Milking Sustainability : Robust Strategies for a Sustainable Dairy Supply Chain in Indonesia

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Abstract
Milk demand in Indonesia continues to rise, but domestic production remains insufficient, leading to a reliance on imports. This study analyzes the sustainability strategy of the dairy agro-industry supply chain using the Analytical Network Process (ANP) method, based on the Sustainable Supply Chain Strategy model by Cetinkaya et al. (2011). The results show that the financial perspective holds the highest weight (56.66%), followed by sustainability (21.86%), supply chain (15.05%), and learning and growth (6.44%). The top strategic priorities are cost efficiency (40.10%), productivity (35.80%), and profitability (14.40%).
The sustainability of the supply chain must be supported by technological innovation, operational efficiency, and long-term policies. With the right strategies, the national dairy industry can become more competitive and reduce its dependence on imports. This study highlights that dairy supply chain sustainability is not solely dependent on financial stability but must also be balanced with technological innovation, operational efficiency, and long-term sustainability policies. By implementing the right strategies, Indonesia's dairy industry can reduce import dependency and enhance its competitiveness in the domestic market.

Keywords: *dairy agro-industry, sustainable supply chain strategy, analytical network process (ANP)*

Introduction

The rapid growth in milk demand in Indonesia is reflected in the increasing per capita consumption trend, which continues to rise each year. This surge in consumption has also driven national milk demand to reach 4.3 million tons per year. In 2020, Indonesia's per capita milk consumption was recorded at 16.27 kg per year, which remains relatively low compared to neighboring countries in Southeast Asia. For comparison, Vietnam's per capita milk consumption reached 20 kg per year, while Malaysia's was significantly higher at around 50 kg per year. This phenomenon strongly indicates that milk is a strategic commodity with immense potential for more extensive and sustainable development. The continuous increase in demand not only reflects changes in consumer behavior but also presents a significant opportunity for the dairy farming industry and downstream sectors to innovate in enhancing production, improving distribution efficiency, and diversifying dairy-based products to meet the increasingly complex and dynamic market needs.

The high demand for milk in Indonesia has not yet been matched by national milk production. Data from the Ministry of Agriculture (2021) reveals that domestic milk production contributes only about 22% of total national demand, with the remaining 88% still reliant on imports. However, the outlook for the domestic dairy industry is becoming more positive. In 2022, national milk production increased by 2.4% compared to the previous year. This growth is an important indicator that the dairy farming sector in Indonesia is starting to recover and showing potential to reduce dependency on imports. If this positive trend continues and is reinforced through strategic policies and industrial innovations, Indonesia's dairy sector could become more competitive in the domestic market and play a more significant role in meeting the population's nutritional needs with high-quality products.

Gold, Kunz, and Reiner (2017) stated that supply chain management in agro-industry has distinct characteristics compared to other sectors. These differences stem from stricter regulations and more complex monitoring and control systems. Products in the agro-industry supply chain have unique characteristics, such as short shelf life, perishable nature, and relatively long production times. Given these specific product characteristics, supply chain management in agro-industry holds a crucial position in ensuring business sustainability. Ivanov, Tsipoulanidis, and

Schönberger (2019) emphasized that supply chain management is no longer solely focused on customer satisfaction but is also directed toward maintaining operational sustainability. Thus, the primary goal of supply chain management, besides maximizing service levels and minimizing costs, must also include sustainability. According to Abdelaziz, Saeed, and Benleulmi (2015), the main objective of sustainable supply chain management is to optimize value for all stakeholders. Additionally, this system aims to meet customer needs through a continuous flow of products, services, information, and capital while strengthening collaboration among entities within the supply chain.

This study explores the development of a sustainable supply chain strategy framework based on the Sustainable Supply Chain Strategy model developed by Cetinkaya, Cuthbertson, Ewer et al.(2011). Fauzi (2019) emphasized that sustainable supply chain strategy is a crucial element in supply chain mechanisms. This strategy is an integral part of sustainability analysis, focusing on achieving long-term sustainability and determining policies aligned with sustainability principles. This study aims to identify the appropriate strategic objectives to support the sustainability of the dairy agro-industry supply chain in Indonesia.

Research Method

The strategy to improve supply chain sustainability in this study is developed using the Sustainable Supply Chain Strategy model by Cetinkaya et al. (2011). This model is based on four key perspectives: 1). Financial Perspective 2).Sustainability Perspective 3). Supply Chain Perspective 4). Learning and Growth Perspective. The Sustainable Supply Chain Strategy model is presented in **Figure 1** as follows :

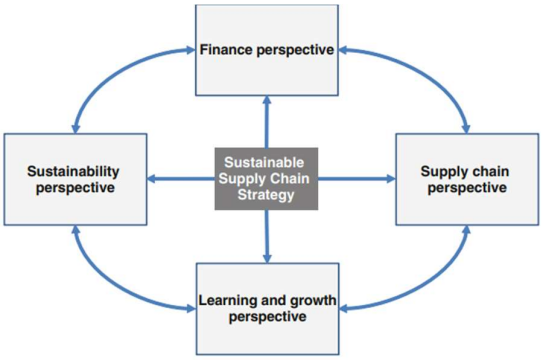

Figure 1. Sustainable Supply Chain Strategy Model
Source : Cetinkaya et al. (2011)

The perspectives and strategic objectives for supply chain sustainability in a dairy agro-industry are presented in **Table 1.**

Table 1. Perspectives and Strategic Objectives for Supply Chain Sustainability in a Dairy Agro-Industry

No.	Perspectives (criteria)	Strategic Objectives (Sub criteria)
1	Financial	1. Produktivity 2. Cost Saving 3. Profitability 4. Competitive Advantage
2	Sustainability	1. Market Share 2. Waste Reduction 3. Energy Efficiency 4. Biodiversity 5. Product Development
3	Supply Chain	1. Supply Chain Technology 2. Processing Technology 3. Animal Feed Technology 4. Vendor Reliability 5. Continuous Improvement
4	Learning and Growth	1. Leadership 2. Employee Engagement 3. Training dan Development 4. Safety Health Environment

Source : Cetinkaya et al.(2011), Haroon et al.(2021),Nashr(2021), Septarianes et al.(2020), Kafa et al.(2013)

In determining the priority strategies to be implemented and analyzing the relationships between criteria and sub-criteria, the Analytical Network Process (ANP) method is used. This method is an extension of the Analytical Hierarchy Process (AHP) introduced by Saaty. One of the advantages of ANP is its ability to measure and synthesize multiple factors within a hierarchy or network.

The Analytical Network Process (ANP) software used in this study is Super Decision Version 3.2.0 developed by William and Saaty. The steps involved in the Analytical Network Process (ANP) method include:

1. Structuring the problem
2. Developing the interrelationship model
3. Forming the pairwise comparison matrix
4. Calculating the criteria weights

Result and Discussion

The research results using Super Decision Version 3.2.0 produced an Analytical Network Process (ANP) model for supply chain sustainability strategies in a dairy agro-industry, as shown in **Figure 2**.

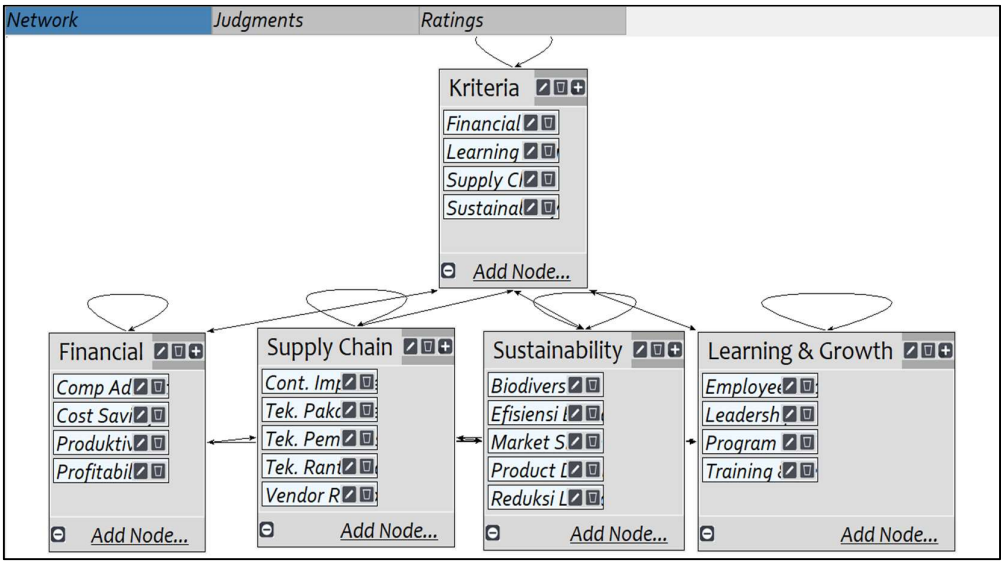

Figure 2. Analytical Network Process (ANP) Model for Supply Chain Sustainability Strategy in a Dairy Agro-Industry

The results for each perspective are as follows: Financial Perspective (56.66%), Sustainability Perspective (21.86%), Supply Chain Perspective (15.05%), and Learning and Growth Perspective (6.44%). The complete results are presented in **Figure 3.**below :

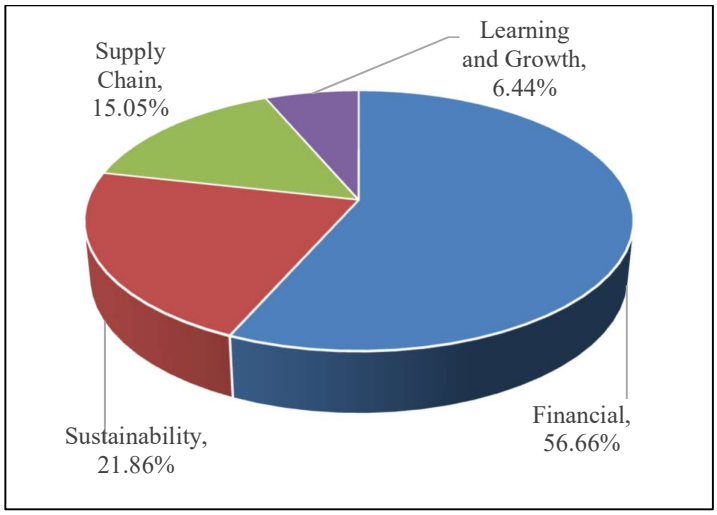

Figure 3. Strategic Perspective Values for Dairy Supply Chain Sustainability

The results above indicate that in ensuring the sustainability of the supply chain in a dairy agro-industry, the financial performance aspect is the top strategic priority.

The Consistency Ratio (CR) was found to have an average value of 8.7%, meaning that the respondent's answers were valid (acceptable). According to Subakti et al. (2017), a CR value is considered valid if CR < 10%.

Based on the Analytical Network Process (ANP) model, the values for each perspective were obtained, with the financial perspective scoring the highest. This implies that the supply chain sustainability strategy in the dairy agro-industry places greater emphasis on financial performance. In any company, especially in the supply chain sector, strong and healthy financial performance is crucial for supporting operational activities. A well-managed financial performance ensures the sustainability of both the company and its supply chain. Strong financial health is characterized by smooth financial cash flow and positive business growth. Several key strategic objectives within the financial perspective include: Cost saving (40.10%), Productivity (35.80%), Profitability (14.40%). Cost saving is a critical factor in financial sustainability. The strategic objective of cost saving focuses not only on reducing expenses but also on long-term efficiency while considering sustainability aspects. The key activities include: 1). Reducing Energy and Raw Material Consumption: Implementing renewable energy and recycled materials in production. 2). Optimizing Inventory Management (Just-in-Time & Lean Inventory): Reducing storage costs and preventing overstocking. 3). Enhancing Logistics and Transportation Efficiency: Using fuel-efficient delivery

routes and more effective logistics systems. 4). Reducing Waste and Disposal Costs: Applying circular economy principles to recycle unused products. Productivity in a sustainable supply chain focuses on resource efficiency and optimization without harming the environment or workforce welfare. The key activities include: 1). Improving Production Process Efficiency: Minimizing waste and increasing output through green manufacturing. 2). Leveraging Digital Technologies: Utilizing AI, IoT, and blockchain to enhance transparency and efficiency in the supply chain. 3). Optimizing Workforce Performance: Enhancing employee skills through training programs to ensure adaptability to new technologies. 4). Reducing Lead Time: Optimizing inventory management and distribution to accelerate the production cycle. Profitability is essential for any company, serving as a key performance indicator. Higher profitability ensures the sustainability of business operations, reflected in business growth and well-managed costs. The key activities include: 1). Increasing Revenue through Sustainable Products: Developing eco-friendly products with high market value. 2). Optimizing Sustainability-Based Pricing Structures: Adjusting pricing based on efficient operational costs and market demand for green products. 3). Maximizing Return on Investment (ROI) from Sustainable Investments: Generating higher profits from projects involving renewable energy, efficient logistics, and effective waste management. 4). Diversifying Revenue Streams: Expanding business lines such as recycling services or circular economy initiatives to boost income.

Apart from the financial perspective, the supply chain sustainability strategy also considers: 1). Sustainability Perspective: Focuses on developing eco-friendly products, expanding market share, and reducing waste. 2). Supply Chain Perspective: Emphasizes supply chain technology implementation, vendor reliability, and innovation in dairy feed. 3). Learning and Growth Perspective: Covers leadership development, employee engagement, and workforce training and development.

To maintain the sustainability of the dairy supply chain, this study proposes four strategic perspectives: financial, sustainability, supply chain, and learning & growth, in alignment with the Sustainable Supply Chain Strategy model by Cetinkaya et al. (2011). By selecting the top three strategic objectives from each perspective based on ANP analysis, the supply chain sustainability strategy for a dairy agro-industry is presented in **Table 2** as follows:

Tabel 2. Sustainable Supply Chain Strategy for a Dairy Agro-Industry

No.	Perspective (Criteria)	Strategic Objective (Sub criteria)
1.	Financial	1. Cost saving 2. Productivity 3. Profitability
2.	Sustainability	1. Product Development 2. Market Share 3. Waste Reduction
3.	Supply Chain	1. Supply Chain Technology 2. Vendor Reliability 3. Animal Feed Technology
4.	Learning and Growth	1. Leadership 2. Employee Engagement 3. Training and development

Conclusion

Based on the research findings, it can be concluded that the sustainability of a dairy agro-industry supply chain heavily depends on financial stability as the top priority. However, it must be balanced with environmental sustainability strategies, supply chain strengthening, and human resource development to ensure a more holistic and long-term sustainability. The dairy agro-industry supply chain sustainability strategy, based on the Cetinkaya model and analyzed using the Analytical Network Process (ANP) method, can be summarized as follows:

1. Financial: cost saving, productivity, and profitability
2. Sustainability: product development, market share, and waste reduction
3. Supply Chain: supply chain technology, vendor reliability, and animal feed technology
4. Learning and Growth : leadership, employee engagement dan training and development

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