 8. Consumer Performance Score

Table 5. XYZ Farmers Group Performance Score

Performance Attribute	Metrics Performance	Weight	Score (%)	Value
Reliability	Perfect order fulfillment	0.35	95.83	33.50
Responsive-ness	Source cycle time	0.07	62.50	4.65
	Make cycle time	0.03	66.67	2.07
	Delivery cycle time	0.10	77.78	7.93
Agility	Upside supply chain flexibility	0.06	46.67	3.02
	Upside supply chain adaptability	0.08	50.00	3.81
	Downside supply chain adaptability	0.04	50.00	2.20
Costs	Total cost to serve	0.16	65.00	10.24
Asset	Cash-to-cash cycle time	0.10	100.00	10.04
Total				77.47
Category				Below Average

Table 6. Consumer Performance Score

Performance Attribute	Metrics Performance	Weight	Score (%)	Value
Reliability	Perfect order fulfillment	0.35	87.50	30.59
Responsive-ness	Source cycle time	0.07	80.00	5.96
	Make cycle time	0.03	87.50	2.72
	Delivery cycle time	0.10	92.50	9.43
Agility	Upside supply chain flexibility	0.06	50.00	3.24
	Upside supply chain adaptability	0.08	50.00	3.81
	Downside supply chain adaptability	0.04	83.33	3.67
Costs	Total cost to serve	0.16	80.00	12.61
Asset	Cash-to-cash cycle time	0.10	100.00	10.04
Total				82.05
Category				Average

vulnerabilities, such as difficulties in meeting more than a 20% continuous increase in daily milk quota and challenges arising from decreased feed supply, high costs due to inefficient team performance, and minimal machinery use. Fragmentation issues are also evident from the chairperson's struggles to collect the increased milk quota from members, who prefer selling directly to milk traders.

Consumer Fresh Milk Processors. Performance results for milk processing SMEs consumers are recorded in Table 6.

Performance metrics with low scores included upper supply chain flexibility with a score of 50% and upper supply chain adjustments of 50%. The difficulty in meeting the demand for more than a 20% increase in processed milk on a continuous basis is due to the difficulty in finding fresh milk suppliers who can deliver products on a continuous basis with the quality assurance standards that fresh milk suppliers must meet.

Identify Areas for Improvement

The subsequent phase involves identifying and addressing the root causes of issues, a process termed 'problem analysis.' Based on existing performance

measurements, it has been determined that overall supply chain performance is categorized as average, with specific performance attributes such as agility, cost, and responsiveness needing enhancement. Notably, agility—the capability to swiftly adapt to changes and meet consumer demands effectively—is the lowest-scoring performance attribute across all actors. A responsive supply chain is characterized by its ability to manage large demand volumes with high service levels and short lead times (Chopra and Meindl 2008). Agility is closely related to the ability to respond to changes and adaptations to serve consumers. Based on these conditions and their relationship with the analysis of the supply chain decision-making framework (Chopra and Meindl 2008), the main problem faced by all actors in the fresh milk supply chain is low responsiveness.

Improving Supply Chain Performance

To achieve performance improvement, it is necessary to improve at all stages, especially in problematic performance activities or performance metrics. The following is a description of the cause and effect analysis on the performance metrics of each actor :

Table 7. Feed Supplier Performance Metrics that are Below Average to Unacceptable

Performance metrics	Definition	Actual score	Target	Cause and effect
Agility				
Upside Supply Chain Adaptability	The maximum sustainable percentage increase in quantity delivered in 30 days	30%	50%	Limited production capacity and number of shipping facilities
Downside Supply Chain Adaptability	The reduction in quantities ordered sustainable 30 days before delivery with no penalties	0%	20%	Difficulty finding new sources of raw materials with quality, quantity, and continuity qualifications
Asset				
Inventory Days of Supply	The amount of inventory (stock) expressed in days of sales	14	7	Warehouse capacity is needed to anticipate the uncertainty of raw material supply.
Days Sales Outstanding	The length of time from when a sale is made until cash for it is received from customers (days)	9	7	Long payment terms are a sales strategy to improve service levels
Responsiveness				
Source Cycle Time	The average time associated with the source process (days)	8	6	The difficulty of finding suppliers of feed raw materials that meet quality requirements

Table 8. XYZ Farmers Group Performance Metrics that are Below Average To Unacceptable

Performance metrics	Definition	Actual score	Target	Cause and effect
Agility				
Upside Supply Chain Flexibility	The number of days required to achieve an unplanned sustainable 20% increase in quantities delivered	2.125	1.125	1. The feed order to arrive takes two days due to distance and adjustment of the delivery schedule. 2. Competition with milk lopers makes it difficult for the chairman to collect the increase in fresh milk.
Upside Supply Chain Adaptability	The maximum sustainable percentage increase in quantity delivered in 30 days	20%	40%	The limited capacity of the delivery fleet
Downside Supply Chain Adaptability	The reduction in quantities ordered sustainable 30 days before delivery with no penalties	0%	20%	Changing the feed will have a noticeable effect on milk yield.
Costs				
The total cost to serve	Total supply chain cost (Rp/liter of milk)	6200	5500	Inefficient use of human resources and minimal use of machinery
Responsiveness				
Source Cycle Time	The average time associated with the source process (days)	7	4	The risk of decreased milk production causes farmers to choose feed carefully.
Make Cycle Time	The average time associated with the making process (days)	2	1	The group's production capacity can only meet the delivery needs every two days due to the lack of lactating cows, and some of the members' milk is sold to milk lopers.
Deliver Cycle Time	The average time associated with the delivery process (minutes)	110	90	The time and effort required for packaging and preparation for shipment

Table 9. Consumer Performance Metrics that are Below Average to Unacceptable

Performance metrics	Definition	Actual score	Target	Cause and effect
Agility				
Upside Supply Chain Flexibility	The number of days required to achieve an unplanned sustainable 20% increase in quantities delivered	23	19	Lack of fresh milk suppliers that do not have clear standards and quality assurance
Upside Supply Chain Adaptability	The maximum sustainable percentage increase in quantity delivered in 30 days	50	100	The production capacity of fresh milk suppliers does not meet the needs of processed milk production.

CONCLUSION

Fresh milk supply chain performance at XYZ Group is in the medium category, with a total score of 81.25. The strengths lie in delivery reliability and asset management, and performance improvements are needed in terms of flexibility and responsiveness, thus implicating the need for more adaptive management strategies to improve supply chain efficiency and responsiveness.

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