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Research Paper

Economic Value Added and Profitability of Recycled-Bottle Seaweed Buoys in North Kalimantan

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ABSTRACT

Plastic waste has become a major environmental challenge in coastal and marine areas, including aquaculture regions. In North Kalimantan, seaweed farming relies heavily on plastic buoys, which contribute significantly to plastic pollution due to degradation and improper disposal. This study aims to analyze the value added and profitability of innovative seaweed buoys made from recycled plastic bottles as an alternative approach to plastic waste management in seaweed aquaculture. The research employed a descriptive quantitative approach combined with economic analysis. Data were collected from seaweed farming groups using recycled-bottle buoys through field observations, interviews, and cost-benefit analysis. The value-added analysis was conducted using the Hayami method, while profitability was measured using indicators such as profit margin, benefit-cost ratio, and break-even point. The results indicate that recycled-bottle seaweed buoys generate positive value added and demonstrate higher profitability compared to conventional plastic buoys. In addition, the innovation contributes to reducing plastic waste and lowering production costs for seaweed farmers. These findings suggest that recycled-bottle seaweed buoys are economically viable and environmentally sustainable, offering a practical solution for plastic waste management and sustainable aquaculture development in North Kalimantan.

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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 (Lähteenmäki-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 buoy float (Tullberg et al., 2022), where all this time people have used mineral water bottles or waste oil slurries as buoy float. 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.

The newest seaweed buoy float technology uses environmentally friendly materials (Benedicte Charrier et al., 2018) and it has an efficient design for collecting and preserving seaweed to the maximum production (Tullberg et al., 2022). However, the current obstacle is that there are not many entrepreneurs in Nunukan and Tarakan who are interested in making this buoy float because it is considered a bottle of wasted water, and waste shrimp are still reliable for most cultivators (Zamroni, 2018). The fact suggests that studies on the added value and profitability of seaweed buoy float as an alternative to plastic waste disposal are important to undertake. Identification of the added value and profitability of buoy floats can be done through several important stages (Kassila et al., 2019), namely the collection of data and important information related to the balls, such as the use of raw materials, the production process, and its sales value on the market. The next step is to identify the factors that can be valued as adding value to the seaweed buoy float, such as attractive designs, the use of quality raw materials, and innovation in the production process (Olanrewaju et al., 2017).

The next stage concerns the identification of potential markets for buoy float in accordance with the already defined added value, which will subsequently involve market and competition analysis (Kim et al., 2019) to be able to determine the most appropriate market segment. To calculate profitability, it can be seen through production costs, sales prices, sales volumes, competition, and other economic factors (Nogueira & Henriques, 2020). To increase profitability, some strategies can be implemented (Kumar et al., 2017), such as reducing production costs, increasing production efficiency, improving product quality, raising sales prices, making innovations, and developing new markets. Novelty in this study is conducting an in-depth economic analysis related to seaweed buoy float unprecedented (Robledo et al., 2013), involving analysis of the socio-economic impact of buoy float seaweeds on the local community in Nunukan, Identifying the use of technology

and automation in buoy float production. The research gap in this study is in studying the sustainability aspects of buoy float activities. Gaps can arise if there are limitations in understanding the socio-economic impact of buoy floats on local communities. Further research can examine in detail how buoy floats affect social and economic aspects (Spillias et al., 2023). The results of this research are very important to know, as they can provide information about the economic and environmental potential of the commodity. Buoy float are a product of high economic value in some Asian countries, including Indonesia (Li et al., 2022).

However, the added value that can be generated from the seaweed buoy float is still not optimally utilized in Northern Kalimantan (Heijden, van der P. G. M Lansbergen et al., 2022), as there is no training like that done in Mamolo Seaweed Village, Southern Nunukan. Literature review has highlighted the importance of added value in the seaweed industry, especially in products such as buoy float. Added value can be related to production processes, product diversification, or the application of innovative technologies to seaweed buoy float (Radulovich et al., 2015). The hypothesis in this study is that the existence of an increase in value added in seaweed buoy float production will contribute positively to corporate profits and the implementation of value added enhancement strategies, such as product differentiation, will have a positive impact on the profitability of the company in the seaweed buoy float market.

Method

Location and Respondent Determination

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 a marine lawnmower 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 buoy float entrepreneur, because there is only one person who has this business in the Nunukan district. The research was conducted from June to August 2024. 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.

Data analysis and presentation

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 buoy float 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/Periode	1
2.	Input	Kg/Periode	2
3.	Labour	HOK	3
4.	Conversion factor		4=1/2
5.	Labour Coefficient	HOK/Kg	5=3/2
6.	Output Price	IDR	6
7.	Labour wages	IDR/HOK	7
B. Revenue and Profit			
8.	Price of raw materials	IDR/Kg	8
9.	Other Input Contributions	IDR/Kg	9
10.	Output Value	IDR/Kg	10=4 x 6
11.	a. Value Added	IDR/Kg	11a=10-9-8
	b. Value Added Ratio	%	11b=11a/10 x 100%
12.	a. Labour Income	IDR/Kg	12a=5 x 7
	b. Share of the labour force	%	12b=12a/11a x 100%
13.	a. Profit	IDR/Kg	13a=11a – 12a
	b. Profit Rate	%	13b=13a/11a x 100%
C. Production Factor Owner Service Response			
14.	Margin	IDR/Kg	14=10 – 8
	a. Labour (%)	%	14a=12a/14 x 100%
	. Capital (Othe Input) %	%	14b=9/14 x 100%
	. 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 bowler ball gives the value added (positive).
- 2.) If the added value < 0, the bowler ball does not give an added value (negative).

Profitability

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 (IDR/production)

TC = Total Cost (Total Cost)

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

Table 2. Calculation of Profitability of Buoy float

No	Description	Profitability
1.	Sales Value (IDR)	A
2.	Total production (IDR)	B
3.	Total Variable Cost (IDR)	C

No	Description	Profitability
4.	Contribution Margin (IDR)	$D = A - C$
5.	Contribution Margin per unit	$E = D/B$
6.	Contribution Margin Ratio	$F = C/A$
7.	Total Fixed Cost (IDR)	G
8.	Break Even Point of Sales (IDR)	$H = G/F$
9.	Break Even Point of volume (unit)	$I = G/E$
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 Buoy Float

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 Buoy float

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

For one production time				
Description	Units	Amount	Price (IDR)	Value (IDR)
Labour	Mens	5,28	50.000	IDR 264.000
	Labor			
Total Variable Cost (c)				IDR 989.384,26
Total Cost (d)				IDR1.235.891
Income (a-d)	IDR			IDR714.109
R/C Ratio				1,57

Source : Primary Data Analysis, 2025

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 buoy float.

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 IDR. 989.384.26 and a fixed cost (TFC) of IDR. 246.507, so that the total cost (TC) in the process of making a seaweed buoy float amounted to IDR. 1.235.891, which is the result of the addition of two cost components, namely variable costs and fixed costs. For receipts (total revenue/TR) of IDR. 1.950,000 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 (IDR), 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 Buoy float Ranger

Value-added analysis is calculated using value-added analysis with a production structure approach (Fuss & McFadden, 2014).

Table 3. 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	IDR	13.000
7.	Labour wages	IDR/HOK	50.000
B.	Revenue and Profit		

No	Variable	Units	Value
8.	Price of raw materials	IDR/Kg	5.000
9.	Other Input Contributions	IDR/Kg	4.745,94
10.	Output Value	IDR/Kg	37.500,00
11.	a. Value Added	IDR/Kg	27.754,06
	b. Value Added Ratio	%	74,01
12.	a. Labour Income	IDR/Kg	961,54
	b. Share of the labour force	%	3,46
13.	a. Profit	IDR/Kg	26.792,52
	b. Profit Rate	%	96,54
C. Production Factor Owner Service Response			
14.	Margin	IDR/Kg	32.500
	a. Labour (%)	%	2,95
	b. Capital (Othe Input) %	%	15
	c. Profit (%)	%	82,44

Source : Primary Data Analysis, 2025

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 (IDR/kg) is the result of dividing the conversion factor by the price of the ordinary product (IDR/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 (IDR/unit) and the costs of raw materials (IDR/kg), and then the value added is obtained. The value added received is used to pay the labor costs (IDR/kg), thus obtaining a profit for the seagrass mining enteIDRrise. 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 mines, 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 buoy float 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 divided by the suIDRlus value, then the rate of profit of the seaweed harvester will be 82,44%, obtaining the profit of IDR 26.792,52 per kg of plastic bottle divided by the added value of IDR 27.754,06 per kg of plastic bottle. This benefit is a net profit because it has taken into account labor remuneration.

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 IDR 32.500. The prime margin is then distributed to labor income, other input contributions, and coIDRorate profits. The size is the distribution of the margin for labor income of 2.95%, the other input contribution of 15%, and the coIDRorate 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 IDR 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 (IDR)	1.950.000,00
2.	Total of Production (IDR)	150,00
3.	Variable Cost (IDR)	989.384,26
4.	Margin Contribution (IDR)	960.615,74
5.	Contribution margin per unit	6.404,10
6.	Ratio of Margin Contribution	0,51
7.	Fixed Cost (IDR)	246.506,87
8.	BEP of Sales (IDR)	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, 2025

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.

Conclusion

This study concludes that innovative seaweed buoys made from recycled plastic bottles provide significant economic and environmental benefits for seaweed aquaculture in North Kalimantan. The value-added analysis demonstrates that the utilization of recycled bottles generates positive added value, indicating that plastic waste can be effectively transformed into productive and economically valuable aquaculture inputs. Furthermore, the profitability analysis shows that the use of recycled-bottle buoys reduces production costs and yields favorable profit margins, making them a financially viable alternative to conventional plastic buoys. Beyond economic advantages, the adoption of recycled-bottle seaweed buoys contributes to plastic waste reduction in coastal environments and supports sustainable aquaculture practices. The integration of waste management and seaweed farming not only enhances farmers' income but also promotes environmentally responsible production systems. Overall, recycled-bottle seaweed buoys represent a practical, cost-effective, and sustainable solution that can be further developed and replicated to strengthen plastic waste management and sustainable aquaculture development in North Kalimantan.

References

- Abramo, G., & D'Angelo, C. . (2014). How do you define and measure research productivity? *Scientometrics* 101, 1129–1144. <https://doi.org/https://doi.org/10.1007/s11192-014-1269-8>
- Andréfouët, S., Dewantama, I. M. I., & Ampou, E. E. (2021). Seaweed farming collapse and fast changing socio-ecosystems exacerbated by tourism and natural hazards in Indonesia: A view from space and from the households of Nusa Lembongan island. *Ocean & Coastal Management*, 207(105586). <https://doi.org/https://doi.org/10.1016/j.ocecoaman.2021.105586>
- Bak, U. G., & Mols-Mortensen, A Gregersen, O. (2018). Production method and cost of commercial-scale offshore cultivation of kelp in the Faroe Islands using multiple partial harvesting. *Algal research*, 33, 36–47.
- Bems, R., & Johnson, R. C. (2017). Demand for value added and value-added exchange rates. *American Economic Journal: Macroeconomics*, 9(4), 45–90.
- Benedicte Charrier, Wichard, T., & Reddy, C. R. K. (2018). *Protocols for Macroalgae Research*. CRC Press.
- Fuss, M., & McFadden, D. (Eds.). (2014). *Production economics: A dual approach to theory and applications: Applications of the theory of production*. North Holland Publishing Company.
- Harrison, H., Birks, M., Franklin, R., & Mills, J. (2017). Case study research: Foundations and methodological orientations. In Forum qualitative Sozialforschung/Forum: qualitative social research. *In Forum qualitative Sozialforschung/Forum: qualitative social research*, 18(1).

- Heijden, van der P. G. M Lansbergen, R., Axmann, H., Soethoudt, H., Tacke, G., Van den Puttelaar, J., & Rukminasari, N. (2022). *Seaweed in Indonesia: farming, utilization and research*. <https://doi.org/https://doi.org/10.18174/578007>
- Jackson, A. B., Plumlee, M. A., & Rountree, B. R. (2018). Decomposing the market, industry, and firm components of profitability: Implications for forecasts of profitability. *Review of Accounting Studie*, 23, 1071–1095.
- Jiang, L., Yang, T., & Yu, J. (2022). Global trends and prospects of blue carbon sinks: a bibliometric analysis. *Environmental Science and Pollution Research*, 29(44), 65924–65939. <https://doi.org/https://doi.org/10.1007/s11356-022-22216-4>
- Kasim, M. R., Jamil, M. R., & Irawati, N. (2017). Occurrence of macro-epiphyte on *Eucheuma spinosum* cultivated on floating cages. *Aquaculture, Aquarium, Conservation & Legislation-International Journal of the Bioflux Society (AAFL Bioflux)*, 10(3).
- Kassila, J., Nhhala, H., Givernaud, T., & MONSOURI, M ABREHOUC, A MOSFI OUI, A. (2019). Opportunities for the development of seaweed farming as a supplementary income for small-scale fishermen in Nador lagoon: experimental cultivations of *Gracilaria gracilis* (Stackhouse). *Mediterranean Fisheries and Aquaculture Research*, 2(1), 12–26.
- Kim, J., Stekoll, M., & Yarish, C. (2019). Opportunities, challenges and future directions of open-water seaweed aquaculture in the United States. *Phycologia*, 58(5), 446–461.
- Kumar, V., Anand, A., & Song, H. (2017). Future of retailer profitability: An organizing framework. *Journal of Retailing*, 93(1), 96–119.
- Lähteenmäki-Uutela A Rahikainen, M., Camarena-Gómez, M. T Piiparinen, J., Spilling, K., & Yang, B. (2021). European Union legislation on macroalgae products. *Aquaculture International*, 29, 487-509. <https://doi.org/https://doi.org/10.1007/s10499-020-00633-x>
- Li, M., Luo, H., Zhou, S., Kumar, G. M. S., Guo, X., Law, T. C., & Cao, S. (2022). State-of-the-art review of the flexibility and feasibility of emerging offshore and coastal ocean energy technologies in East and Southeast Asia. *Renewable and Sustainable Energy Reviews*, 162.
- Liapis, K. J., & Kantianis, D. D. (2015). Depreciation methods and life-cycle costing (LCC) methodology. *Procedia Economics and Finance*, 19, 314–324.
- Lubova, T., & Zalilova, Z Sharafutdinov, A. (2020). The role of agriculture in gross added value. *Montenegrin Journal of Economics*, 15(1), 183–191.
- Lukas, A. Y. (2023). Quality management and industrialization of seaweed products as an effort to improve the welfare of coastal communities in the province of East Nusa Tenggara, Indonesia-A review. *Aquaculture, Aquarium, Conservation & Legislation*, 16(5), 2488–2494.
- Medjoudj, R., Aissani, D., & Haim, K. D. (2013). Power customer satisfaction and profitability analysis using multi-criteria decision making methods. *International Journal of Electrical Power & Energy Systems*, 45(1), 331–339.
- Michael Niaounakis. (2017). *Management of Marine Plastic Debris* (David Jackson (ed.)). William Andrew Applied Science Publisher.
- Nogueira, M. C. F., & Henriques, M. B. (2020). Large-scale versus family-sized system production: economic feasibility of cultivating *Kappaphycus alvarezii* along the southeastern coast of Brazil. *Journal of Applied Phycology*, 32(3), 1893–1905.
- Nurdin, N., Setiawan, R. Y., Helmi, M., Maslukah, L., Agus, A., & Komatsu, T. (2020). Spatial

- water quality and plastic buoy of seaweed culture in coastal area, Indonesia. *In SPIE Future Sensing Technologies*, 11525, 231–243.
- Olanrewaju, S. O., Magee, A., Kader, A. S. A., & Tee, K. F. (2017). Simulation of offshore aquaculture system for macro algae (seaweed) oceanic farming. *Ships and Offshore Structures*, 12(4), 553–562.
- Radulovich, R., Neori, A., Valderrama, D., Reddy, C. R. K., Cronin, H., & Forster, J. (2015). Farming of seaweeds. In: *Seaweed sustainability*. Academic Press, 27–59.
- Robledo, D., Gasca-Leyva, E., & Fraga, J. (2013). Social and economic dimensions of carrageenan seaweed farming in Mexico. *Fisheries and Aquaculture Technical Paper*, 580.
- Sari, I. A. G. D. M., & Sedana, I. B. P. (2020). Profitability and liquidity on firm value and capital structure as intervening variable. *International research journal of management, IT and Social Sciences*, 7(1), 116–127.
- Spillias, S., Kelly, R., Cottrell, R. S., O'Brien, K. R., Im, R. Y., Kim, J. Y., & McDonald-Madden, E. (2023). The empirical evidence for the social-ecological impacts of seaweed farming. *PLOS Sustainability and Transformation*, 2(2).
- Tullberg, R. M., Nguyen, H. P., & Wang, C. M. (2022). Review of the Status and Developments in Seaweed Farming Infrastructure. *Journal of Marine Science and Engineering*, 10(10), 1447.
- Uyar, M. (2014). A research on total cost of ownership and firm profitability. *The International Institute for Science, Technology and Education (IISTE)*, 5(1), 9–16.
- Virnstein, R. (2021). Can we plant seagrass as part of restoration? A proposal, using small plots, volunteers, and feedback loops. *Florida Scientist*, 84(2/3), 138–146. <https://www.jstor.org/stable/27091240>
- Zamroni, A. (2018). Small scale entrepreneurship of seaweed in Serewe Bay, East Lombok, Indonesia: challenges and opportunities. *Journal of Development and Agricultural Economics*, 10(5), 165–175.