

Value Added and Profitability Analysis of Innovative Seaweed Buoy Production in North Kalimantan

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ABSTRACT

Seaweed cultivation requires supporting facilities, including buoys to maintain the stability of cultivation lines in marine waters. In coastal areas of Nunukan, discarded plastic bottles and shrimp feed containers are widely used as buoy materials, contributing to marine plastic waste accumulation. This study employed a single case study approach focusing on a pioneer entrepreneur producing recycled seaweed buoys in Mamolo, Southern Nunukan. The research aimed to analyze the value added and profitability of this business. Data were obtained from one respondent who actively manages buoy production, and the Hayami method was applied to estimate value added from processing plastic waste into seaweed buoys. The results showed that value added reached Rp 47,702.70. Margin distribution indicated that 2.83% was allocated to labor income, 10% to other inputs, and 87.22% to entrepreneur profit. The Margin of Safety was 75.08%, the MIR was 49.26%, and profit reached 36.99%, demonstrating both economic and environmental potential.

ABSTRAK

Budidaya rumput laut membutuhkan fasilitas pendukung, termasuk pelampung untuk menjaga stabilitas jalur budidaya di perairan laut. Di daerah pesisir Nunukan, botol plastik bekas dan wadah pakan udang banyak digunakan sebagai bahan pelampung, yang berkontribusi pada akumulasi sampah plastik di laut. Penelitian ini menggunakan pendekatan studi kasus tunggal yang berfokus pada seorang pengusaha perintis yang memproduksi pelampung rumput laut daur ulang di Mamolo, Nunukan Selatan. Penelitian ini bertujuan menganalisis nilai tambah dan profitabilitas bisnis ini. Data diperoleh dari satu responden yang aktif mengelola produksi pelampung, dan metode Hayami diterapkan untuk memperkirakan nilai tambah dari pengolahan limbah plastik menjadi pelampung rumput laut. Hasil menunjukkan bahwa nilai tambah mencapai Rp 47.702,70. Distribusi margin menunjukkan bahwa 2,83% dialokasikan untuk pendapatan tenaga kerja, 10% untuk input lain, dan 87,22% untuk keuntungan pengusaha. Margin Keamanan adalah 75,08%, MIR adalah 49,26%, dan keuntungan mencapai 36,99%, menunjukkan potensi ekonomi dan lingkungan.



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INTRODUCTION

Seaweed is a commodity that has been the food of most Indonesians for a long time. Seaweed was first discovered in the 17th century by foreign explorers, but in the 1980s, the Indonesian government began to prioritize seaweed production as an alternative source of revenue for coastal communities (Andréfouët et al., 2021). Not only as food, but now seaweed is used as a medicinal ingredient, food additive, cosmetic, livestock feed, and organic fertilizer (Lähtenmäki-Uutela A Rahikainen et al., 2021).

The high global demand for cause the seaweed producing countries, including Indonesia, are competing to produce large quantities of good-quality seaweed. The seaweed is easy to cultivate and takes a short time to grow (Virnstein, 2021). To date, Indonesia ranks second after China as the world's largest seaweed producer (Jiang et al., 2022), and one of the provinces

contributing to national production is Northern Kalimantan. Since 2012, seaweed cultivation in the Northern Kalimantan Province has been on the rise in Tarakan City and Nunukan District. *Eucheuma cottoni* (Kasim et al., 2017). The Central Statistical Agency of Northern Kalimantan Province recorded the largest production of seaweed in 2021 in Nunukan District with 416,230 tons, followed by Tarakan City with 211,464 tons (Lukas, 2023).

One of the seaweed production factors is the seaweed buoy (Tullberg et al., 2022), where all this time people have used mineral water bottles or waste oil slurries as seaweed buoy. The use of these mineral water bottles is not long-lasting (Michael Niaounakis, 2017), so when they become unfit, they contribute to the accumulation of plastic waste in the coastal area of Nunukan (Nurdin et al., 2020). This has given birth to the innovation of using plastic-derived refill balls as a replacement for used mineral water bottles and shrimp with longer durability, as managed by one of the Non Government Organization : Harapan Bersama.

This study contributes to the literature by providing a focused economic analysis of recycled seaweed seaweed buoy production using plastic waste in the coastal area of Nunukan, North Kalimantan (Benedicte Charrier et al., 2018). While previous studies have primarily emphasized technological development and environmental aspects of seaweed seaweed buoys, limited attention has been given to their economic feasibility at the small-enterprise level (Zamroni, 2018). This research addresses that gap by applying value-added analysis using the Hayami method combined with profitability analysis to evaluate the economic performance of seaweed buoy production. The study is conducted as a single case study of a pioneer entrepreneur in Mamolo, Southern Nunukan, offering contextual insights into the potential of recycled buoy production as both a waste management initiative and a coastal livelihood opportunity.

This study addresses the limited understanding of sustainability aspects in small-scale buoy production initiatives in coastal areas. While previous studies mainly focus on technical or environmental aspects of seaweed cultivation infrastructure, the socio-economic dynamics of locally initiated buoy production remain underexplored. This research examines a pioneer entrepreneurial initiative to better understand its potential contribution to local economic opportunities and plastic waste recycling in the coastal community of Southern Nunukan (Spillias et al., 2023).

RESEARCH METHOD

The case study method was used in this research to examine phenomena or events that occur on a particular object (Harrison et al., 2017). The data used in this study are primary and secondary. The primary data was obtained through a direct and in-depth interview with seaweed buoy producer using a questionnaire. Secondary data was obtained from related institutions and literature related to the research object. The survey respondent numbered one is the perpetrator of the seaweed buoy entrepreneur, because there is only one person who has this business in the Nunukan district. The data collection was carried out in Mamolo Village, Kelurahan Tanjung Harapan, a seaweed village in Nunukan District. The selection of this location is due to the fact that Mamolo village has been designated by the Minister of Marine Affairs and Fisheries as a fishing village for seagrass cultivation, and the village is the largest seaweed producer center in Nunukan.

Value-added analysis is the difference between the output cost and the input value (Bems & Johnson, 2017). In the analysis of the value added of seaweed buoy using the Hayami method,

there are three variables that are observed: 1) output value, input, and price; 2) revenue and profit; and 3) reimbursement of production factor. Gross surplus value is the difference between the value of production and the cost of production (Lubova & Zalilova, Z Sharafutdinov, 2020), whereas net surplus is the gap between the gross surplus price and the costs spent on the factor of production. The value-added ratio is the ratio between the gross value added and the value of production. An analysis of the added value of the Hayami method can be written as follows:

Table 1. Hayami Method Additional Value Calculation

No	Variable	Units	Value
A.	Output, Input, and price		
1.	Output	Unit/Period	1
2.	Input	Kg/Period	2
3.	Labour	HOK	3
4.	Conversion factor		4=1/2
5.	Labour Coefficient	HOK/Kg	5=3/2
6.	Output Price	Rp	6
7.	Labour wages	Rp/HOK	7
B.	Revenue and Profit		
8.	Price of raw materials	Rp/Kg	8
9.	Other Input Contributions	Rp/Kg	9
10.	Output Value	Rp/Kg	10=4 x 6
11.	a. Value Added	Rp/Kg	11a=10-9-8
	b. Value Added Ratio	%	11b=11a/10 x 100%
12.	a. Labour Income	Rp/Kg	12a=5 x 7
	b. Share of the labour force	%	12b=12a/11a x 100%
13.	a. Profit	Rp/Kg	13a=11a - 12a
	b. Profit Rate	%	13b=13a/11a x 100%
C.	Production Factor Owner Service Response		
14.	Margin	Rp/Kg	14=10 - 8
	a. Labour (%)	%	14a=12a/14 x 100%
	a. Capital (Othe Input) %	%	14b=9/14 x 100%
	b. Profit (%)	%	14c=13a/14 x 100%

As for the criteria for making the decision, it is as follows (17) :

- 1.) If the value added > 0, the seaweed buoy gives the value added (positive).
- 2.) If the added value < 0, the seaweed buoy does not give an added value (negative).

Profitability can be seen through two components, namely costs spent and receipts obtained in the production process (Jackson et al., 2018). Profitability is expressed as a percentage obtained from the ratio of profit to product sales. Profitability is crucial to maintaining business in the long term, and the results will show prospects in the future (Sari & Sedana, 2020). The profitability equation can be written as follows (Uyar, 2014) :

$$\text{Profitability} = \pi / \text{TC} \times 100\%$$

Description :

π = profit (Rp/production)

TC = Total Cost (Total Cost)

Or by means of calculations like in table 2 below (19):

Table 2. Calculation of Profitability of Seaweed buoy

No	Description	Profitability
1.	Sales Value (Rp)	A
2.	Total production (Units)	B
3.	Total Variable Cost (Rp)	C
4.	Contribution Margin (Rp)	$D = A - C$
5.	Contribution Margin per unit	$E = D / B$
6.	Contribution Margin Ratio	$F = C / A$
7.	Total Fixed Cost (Rp)	G
8.	Break Even Point of Sales (Rp)	$H = G / F$
9.	Break Even Point of volume (Units)	$I = G / E$
10.	Margin of Safety (MOS)	$J = (A - H) / A \times 100$
11.	Marginal Income Ratio (MIR)	$K = 1 - (C / A) \times 100$
12.	P	$L = J \times K / 100$

The criteria used in the assessment of profitability are (Medjoudj et al., 2013) : if profitability > 0, it means profitable; if profitability = 0, it means a dead end; whereas when profitability < 0, it means unprofitable.

RESULTS AND DISCUSSION

Analysis of the revenue of the seaweed seaweed buoy

The value of income can be obtained by pre-analyzing the costs incurred during the production process, but in this study there are two categories of costs : fixed costs and variable costs. The results of the calculation of fixed and variable costs can be seen in Table 3 below.

Table 3. Analysis of The Revenue of The Seaweed Seaweed buoy

Description	For one production time			
	Units	Amount	Price (Rp)	Value (Rp)
Revenue (a)				
Output	Unit	150	13.000	1.950.000
1. Fixed Cost				
Machine and tool reducing :				
Chopping Machine	Unit	1		Rp 31.500,00
Printing Machine	Unit	1		Rp 29.500,00
Compressor Machine	Unit	1		Rp 1.248,00
Tricycle Bike	Unit	1		Rp 20.000,00
Rice bag	Sheet	50		Rp 625,00
Filtering Machine	Meter	0,03		Rp 1,00
Drying Bucket	Unit	20		Rp 12.500,00
Tarpaulin	Meter	2		Rp 233,00
120 Ampere battery	Unit	1		Rp 900,00
Production Building	Unit	1		Rp 150.000,00
Total Fixed Cost (b)				Rp 246.507,00
2. Variable Cost)				
HDPE Bottle	Kg	40	5.000	Rp 200.000,00
LDPE Bottle	Kg	12	5.000	Rp 60.000,00
Electricity Cost	Kwh	122,69	489	Rp 59.995,41
Vanbelt	Meter	3	462,95	Rp 1.388,85
Fuel Oil	Liter	30	13.400	Rp 402.000,00
Oil Machine	Liter	0,04	50.000	Rp 2.000,00
Labour	Mens Labor	5,28	50.000	Rp 264.000,00
Total Variable Cost (c)				Rp 989.384,26

Total Cost (d)		Rp 1.235.891,00
Income (a-d)	Rp	Rp 714.109
R/C Ratio		1,57

Source : Primary Data Analysis, 2026

Production costs in this activity are costs incurred during the production process. Production costs include fixed costs and variable costs (Bak & Mols-Mortensen, A Gregersen, 2018). The fixed cost consists of the cost of reducing equipment, machinery and buildings. The reduction cost is included as a fixed charge because it does not change in proportion to the volume of production or the level of business activity that fluctuates. Reduction is the process of systematically acknowledging a depreciation or decrease in the value of a fixed asset during its lifetime (Liapis & Kantianis, 2015). When a company decides to reduce an asset, the cost of the reduction will remain at a relatively constant rate each period, regardless of how much or how little the asset is used during that period. While the variable cost consists of the cost of raw materials, engine and oil spare parts, electricity costs, fuel costs, and labor. The raw materials used are made up of two kinds of HDPE and LDPE bottles. The spare stock and oil are required to replace if there is damage to the plastic cane machine or the compressor to form a seaweed seaweed buoy. The fuel cost is used to operate the cart motorbike that will be used to buy the raw material.

The size of the small cost per unit of activity varies depending on the method of allocation, productivity, and size of production (Abramo & D'Angelo, 2014). The data analysis resulted in a variable cost (TVC) of Rp 989.384,26 and a fixed cost (TFC) of Rp 246.507,00 , so that the total cost (TC) in the process of making a seaweed seaweed buoy amounted to Rp 1.235.891,00 which is the result of the addition of two cost components, namely variable costs and fixed costs. For receipts (total revenue/TR) of Rp 1.950.000,00 that are obtained from the sale price (P) per unit, the amount (Q) each time the production is 150 units further from the receipt (TR) for 1 times the production (Rp), Looking at the production frequency over a month, it's a profitable and very prospective effort to continue to develop, as it can reduce plastic waste in huge quantities.

Value Added of the Seaweed buoy Ranger

Value-added analysis is calculated using value-added analysis with a production structure approach (Fuss & McFadden, 2014). This discussion of added value is in three parts : output value, input, and price; revenue and profit; property factor owner's service return.

Table 4. Analysis of Value Added

No	Variable	Units	Value
A.	Output, Input, and price		
1.	Output	Unit/Period	150
2.	Input	Kg/Period	52
3.	Labour	Labor Hour	1
4.	Conversion factor		2,88
5.	Labour Coefficient	Labor Hour/Kg	0,019
6.	Output Price	Rp	13.000
7.	Labour wages	Rp/HOK	50.000
B.	Revenue and Profit		
8.	Price of raw materials	Rp/Kg	5.000
9.	Other Input Contributions	Rp/Kg	4.745,94
10.	Output Value	Rp/Kg	37.500,00

11.	a. Value Added	Rp/Kg	27.754,06
	b. Value Added Ratio	%	74,01
12.	a. Labour Income	Rp/Kg	961,54
	b. Share of the labour force	%	3,46
13.	a. Profit	Rp/Kg	26.792,52
	b. Profit Rate	%	96,54
C. Production Factor Owner Service Response			
14.	Margin	Rp/Kg	32.500
	a. Labour (%)	%	2,95
	b. Capital (Othe Input) %	%	15
	c. Profit (%)	%	82,44

Source : Primary Data Analysis, 2026

Based on the value added analysis calculations, the average output in one production of 150 bottles was obtained from an input of 52 kg of plastic bottles with a conversion factor of 2,88 , which means that one kilogram of plastic can produce 2 until 3 products. The labor coefficient is the result of the labor force (HOK) and the amount of raw materials used in the production process, so the more raw materials used, the smaller the value of the factor produced. The labor consumption of the seagull maker in Nunukan is more efficient, which is due to the undertaking's coefficient of 0,019.

Income and Profit

The output value (Rp/kg) is the result of dividing the conversion factor by the price of the ordinary product (Rp/kg). If the value of the converting factor produced is high, then the resulting value is likely to be high. The result of such an output value is deducted from the cost of other input contributions (Rp/unit) and the costs of raw materials (Rp/kg), and then the value added is obtained. The value added received is used to pay the labor costs (Rp/kg), thus obtaining a profit for the seagrass mining enterprise. If the added value is divided by the value of the output, then it will obtain a value-added ratio of 74,01%. This means that each kilogram of plastic bottle multiplied by a percentage of value added ratios represents value added from processing plastic bottles into seaweed buoy, and this value added represents a gross value added because it has not been reduced by the reward for labor. The value-added analysis shows that the amount of value added generated is influenced by the value of the product, other input contributions, and the price of raw materials. Further analysis of the processing of plastic bottle waste into seaweed buoy shows the profits generated by the entrepreneur. The profit obtained by the entrepreneur is the difference between value added and labor. If the profit is compared with the value added, the profit rate of seaweed seaweed buoy production reaches 82,44 %. This figure is obtained from a profit of Rp 26.792,52 per kg of plastic bottles relative to a value added of Rp 27.754,06 per kg of plastic bottles. The value added of Rp 27.754,06 per kg is equivalent to approximately Rp 47.702,70 per production batch of 150 units. This profit represents a net return, as labor remuneration has already been included in the calculation.

Property Factor Owner's Service Return

The added value obtained is a reward for each factor of production used. In order to determine how much of the value added gained is paid, it is first necessary to know the margin between the value of the output produced and the main raw material used. The size of the margin obtained from the calculation of the value-added analysis on the treatment of plastic

wastes in the seaweed is Rp 32.500,00. The prime margin is then distributed to labor income, other input contributions, and corporate profits. The size is the distribution of the margin for labor income of 2.95%, the other input contribution of 15%, and the corporate profit of 82.44%. The margin distributed for profits is the largest part when compared to direct labor income and other input donations. It shows that the production activities carried out by the entrepreneur have reached the level of profitability for the enterprise.

Profitability

In order to measure the level of profitability, there are two variables that are needed: the total receipt, which is the surplus between the production and the selling price of the product, and the total cost, which represents the aggregate of the entire cost of either the cost of reducing the equipment, labor costs, raw material costs, and so on. This product is mostly sold out in northern Kalimantan, like Maluku and Makassar, which are also seaweed producers. The BEP of sales was Rp 485.846,01, which means that at the level of sales, the company reached an impasse where the total revenue from sales was sufficient to cover all expenditure. While the BEP (Break Even Point) volume is 38.49, this means that a company reaches an impasse when they succeed in selling or producing as many as 38.49 product units. The BEP volume reflects the level of production or sales where the revenue from the sale of the product or service is equivalent to the total cost, including fixed and variable costs. The results of the analysis of research data on the profitability of Seaweed balls can be seen in Table 5.

Table 5. Profitability Analysis

No	Description	Profitability
1.	Sales Value (Rp)	1.950.000,00
2.	Total of Production (Units)	150,00
3.	Variable Cost (Rp)	989.384,26
4.	Margin Contribution (Rp)	960.615,74
5.	Contribution margin per unit	6.404,10
6.	Ratio of Margin Contribution	0,51
7.	Fixed Cost (Rp)	246.506,87
8.	BEP of Sales (Rp)	485.846,01
9.	BEP of volume (unit)	38,49
10.	MOS	75,08
11.	MIR	49,26
12.	P	36,99

Source : *Primary Data Analysis, 2026*

The results of the analysis of the research data showed that the margin of safety (MoS) in the processing of plastic waste into landfills is 75,08%. The value of this size indicates that if the next volume of sales decreases from 75,08% of current sales, then this processing activity will suffer losses. This condition also indicates that the sales of the plumbing are 75,08% above the deadline. A marginal income ratio (MIR) of 49,26% indicates that the processing of plastic waste into landfills has the ability to cover fixed costs and generate a profit of 49,26% of the value of its sales. After knowing the margin of safety (MoS) and marginal income ratio (MIR), it can be calculated that seagrass miners earn a profit of 36,99%. This shows that from the sales value that can be achieved in the period of the year analysis, the processing of plastic waste into miners can get a profit of 36,99% of the value of such sales.

CONCLUSIONS

Based on the results of the study on the identification of value added and profitability of seaweed buoys as an alternative approach to plastic waste management in Seaweed Village, North Kalimantan, it can be concluded that the case examined in this research demonstrates a promising level of economic feasibility. The value-added analysis shows that an average production output of 150 seaweed buoys per production cycle is generated from an input of 52 kg of plastic bottles, resulting in a conversion factor of 2.88. The value-added ratio reaches 74.01%, while the profit rate of seaweed buoy production is 96.54%, with a profit of Rp 26.792,52 per kg of plastic bottles from a value added of Rp 27.754,06 per kg of plastic bottles. In addition, the margin of safety (MoS) value for the plastic waste processing activity is recorded at 75.08%, indicating a relatively safe production level against potential fluctuations. The margin of income ratio (MIR) of 49.26% suggests that the activity is able to cover fixed costs while generating profit equivalent to 49.26% of its sales value. These findings indicate that, within the specific case studied, recycled seaweed buoy production shows high profitability potential and may serve as a promising small-scale business model. However, the results should be understood within the context of this single-case study, although the model may have the potential to be replicated by other coastal entrepreneurs in areas with similar environmental and economic conditions. The findings of this study highlight the economic and environmental potential of recycled seaweed seaweed buoy production. Increasing value added through improved production processes and product differentiation can support higher business profitability. Therefore, the development of value-added strategies in seaweed buoy production can become an alternative approach to both coastal waste management and small-scale economic development.

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