

Supply Chain Analysis of Raw Materials for the Seaweed Industry (*Eucheuma cottonii*) in the PT. Bantimurung Indah area

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Abstract. Seaweed stands out as a significant mariculture commodity with substantial economic potential, contributing to the advancement of the national economy. The supply chain represents the seamless integration of company activities, collaboratively producing semi-finished to finished products and facilitating their delivery to end consumers. This study utilizes research interviews to gather data, following the systematic stages of seaweed supply chain analysis. The primary objective of this research is to gain insights into the operational mechanisms and efficiency of the seaweed supply chain within PT. Bantimurung Indah. The key components of this supply chain include seaweed farmers, suppliers, retailers, and seaweed exporters, collectively referred to as seaweed suppliers. Notably, seaweed farmers, suppliers, retailers, and exporters form the main circuit, consolidated under the umbrella term "seaweed suppliers." The calculated total marketing margin for seaweed amounts to IDR 5,900 per kg, with a comprehensive profit of IDR 3,650 per kg and total costs of IDR 2,250 per kg. The percentage of the price received by farmers (farmer share) is 70.5%. The seaweed supply chain in the PT. Bantimurung Indah attains classification as efficient, given that the FS percentage exceeds 70%.

1 Introduction

Seaweed, recognized as a mariculture commodity with significant economic potential, holds a pivotal role in advancing national economic growth [19]. Rich in antioxidants, polyphenols, proteins, minerals, and vitamins, seaweed emerges as a natural commodity with diverse therapeutic properties, including antibacterial, antiviral, anticancer, and antioxidant activities. Its status as a preferred source of bioactive compounds is attributed to the stability of its antioxidants, surpassing those found in land plants, thereby contributing to the prevention of oxidative stress and various mammalian diseases [20]. The well-established quality of seaweed makes it highly sought after by numerous industries. Its composition, featuring elevated levels of yeast, gelatin, and alginate, adds to its appeal, positioning seaweed as a valuable resource in meeting the demands of various sectors [12].

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Seaweed offers significant advantages to humanity, serving as a versatile resource in the realms of food, medicine, and cosmetics [1]. To meet the high global demand for Indonesian seaweed, it is crucial that seaweed intended for consumption possesses specific attributes, including freshness, cleanliness, vibrant coloration, and freedom from epiphytes (moss or attached dirt) [21]. Indonesia, an archipelagic nation, boasts substantial opportunities and potential for the cultivation of marine commodities, with approximately 2 million hectares available for seaweed development and an average production rate of 16 tons per hectare [13]. Globally, the top ten seaweed-exporting countries include China, Indonesia, Japan, Chile, the United States, South Korea, France, the Philippines, Ireland, and Peru. Indonesia stands out as the second-largest global producer and the foremost exporter of seaweed commodities [16]. Indonesia's seaweed sector demonstrates vast potential for growth, underscored by its expansive land area, high seaweed production, productivity rates, and the increasing demand for seaweed [10]. As a major player, Indonesia holds a dominant position, controlling 50% of the world market share, particularly in meeting the export demands of the cosmetic and pharmaceutical industries [10]. The surge in seaweed production aligns with the simultaneous growth in both export volume and value of seaweed commodities [17]. Currently, Indonesia's seaweed exports predominantly consist of dried seaweed, serving as a crucial raw material for various processing industries [17].

The surge in seaweed production is attributed to the expansion of seaweed cultivation areas. While the focus has traditionally been on increasing production, it is imperative to shift attention towards downstream subsystems, specifically the seaweed marketing and processing systems. In the agribusiness system, the marketing of agricultural products plays a crucial role. Enhancing the efficiency of the marketing system is vital to meet the demands and satisfaction of end consumers while maximizing the value returned to fishermen. Agricultural subsystem processing assumes significance, as processing activities have the potential to augment added value, enhance product quality, increase labor absorption, and elevate income for both individual farmers and the industry as a whole [10].

A valuable strategy to enhance a company's capabilities, as advocated by Soethoudt (2022), is supply chain analysis. The supply chain represents an integration of company activities collaborating to generate semi-finished to finished products, ensuring their seamless delivery to end consumers [2]. This approach involves the strategic management of product, information, and monetary flows, engaging various parties such as suppliers, factories, distribution activities, and logistics services [5]. Implementing a supply chain proves instrumental in meeting the escalating demands within an industry. While larger industries widely adopt supply chain management for operational smoothness, smaller industries may not fully grasp its importance. The supply chain, with its extensive scope, has been utilized by numerous large industries to streamline operations, underscoring its potential significance, which smaller industries may overlook. Certainly, in the management of a supply chain, three key elements need careful consideration:

1. Flow of Goods

This involves the movement of raw materials from suppliers to factories, the subsequent production process, and the delivery of finished products to distributors, retailers, and eventually to end consumers. Managing this flow efficiently ensures timely production and delivery.

2. Financial Flows

This pertains to the monetary aspects of the supply chain. It includes financial transactions, payments, and the allocation of funds between different entities within the supply chain. Effective financial management ensures the smooth operation and sustainability of the entire supply chain.

3. Information Flow

Information flow involves the communication and exchange of data between various entities in the supply chain. This includes sharing information about demand forecasts, inventory levels, production schedules, and transportation details. A well-managed information flow enhances coordination and responsiveness throughout the supply chain, helping to make informed decisions and adapt to changing circumstances.

The seaweed supply chain in Indonesia is composed of seaweed suppliers, producers, and customers, with a notable and robust interdependence among its components, emphasizing the significance of risk management for the seaweed industry in Indonesia and other producing countries [11]. An effective strategy to reduce costs without compromising product quality involves optimizing the distribution of materials throughout the entire material flow—from suppliers through the production process to the distribution of products to consumers. This optimization can be achieved through the application of the Supply Chain Management concept [12]. Efficient management of the seaweed supply chain requires collaborative efforts in overseeing distribution channel relationships among all involved parties. At PT. Bantimurung Indah, a seaweed commodity supply chain approach is employed to provide an overview of seaweed supplies. This approach serves as a valuable consideration for managing seaweed supply chains, catering to the needs of both consumers and processing industries [15]. To enhance the quality and quantity of business operations, the optimal strategy lies in the efficient management of an effective supply chain management system. This necessitates companies to cultivate and maintain strong relationships between suppliers, companies, and distributors, ensuring the smooth flow of products to consumers in a timely and appropriate manner. The collaborative and integrated approach to supply chain management is crucial for the success of the seaweed industry in Indonesia.

1.1 Research Purposes

The research objectives in this study are:

1. To comprehend the seaweed commodity supply chain mechanism, specifically related to the flow of products, financial transactions, and information exchange within the PT. Bantimurung Indah area
2. To determine the efficiency level of the seaweed supply chain within the PT. Bantimurung Indah area.

1.2 Formulation of the Problem

In supporting the business development in the seaweed sector in the PT. Bantimurung Indah region, efforts are needed to enhance the effectiveness of seaweed marketing. However, the market price of seaweed is highly fluctuating and can be attributed to inefficient supply chain management. The efficiency of supply chain management can be achieved if the management and supervision of distribution channel relationships are cooperatively carried out by all parties involved in the chain. The implementation of a seaweed commodity supply chain approach in the PT. Bantimurung Indah region is expected to provide an overview of the availability of seaweed supplies, serving as a consideration for managing the seaweed supply chain in the area.

2. Methodology

2.1 Data collection technique

This research employs the primary data collection technique obtained directly from firsthand sources, including individuals and entities, through methods such as interviews, document studies, and field observations conducted in the PT. Bantimurung Indah region. The researcher personally conducted these activities. Additionally, secondary data is utilized, sourced from literature such as books, journals, and theses, as well as directly from PT. Bantimurung Indah. The secondary data has been further processed and presented by the party responsible for collecting the primary data.

2.2 Data analysis technique

The data analysis technique used in this research to determine the seaweed supply chain is by using the FSCN (Food Supply Chain Network) approach, mapping actors, product flows, financial flows and information flows presented descriptively.

The analytical method used to determine the level of supply chain efficiency is the marketing efficiency approach using marketing margin and marketing efficiency. Systematically, marketing margin can be determined using the marketing margin formula, which is as follows:

$$MP = Pr - Pf \quad (1)$$

Information MP Marketing margin, Pr Price at the final level, Pf Price at farm level.

The marketing efficiency approach used in this research is a comparison between the prices received by farmers and the prices paid by consumers. Systematically knowing marketing efficiency is calculated using the following formula:

$$Eps = \frac{Pf}{Pk} \times 100\% \quad (2)$$

Information Eps Marketing efficiency (%), Pf Price at farm level (Rp/kg), Pk Price at exporter level (Rp/kg)

According to [22], determining marketing efficiency can be done using decision-making criteria such as the following:

Criteria:

1. If %Pf (PS) > 70% then marketing is considered efficient.
2. If %Pf (PS) ≤ 70% then marketing is considered inefficient.

The costs are:

$$Sbij = [cij / (Pr)] * 100\% \quad (3)$$

While the advantages are:

$$Skj = [Hij / (Pr)] * 100\% \quad (4)$$

Information Sbij share of costs for carrying out marketing functions (%), Cij costs for carrying out marketing functions (rupiah), Pr price at exporter level (rupiah), Hij marketing agency profit (rupiah), Skj marketing agency profit percentage (%).

2.3 Frame of mind

A framework of thinking is a way of thinking that is conceptualized to obtain an overview in research. The framework for this research is as follows:

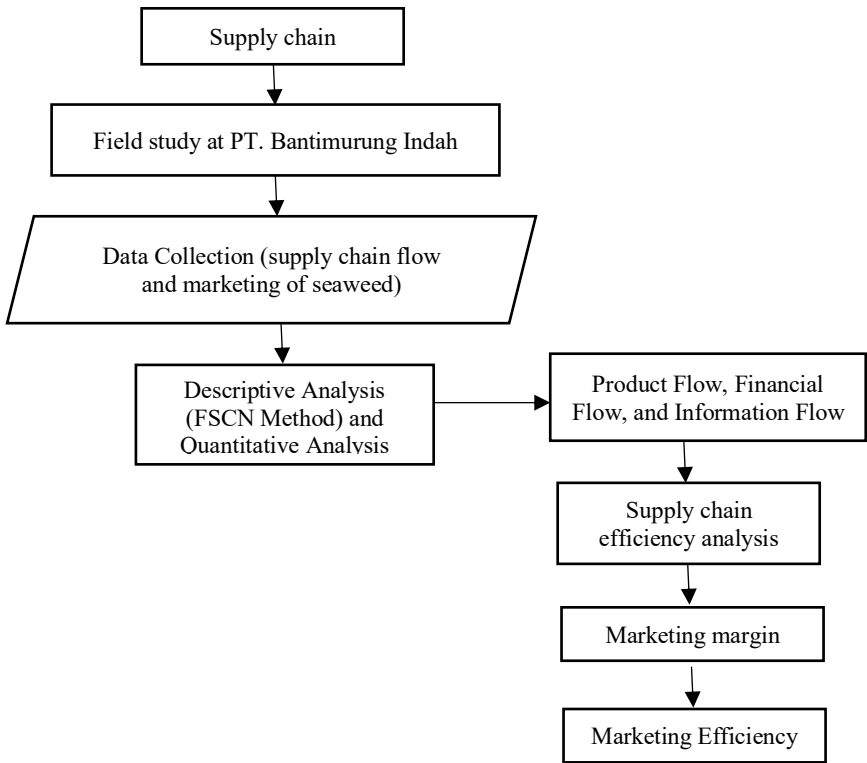
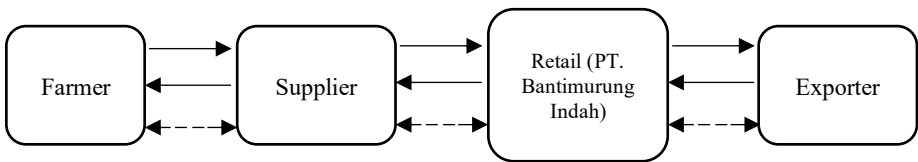


Fig. 1. Seaweed supply chain analysis framework.

3. Results and discussion

3.1 Supply chain structure

The supply chain is a process carried out by each chain link involved in the distribution process for each product. Seaweed supply chain structure in the PT. Bantimurung Indah area



explained the role of each member of the supply chain involved. Determining the supply chain structure can be influenced by the needs of the orderer or consumer, the number of supply chain actors involved, and the distance of delivery.

Fig. 2. Seaweed supply chain structure.

Information :
→ = Product Flow

- ←———— = Financial Flow
←-----> = Information Flow

In Figure 2 above, it can be seen that regarding the seaweed supply chain in the PT. Bantimurung Indah area in Maros district is divided into 3 types, namely product flow, financial flow and information flow. There are 4 chain members involved in the seaweed supply chain mechanism at PT. Bantimurung Indah in Maros, namely farmers, suppliers, retailers (PT. Bantimurung Indah), and exporters. The explanation regarding each member of the chain is as follows.

1. Farmer
Seaweed farmers are institutions or links in the chain that act as the main producers in the seaweed supply chain. Farmers are one of the members in the supply chain mechanism that carries out seaweed cultivation starting from the seeding process, maintenance, harvest process, to the post-harvest process of seaweed. Seaweed farmers are the initial stage of the seaweed supply chain in the PT. Bantimurung Indah Maros area. The farmers involved come from the South Sulawesi area, namely East Luwu, North Luwu, farmers assisted by the Palopo factory, farmers assisted by PT. Bantimurung Indah, etc.
2. Suppliers
Suppliers are the first marketing intermediary institutions involved in the distribution of seaweed. Suppliers are one of the members in the supply chain mechanism after farmers who have a role in directly distributing seaweed to retailers (PT. Bantimurung Indah). Seaweed supplier at PT. Bantimurung Indah is from various areas in South Sulawesi, namely the south coast of Jenepono, Bone, Pangkep, Palopo, and Sumbawa (Farmers assisted by PT. Bantimurung Indah).
3. Retail
Retail (PT. Bantimurung Indah) is one of the chain members in the supply chain mechanism after the supplier. PT. Bantimurung Indah is a chain agency that distributes seaweed to exporter partners. Exporting countries that use services from PT. Bantimurung Indah is Asia, Europe, Latin America and England.

3.2 Distribution pattern

The distribution pattern in the seaweed supply chain involves careful consideration of three main components: product flow, financial flow, and information flow. Product flow, within seaweed supply chain management, pertains to the distribution of raw seaweed products. Financial flow represents the monetary transactions involved in the supply chain, encompassing costs incurred and profits gained by each link in the seaweed supply chain, measured in Indonesian Rupiah. Information flow involves the communication process among the links in the seaweed supply chain, including farmers, suppliers, retailers, and exporters. These three integral components play a crucial role in comprehensively analyzing the seamless distribution flow within the seaweed supply chain in the PT. Bantimurung Indah area. Understanding the dynamics of product movement, financial transactions, and information exchange is essential for effective supply chain management in the seaweed industry. Certainly, here's an explanation of each component:

1. Product flow
In the seaweed supply chain, the distributed product is high-quality raw seaweed intended for marketing institutions, particularly suppliers within the PT. Bantimurung Indah area. The distribution process initiates with seaweed farmers conducting harvesting activities, and the harvested seaweed is then appropriately packaged, typically using plastic sacks. Subsequently, these packaged seaweed batches are

transported to supplier partners. Farmers usually make these seaweed deliveries in the afternoon or evening, each batch averaging around 80-100 kg of seaweed.

Upon reaching the supplier, the received seaweed undergoes re-weighing and recording processes to facilitate payment. The distribution of seaweed is carried out based on pre-established agreements between seaweed farmers and suppliers made during the harvest. For instance, the seaweed factory in Palopo, as mentioned by Mr. Mursalim S.pi, has collaborated with farmers in North Luwu, providing assistance to them. Once PT. Bantimurung Indah receives seaweed from its suppliers, a sorting process is conducted before dispatching the seaweed to exporters. After sorting, seaweed from various suppliers is re-weighed and packaged using plastic sacks, preparing it for shipment to the designated exporter partner, PT. Bantimurung Indah. This intricate process ensures the quality and consistency of seaweed products throughout the supply chain.

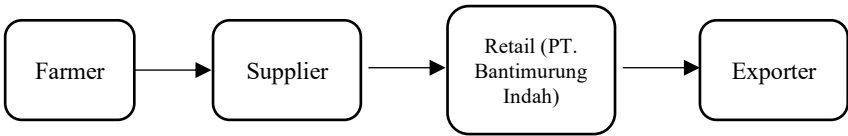


Fig. 3. Seaweed Supply Chain Product Flow.

2. Financial flow

Financial flows within the seaweed commodity supply chain in the PT. Bantimurung Indah area represent the movement of value in Indonesian Rupiah. This financial flow comprises various cost components and profits acquired by each link involved in the chain. The financial flow in the seaweed supply chain in this region follows a downstream direction. The mechanism of the financial flow in the seaweed supply chain within PT. Bantimurung Indah emphasizes the payment transaction system utilized by each link in the chain. Payments within the supply chain include the following:

- a. From Supplier to Farmers:
Payment is made in cash, amounting to IDR 14,000/kg for each seaweed delivery made by the farmer. This cash payment method allows seaweed farmers to engage in cultivation activities for the upcoming planting season and covers associated expenses, including transportation costs.
- b. From Retail (PT. Bantmurung Indah) to Suppliers:
Payment for shipping seaweed from retail to suppliers is typically in cash or follows a one-day delay payment system, amounting to IDR 16,000/kg with a profit of IDR 1,100/kg.
- c. From Seaweed Exporters to Retail (PT. Bantmurung Indah):
Payment is also carried out in cash or through a one-day deferred payment system, amounting to IDR 20,000/kg with a profit of IDR 2,550/kg. This payment covers total labor, transportation, and packaging costs of IDR 1,450/kg.

The financial flow from exporting countries back to farmers is categorized as smooth and without any problems. This structured financial system ensures a fair distribution of profits and covers necessary costs within the seaweed supply chain in the PT. Bantimurung Indah area.

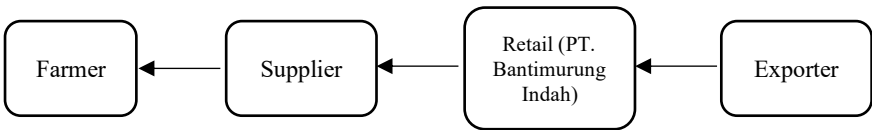


Fig. 4. Seaweed supply chain financial flow.

3. Information flow

Information flow stands out as a crucial component that requires meticulous attention to attain the objectives of the seaweed supply chain. Among seaweed farmers, the flow of information materializes through the exchange of insights, encompassing cultivation techniques, tillage methods, and the selection of superior seeds to enhance production outcomes. A robust information flow among the various actors in the supply chain fosters transparency, trust, and commitment, thereby nurturing collaborative relationships. In the seaweed supply chain, information flow takes on several dimensions, including:

a. Cultivation Information among Farmers:

Information sharing on cultivation techniques and seed selection contributes to increased production outcomes.

b. Market Information:

This includes details about the final target market (exporter), preferences of the exporting country, and the desired product quality. Market information from suppliers to farmers involves updates on changes in demand for seaweed quality and quantity. This information often includes insights into price changes and fluctuations in seaweed demand. Communication channels like telephones facilitate the exchange of this vital market information.

The flow of information within the seaweed supply chain is characterized as smooth, and the type of information exchanged is asymmetric. This smooth information exchange plays a pivotal role in ensuring that each link in the supply chain remains well-informed and can make informed decisions based on the market dynamics and changing demands.

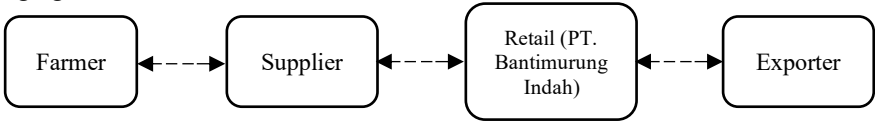


Fig. 5. Seaweed supply chain information flow.

3.3 Supply chain efficiency

Supply chain efficiency is carried out using marketing margin indicators and a marketing efficiency approach. Supply chain efficiency assessments can be used to see how chain resources have been allocated. The supply chain discussed in this research only has one marketing channel, namely involving farmers, suppliers, retailers (PT. Bantimurung Indah), and exporters.

Table 1. Marketing Margin and Marketing Efficiency in the Seaweed Commodity Supply Chain.

No	Marketing Institute	Price (IDR/Kg)	Share Value (%)	
			Profit	Cost
1	Farmer			
	Selling price	IDR 14.100	70.5	
2	Supplier			
	Purchase price	IDR 14.100		
	Transportation costs	IDR 350		1.75
	Labor costs	IDR 350		1.75
	Packaging Costs	IDR 100		0.5
	Selling price	IDR 16.000		
	Profit	IDR 1.100	5.5	
3	Retail			
	Purchase price	IDR 16.000		
	Labor costs	IDR 450		2.25
	Packaging Costs	IDR 300		1.5
	Transportation costs	IDR 700		3.5
	Selling price	IDR 20.000		
	Profit	IDR 2.550	12.75	
4	Exporter			
	Selling price	IDR 20.000		
	Total Margin	IDR 5.900		
	Total cost	IDR 2.250		11.25
	Total Profit	IDR 3.650	88.75	
	Marketing Efficiency (%)			70.5

Table 1 above shows that the relevant seaweed marketing institutions are suppliers and retailers (PT. Bantimurung Indah). Suppliers incur costs such as transportation, labor and packaging costs. The highest cost is labor costs, which are IDR 350 per kg. Transportation costs incurred by suppliers are influenced by the amount of seaweed calculated in sacks and the distance between suppliers. Transportation costs for one sack are IDR 21,000 containing approximately 60 kg. The purchase price for seaweed from producer farmers is IDR 14,100 per kg and sold to retailers (PT. Bantimurung Indah) for IDR 16,000 per kg. Total costs at the supplier level are IDR 800 and profits are IDR 1,100 per kg. The marketing margin obtained by suppliers is IDR 1,900 per kg.

Next, the retailer (PT. Bantimurung Indah) buys seaweed from the supplier at a price of IDR 16,000 per kg. Retailers incur marketing costs of IDR 1,450 per kg, which consists of labor costs of IDR 450 per kg, packaging costs of IDR 300 per kg, and transportation costs of IDR 700 per kg. Retail (PT. Bantimurung Indah) then sells it to exporter partners. The selling price of seaweed to exporters is IDR 20,000 per kg. The profit obtained by the retail (PT. Bantimurung Indah) is IDR 2,550 per kg and the marketing margin is IDR 4,000 per kg.

The total marketing margin value for seaweed is IDR 5,900 per kg, total profit is IDR 3,650 per kg and total costs are IDR 2,250 per kg. The profit share value is 88.75% while the cost share value is 11.25%. According to Prayitno, et al (2013) in Kurniawan et al (2014), which states that if the FS (Farmer Share) percentage is > 70%, then marketing will be considered efficient. The share of the price received by farmers (farmer share) is 70.5% so that the seaweed supply chain in the PT. Bantimurung Indah area has been categorized as efficient.

4. Conclusions and recommendations

4.1 Conclusions

1. The supply chain of seaweed in the PT. Bantimurung Indah area encompasses various key links, including farmers, suppliers, retailers, and exporters. The distribution pattern of the seaweed supply chain involves careful consideration of three primary components: product flow, financial flow, and information flow. These components are seamlessly integrated within each supply chain category, contributing to the efficient functioning of the overall system.
2. The comprehensive marketing analysis for seaweed reveals a total marketing margin of IDR 5,900 per kg, generating a total profit of IDR 3,650 per kg, and incurring total costs of IDR 2,250 per kg. The profit share represents 88.5%, while the cost share amounts to 11.5%. Notably, the share of the price received by farmers, known as the farmer share, is 70.5%. This categorization emphasizes the efficiency of the seaweed supply chain in the PT. Bantimurung Indah Maros area, as the Farmer Share (FS) percentage exceeds the recommended threshold of 70%.

4.2 Recommendations

Collaboration among farmers in the distribution process needs enhancement to explore avenues for expanding seaweed distribution. Prioritizing the improvement of seaweed production capacity and quality is crucial for securing a stronger bargaining position. Additionally, farmers should focus on reducing marketing costs by establishing new and more efficient supply chains, aiming to further increase the value of the farmer share. This strategic approach will contribute to the overall efficiency and sustainability of the seaweed supply chain.

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