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The Impact of Foot and Mouth Disease on Cow Milk Supply Chain in Bogor

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ABSTRACT

Foot and Mouth Disease (FMD) outbreak in 2022 reportedly led to a significant decrease in cow milk production, resulting in major changes to supply chain. Therefore, this study aims to determine the current supply chain performance of dairy milk at Bogor Dairy Farm Cooperative (BDFC) using Supply Chain Operation Reference (SCOR) metric. A quantitative descriptive method was used, and data were collected through field observation, interviews, and Focus Group Discussions (FGDs). Furthermore, the data were analyzed using SCOR metric. The results showed that the current supply chain performance comprised several entities, including cow milk suppliers (152 dairy farmers), cooperative, 3 manufacturers (milk processing industries), and end consumers. The time required by BDFC to distribute cow milk to processing industries was relatively fast (around 2 hours) due to the perishable nature. The calculation of supply chain performance yielded positive results, with SCOR metric achieving perfect order-fulfillment (POF) value of 86.9% and order fulfillment cycle time (OFCT) of 2 days. Meanwhile, the cost of goods sold (COGS) value was 42.3%,

INTRODUCTION

Foot and Mouth Disease (FMD) outbreak recorded in 2022 has significantly changed the livestock agribusiness system, specifically dairy cow in Bogor, Indonesia. The outbreak led to a significant decrease in cow population by 50%, including both adults and calves. Putri *et al* (2024) also reported a decrease in the population of female cow by 45%. Consequently, milk production has reduced, causing a major impact on livestock farming and related businesses (Govindaraj et al. 2021). Dairy farmers in Bogor are generally members of cooperative, which was formed to help develop and expand businesses, both individually and collectively. In general, cooperative play plays a significant role in strengthening the economic position and welfare of members. Farmers engaged in producing dairy cow milk

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formed Bogor Dairy Farm Cooperative (BDFC) (Ramadhan, Mulatsih, and Amin 2015); (C., T, and A 2015); (Yilmaz, Gelaw, and Speelman 2020). BDFC business units include milk collection, distribution to consumers, sales of concentrate feed, livestock drug stores, and livestock health services. This cooperative distributes pure milk products to only one milk processing industry company, namely Cimory, while the rest is sold to SMEs such as Susu Mbok Darmi.

Dairy cow milk supply chain starts from farmers, who are the main suppliers and greatly influence the availability of raw materials (quality and quantity) produced. Milk is then distributed to various actors in dairy supply chain in cooperative. The process of delivering milk products to the industry is influenced by the established quality standards. In general, the price of milk at the farmer level is relatively low, as well as the amount of production and quality standards. This can affect the performance of the actors in milk supply chain. To address these challenges, the performance of dairy cow milk supply chain at BDFC can be measured using Supply Chain Operation Reference (SCOR) method (Molinaro et al. 2022); (Errassafi, Abbar, and Benabbou 2019); (Yolandika, Berliana, and Anggraini 2021); (Negi 2021). This study represents the first attempt at examining the impact of FMD on dairy cow supply chain management in the production center of Bogor, specifically in relation to the role of cooperative.

Based on various existing problems, this study aims to determine the flow pattern of dairy cow milk product supply chain using SCOR method at BDFC. The results will offer insights into the impact of FMD on the performance of dairy supply chain in Bogor, as well as provide recommendations for improvement.

METHODS

This study was conducted at BDFC from July to August 2024. The data consisted of primary and secondary data. Primary data were collected through direct surveys and interviews using questionnaires and Focus Group Discussions (FGDs). Respondents interviewed were mainly dairy farmers (30), cooperative administrators (6), Small Medium Enterprises (SMEs) (4), and end consumers (8) selected using the purposive sampling method. Secondary data were obtained from the Central Bureau of Statistics (BPS) and the annual report of BDFC. The data processing started with supply chain identification and process decomposition based on SCOR Model (Mishra 2012); (Ikhwana and Subagja 2022). This was followed by validation of Key Performance Indicators (KPIs), and weighting of KPI hierarchies using AHP (Pairwise Comparison) method until recommendations for improvement were provided. The flowchart of the data processing methodology is shown in Figure 1.

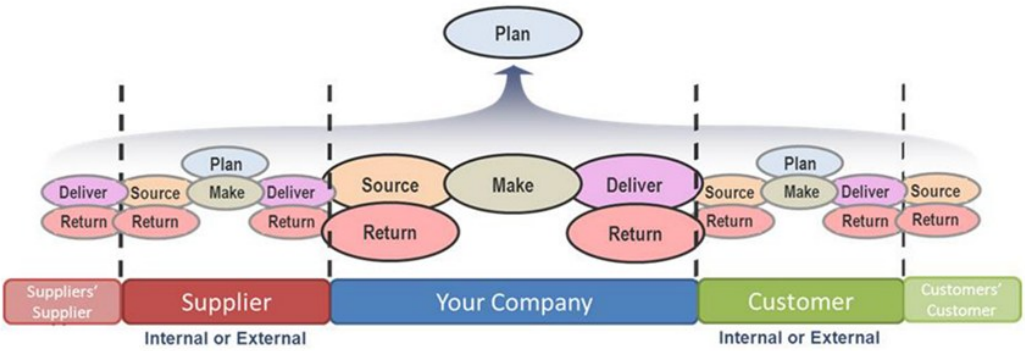

Figure 1. Supply Chain Model
Source: Negi (2021)

1. Determining the Performance Measurement Model

- POF (Perfect Order Fulfilment):

$$POF = \frac{(Total\ orders - Number\ of\ problematic\ orders)}{(Total\ Orders)} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Data collection methods used include interviews, observations, and FGDs. The design of data analysis in the study consisted of: 1) *Collecting Data*. This data collection was used to calculate supply chain performance in dairy products by identifying metrics at each level. The components include order data, delivery time, orders sent, material costs, supply inventory costs, and receivables. 2) *Identifying Metrics at Each Level*

The design of performance measurement was made based on SCOR model by identifying level one metrics, namely SCM process in SCOR. This process includes planning (planning process), sourcing (raw material procurement process), make (production process), delivering (shipping process), and returning (return process). Metrics at level 2 are dimensions for measuring SCM performance. The dimensions used include Reliability (Reliability), and Responsiveness (Molinaro et al. 2022); (Yolandika, Berliana, and Anggraini 2021); (Negi 2021).

- OFCT: Order Fulfillment Cycle-Time indicator is the duration between when customers order a product and delivery.

OFCT formula:

OFCT = Total actual cycle time for all orders shipped……(2)

- COGS: Cost of Goods Sold indicator explains all costs incurred to obtain goods sold or the acquisition price of goods sold.

COGS formula:

COGS = Initial Inventory + Purchases during the period - Ending Inventory ……(3)

- CTCCT. Cash-to-cash cycle time indicator explains the financial turnover of cooperative, starting from the payment of suppliers for raw materials to the payment or settlement of products by consumers.

CTCCT formula:

CTCCT = Inventory Days of Supply + average days of Account Receivable - average days of Account Payable ……(4)

Table 1. SCORcard

Attribute Performance	Metric	Data Actual	*Benchmark*		
			Superior	Advantage	Parity
Supply Chain Reliability	POF	%	%	%	%
Supply Chain Responsiveness	OFCT	Days	Days	Days	Days
Supply Chain Cost	COGS	%	%	%	%
Supply Chain Asset Management	CTCCT	Days	Days	Days	Days

Source: Supply Chain SCOR (2024)

2.Supply Chain Performance Calculation Using SCOR

Supply Chain performance was calculated using SCOR method at BDFC based on 4 performance attributes, including reliability, responsiveness, cost, and asset management. The results of SCOR analysis will produce output in the form of SCORcard as shown in Table 1.

3.Benchmarking

Benchmark data were used to determine target performance, provide an overview of the gap between BDFC and reference cooperative in the annual trends, and assist in directing supply chain development. These data were obtained from similar cooperative, global data from similar industries. After obtaining actual data from the calculation results of each matrix, the next step was Gap Analysis. This step was used to calculate the difference between actual conditions and determine the target performance for each matrix based on benchmark data.

4.Supply Chain Improvement Recommendations

Recommendations were obtained when a series of supply chain reference operation methods, benchmarking calculations, opportunity, and requirement gap calculations were calculated in the company being studied (Shi et al. 2017); (Andrejić 2023).

5.Improving Supply Chain Performance

Measuring the level of cooperative performance is the final stage in analyzing good supply chain management performance that can provide cooperative success (Kerekes et al. n.d.); (Errassafi, Abbar, and Benabbou 2019)(Suhita, Irham, and Utami 2021);(Errassafi, Abbar, and Benabbou 2019).

RESULTS AND DISCUSSION

BDFC supply chain system network is made up of various entities (Duwimustaroh, Astuti, and Rahayu Lestari 2016); (Yolandika, Berliana, and Anggraini 2021); (Burinskiene Aurélia 2018). Actors in the network includes suppliers, factories, distributors, and retailers. Supply chain flow at BDFC is the flow of industrial processes of milk from upstream to downstream. Figure 2 shows BDFC supply chain flow pattern (Figure 2).

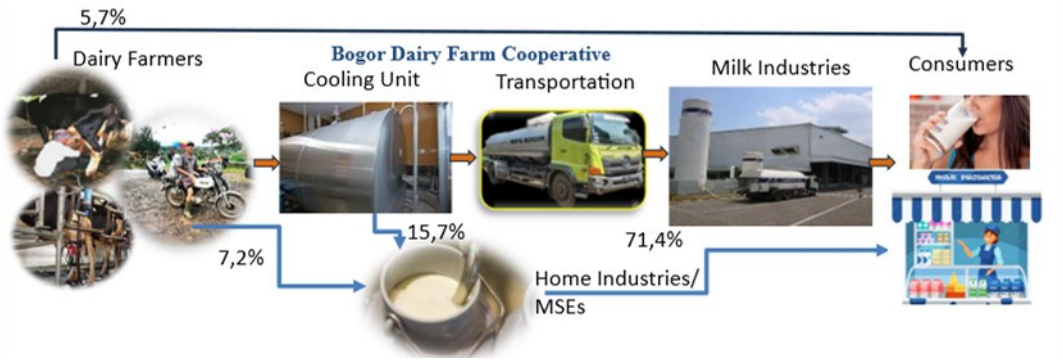

Figure 2. Milk Supply Chain of Bogor Cooperative Members
Source: Primary Data (2024)

The purchase price from farmers was based on an agreement between the partner and cooperative. Cooperative pays Rp 7.000/kg and the milk obtain not far from BDFC location is deposited twice a day.

Bogor Milk Production Cooperative (BMPC) has two Cooling Units (CU) that serve all member farmers. CU facilities are located near the farmers to ensure quick milk handling and minimize bacteria growth. The process is carried out to prevent bacteria growth up to the point of delivery at Milk Processing Industries (MPI), which is about 2 hours away. After being cooled, milk is then loaded into a tanker truck with a capacity of around 6,000 liters. The average milk sent to MPI is currently only around 5,000 liters/ day, and the rest 1,000 liters/day is delivered to SMEs (Mbok Darmi and others). Cooperative milk production has dropped significantly due to FMD outbreak, decreasing from around 10,000 tons to an average of only 5,000 tons/day. A previous study found that the direct losses suffered by beef cow farmers include a decrease in body weight by 24% and an average of one animal death per farmer, both of which have significantly reduced the selling prices (Şentürk and Yalçin 2008). This decrease in production also occurs in other regions (Alhaji et. al 2020; Oktanella et al, 2023). In practice, milk production by farmers exceeds 5,000 tons/day, but some farmers, specifically those living in urban areas, sell directly to consumers due to the significantly higher selling price (Rp. 10,000-11,000/liter) compared to cooperative (Rp. 7,000-8,000/liter). Additional motivations include convenience, as farmers can sell from home without needing to transport milk, and the benefit of receiving immediate cash payments. Supply chain flow pattern at BMPC is divided into 3 flows, namely goods, money, and information. The explanation of each supply chain flow at BMPC is provided as follows:

1. Flow of Goods

Flow of goods in supply chain starts from cow farmers as members of BDFC. Cow milk is obtained from cow farmers who are members of BMPC. Cooperative collects cow milk from farmers and subjects it to a testing process conducted by BMPC laboratory. This is important to

ensure milk being transported meets SNI (Indonesian National Standard) applied by MPI, which is also one of the requirements for issuing a delivery note for the tank truck. After receiving the waybill, milk is sent from Cibungbulang Livestock Business Area (Kunak), to MPI located in Sentul, Bogor, namely PT. Cimory or FFI. The time required to distribute fresh cow milk to MPI is around 2 hours because the distance is in the same area of Bogor.

2. Money Flow

Money flow in cow milk supply chain includes various actors namely end consumer, MPI, BDFC, and cow farmers. MPI pays on credit to BDFC cooperative 2 weeks after milk is sent. Farmers will receive monthly payments from BDFC according to the amount of milk.

3. Information Flow

Information flow occurs from end consumers, Mbok Darmi, and MPI SMEs, cooperatives, and dairy farmers, or vice versa. Communication between cooperative and dairy farmers occurs primarily through mobile phones or visits by BDFC extension department, which provides information related to market conditions and price agreements. Information shared from cooperative to farmers includes the delivery status, as well as the volume and the quality of milk sent. Meanwhile, communication between cooperative, SMEs, and MPI occurs through telephone, fax, and email. Advances in technologies such as Internet of Things have increased the potential for supply chains to reach sustainability values (Srhir, Jaegler, and Montoya-Torres 2023). In this study, supply chain performance at BDFC was assessed using Supply Chain Operation Reference Method.

Based on the results in Table 2 and in accordance with the primary business objectives set by BMPC, namely to provide the best level of service to all customers without errors and delays, cooperative must set a target performance for POF in the superior position.

Determining the target performance for POF and OFCT in a superior position is in line with the

Table 2. Level 1 Model SCOR Metrics to Establish Target Performance

Performance attributes	Indicator Level 1	Results
1. Reliability	Perfect order fulfillment (POF)	100%
2. Responsiveness	Order Fulfillment Cycle-Time (OFCT)	0.1 day
3. Agility	-Supply chain flexibility	2 days
	-Adaptability to the supply chain	7.20%
	-Downstream adaptability of supply chain	65.00%
	- Overall risk value	62%
4.Costs	Total cost of product delivery (COGS)	IDR 53,148,600
5.Assets	-Cash-to-cash cycle (CTCCT)	28 days
	-Return of fixed assets in supply chain	12.20%
	- Return on working capital	28.58%

Source: Primary Data (2024)

Table 3. GAP Analysis between Actual Data and Target Performance

Metric	Actual Data	Target Data	Gap Analysis	Opportunity
POF	100%	100%	0%	Rp 568,300,260
OFCT	0.1 day	0.5 day	-0.4 day	Maintain delivery reliability
COGS	42.5 %	41.8 %	0.7 %	Rp 12,821,442
CTCCT	28 days	0	28 days	no data

Source: Data Processed (2024)

first business objectives of BDFC. The low adaptability value of cow milk supply chain is caused by the low productivity of farmers who are members of cooperative. On average, farmers produce 8-10 liters of cow milk per head.

The metric for the second business objective is to increase cooperative profit, which is represented by COGS and CTCCT metrics. In SCOR matrix, it is not recommended to have more than one business objective with target performance in a superior position. This is because the development of a complex supply chain project requires a focused approach, and having multiple objectives at a superior performance level can dilute improvement efforts. Therefore, the target performance for COGS and CTCCT is set at the advantage and parity positions, respectively. This is also due to the rules in SCOR that do not allow more than one target in the advantage position.

After setting the target performance, GAP analysis was conducted to calculate the magnitude of the difference between the actual condition of cooperative and the target. In this study, the performance gap was interpreted as the potential increase in income that could be realized when cooperative meets the target performance levels. GAP analysis table presents an opportunity, which refers to the magnitude of the increase in income when the performance for POF and OFCT metrics is improved to the targeted position.

Table 3 shows GAP analysis results between actual and target datasets by cooperative. GAP for the reliability performance attribute is 0%, indicating that actual data of the current supply chain performance has reached the 100% target of benchmark data. For the respon siveness attribute, actual data also shows good performance in achieving the target set, which is 0.1 days. GAP of the cost performance attribute for COGS metric is 0.7%, exceeding benchmark data from a similar cooperative of 41.8%. The asset management performance attribute GAP is 0 days because the actual value is below the benchmark data of a similar cooperative.

The magnitude of the opportunity for OFCT metric in achieving the set target is in line with that of POF metric. A reduction in OFCT automatically increases POF value, and this has a direct impact on improving revenue. The opportunity for COGS metric was obtained by calculating the magnitude of the decrease after achieving the target

performance. This decrease directly indicates an increase in gross profit.

Based on the calculations using supply chain reference operation methods, benchmarking, opportunity, and requirement GAP analysis, the results appear generally unsatisfactory. Supply chain reference operation methods have deviated significantly from cooperative initial plans due to disruptions from two consecutive events, namely COVID-19 in 2019 and FMD outbreak in 2022. Cooperative had planned to produce 11 tons/day and purchased a large-capacity CU truck, but in reality, milk production actually decreased from 8 tons to 5 tons/day. The two-story office infrastructure was also under construction. However, in mid-2022, FMD disaster occurred, which led to significant cow deaths, resulting in a population decline of about 27% and a milk production drop of approximately 30.9%. The feed and medicine business units also witnessed a significant decline. This disaster caused a decrease in the performance of both farmers and cooperative.

The construction of the office infrastructure was paused, CU truck was sold at a low price, while contracts for milk sales to MPI and potential buyers (FFI, PTIL, Diamond, Nutrifood) were canceled because milk production did not meet capacity, ultimately leading to a drastic decline in cooperative income. The subsequent impact was that the revolving cow credit recently received by farmers from LPDB/ Kemenkop was almost at a standstill. Some farmers even closed livestock businesses by selling off the remaining cow and switching to other ventures. The decrease in milk production from the planned 11 tons to only 4 tons/day led to increased operational costs for cooperative. When the price of milk to MPI could not easily be raised due to the relative dependence on MPI decisions, cooperative was forced to lower the purchase price for farmer members. Consequently, the fees received appeared to increase, but part was used for the rising operational costs of milk handling. Several steps taken by the management to assist members include encouraging farmers to improve both the quality and quantity of milk, negotiating for higher selling prices to the industry, selling to nearby industries, and serving SMEs that offered higher prices to increase purchases. Some farmers sold milk directly to home industries or consumers to obtain better prices. Cooperative management also provided leniency to farmers in repaying cow loans. Regarding the development of milk processing into value-added products such as yogurt and pasteurized milk, the progress appears limited due to a lack of expertise and inability to compete in the market. Consequently, only a few farmers have engaged in this aspect as a home industry on a small scale. Other studies found that collaboration with SMEs in supply chain may provide an opportunity to share risk tools to improve performance. Partnership with large, more experienced companies carry the potential for organizational

learning that can stimulate the operation of small ones (Kerekes et al. n.d. 2020);(Alomar and Pasek 2014).

CONCLUSION AND SUGGESTION

In conclusion, this study showed that the performance of cow milk supply chain at BDFC was generally in good condition. The supply chain was composed of several actors, including milk suppliers, factories, and end consumers. BDFC collected fresh milk from farmers to be delivered to MPI, namely PT. Cimory.

Based on the results, POF percentage was 100%, indicating that nearly all customer orders are completed accurately and on time. OFCT value was below 1 day, COGS value was 42.8%, and CTCCT was 28 days. However, the quantity and quality of the product remain a problem. This underscores the need for farmers to increase livestock population and product quality to achieve higher selling prices. To reduce COGS at BDFC, cooperative should reduce production costs to minimize rising raw material prices and increase profits.

One of the limitations is the failure to extensively address digitalization in cooperative, which is becoming necessary in this Industry 4.0 era. Therefore, the aspect of digitalization in cooperative is recommended for further studies.

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