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IMPLEMENTING INTEGRATED MULTI-TROPHIC AQUACULTURE (IMTA) AS A STRATEGY FOR ALTERNATIVE LIVELIHOOD DEVELOPMENT FOR BANDA ISLAND FISHERMEN

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Abstract

Creating alternative economic activities that generate additional income for fishermen is a method to alleviate poverty in their households. One such endeavor is diversifying household income sources through activities beyond fishing. Implementing IMTA as an environmentally friendly cultivation system is a potential alternative livelihood for Banda fishermen. This study aims to devise strategies to make IMTA a viable alternative livelihood for the Banda Islands fishing community. Using a descriptive method, data collection involved observing IMTA cultivation pilot projects over six months, conducting FGDs with 50 participants including fishermen, local government officials, and academics, and reviewing relevant literature. Research data underwent SWOT analysis. Livelihood development strategies derived from IFAS and EFAS analysis, with weighted scores of (S = 3.57; W = -2.86) and (O = 3.90; T = -3.84) respectively, with X = 0.92 and Y = 0.26. The intersection of X and Y axes yielded S-O strategies in quadrant I, comprising (1) Socialization and training on IMTA cultivation techniques for the community, (2) Mapping suitable areas for IMTA cultivation, (3) Developing a seasonal calendar for IMTA cultivation activities, and (4) Providing assistance in using local seeds and natural feed to minimize production costs and post-harvest handling in IMTA cultivation.

Keywords: Alternative Livelihood, Banda Fishermen, IMTA, Poverty Alleviation, Strategy, SWOT Analysis.

INTRODUCTION

Banda Neira is an administrative region with a diverse population that continues to grow each year. The population of Banda District in 2023 was 21,425 people, consisting of 10,723 males and 10,702 females [1)]. The majority of the Banda community relies on fishing, which is heavily dependent on natural conditions [2)]. During certain conditions, such as rough seas, fishermen are unable to carry out fishing activities [3)]. Therefore, alternative livelihoods are needed for the Banda fishermen so that during rough sea conditions, they can still utilize the sheltered bay waters for fishing activities.

According to KEP.69/MEN/2009 [4)], the Banda Marine Conservation Area includes three sub-zones for aquaculture, with a total area of 109.2 hectares. These locations are in the waters of Waling-Spanciby Village, Boiyau Village, Lonthoir Village, and Kalombo Hamlet of Mount Api Island in Nusantara Village. The first location, Waling-Spanciby Village, covering 53.405 hectares, is designated for pearl oyster farming.

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The other two locations, Boiyau Village and Lonthoir Village, along with Kalombo Hamlet, are designated for seaweed farming, with areas of 40.602 hectares and 15.188 hectares, respectively. However, to date, no aquaculture activities are operating as planned in these areas. To maximize the use of these sub-zone areas, environmentally friendly aquaculture activities can be implemented as an alternative livelihood for the Banda fishermen.

Aquaculture activities can have significant economic, social, and environmental impacts [5)]. In recent decades, food production growth from aquaculture has been the fastest compared to other sectors [6)]. However, aquaculture activities also have negative impacts from the waste produced [6)]. Organic waste from leftover feed and feces of cultured organisms significantly contaminates the aquaculture environment [7)]. This can lead to increased nutrient levels in the water, which can be detrimental to aquatic organisms in the farming area [8,9)]. Therefore, integrated multi-trophic aquaculture (IMTA) can be selected as the model for aquaculture to be implemented in the Banda Islands waters.

The use of the IMTA system helps maintain ecosystem balance because each specific species has different functions such as carnivores, herbivores, and filter feeders, ensuring a well-maintained ecosystem balance. The principle of the IMTA system is to recycle waste from the main species' farming process into energy and nutrient sources for other commodities, thus producing harvestable products and reducing environmental impact [10)]. According to published article, IMTA can be developed to increase the efficiency and productivity of an area by utilizing local organisms such as fish, sea cucumbers, and seaweed, and it can provide a new alternative livelihood for the community[11)]. The purpose of this study is to prepare strategies to make IMTA an alternative livelihood for the Banda Islands fishing community.

MATERIAL AND METHODS

The method used in this research is descriptive, aimed at systematically, factually, and accurately describing the facts and characteristics of a particular population or area [12)]. Data collection techniques included observing pilot IMTA aquaculture activities over six months, conducting FGDs involving fishermen, local government, and academics with a total of 50 participants, and performing a literature review. The research data obtained were analyzed using quantitative analysis and SWOT analysis.

The strategic planning process in SWOT analysis involves three stages: data collection, analysis, and decision-making[13)]. The SWOT analysis in this research aims to determine strategies for implementing IMTA system aquaculture as an alternative livelihood for Banda fishermen. SWOT analysis is used to identify and evaluate internal and external factors, systematically identifying various factors to formulate development strategies [13)]. This analysis is based on logic that maximizes strengths and opportunities while simultaneously minimizing weaknesses and threats. In the analysis stage, the SWOT Matrix Model is used, generating four strategies: SO, WO, ST, and WT. The SWOT analysis results can be seen in Table 1.

Table 1: SWOT Matrix Model

SWOT Matrix	Strengths	Weaknesses
Opportunities	SO1	WO1
	SO2	WO2
	SO3	WO3
	SOn	WOn
THREATS	ST1	WT1
	ST2	WT2
	ST3	WT3
	STn	WTn

After obtaining the SWOT matrix, all generated strategies are ranked based on the factors constituting those strategies. The SWOT Quadrant Model is then used to determine the grand strategy based on the projection of IFAS and EFAS factors through the intersection of the X and Y axes. The intersection determines the position within four quadrants: Quadrant I (+, +) progressive; Quadrant II (+, -) diversification; Quadrant III (-, +) change strategy; and Quadrant IV (-, -) defensive strategy. These will be used as the grand strategy in guiding organizational direction and policy for decision-making.

RESULT AND DISCUSSION

The results of identifying internal factors which include strengths and weaknesses as well as external factors which consist of opportunities and threats regarding IMTA implementation strategies as an alternative livelihood for Banda fishermen are presented in tables 2 and 3.

Table 2: The results of identifying internal factors

Strengths	Weight	Rating	Score
Adequate Land Available for Aquaculture Activities with The Imta System	0.19	4	0.76
Easy-To-Apply Imta System Aquaculture Techniques with Higher Production Targets	0.19	4	0.76
Availability of Labor for Aquaculture Activities with The Imta System	0.19	4	0.76
Availability of Natural Seeds That Can Be Used for Aquaculture Activities with The Imta System	0.19	4	0.76
Abundance of Small Fish Around Kja That Can Be Used as Trash Feed	0.24	4	0.96
Total	1.00		3.80
Weaknesses	**Weight**	**Rating**	**Score**
IMTA system aquaculture is a newly applied technique in the Banda Islands waters	0.35	3	1.05
Lack of understanding among aquaculturists about the IMTA system techniques	0.35	3	1.05
Marketing of aquaculture products is still predominantly conducted in local markets	0.30	3	0.90
Total	1.00		3.00

The research identified several strengths and weaknesses associated with implementing the Integrated Multi-Trophic Aquaculture (IMTA) system in the Banda Islands. The strengths and weaknesses were analyzed using a SWOT analysis, with results detailed in Table 1.

Strengths

Several strengths of the IMTA system were identified. Adequate land for IMTA aquaculture activities was found to be available, which scored a weight of 0.19 and a rating of 4, yielding a score of 0.76. The ease of applying IMTA aquaculture techniques, which promise higher production targets, was also highlighted with the same weight and rating, resulting in a similar score. The availability of labor specifically for IMTA activities was another strength, contributing a score of 0.76. Additionally, natural seeds that can be utilized for IMTA activities were available, with a score of 0.76. Finally, the abundance of small fish around the floating net cages (KJA) that can be used as trash feed was noted as a significant strength, having the highest score of 0.96. The total score for strengths was calculated to be 3.80.

Weaknesses

Despite these strengths, several weaknesses were identified. The IMTA system is a newly applied technique in the Banda Islands waters, with a weight of 0.35, a rating of 3, and a score of 1.05. A lack of understanding among aquaculturists regarding IMTA techniques was also noted, contributing another 1.05 to the total score. Additionally, the marketing of aquaculture products is still predominantly conducted in local markets, which scored 0.90. The total score for weaknesses was calculated to be 3.00.

The findings of this research indicate that while there are considerable strengths associated with the implementation of the IMTA system, there are also notable weaknesses that must be addressed. The availability of land and natural seeds, coupled with an abundant labor force and the presence of small fish for feed, provides a strong foundation for the successful implementation of IMTA in the Banda Islands [14)]. However, the novelty of the IMTA technique in this region presents a challenge, as does the lack of understanding among local aquaculturists regarding its implementation. Furthermore, the focus on local markets for the sale of aquaculture products suggests a need for broader market access to ensure the sustainability and profitability of IMTA operations [15)].

Addressing these weaknesses through education and training programs for local aquaculturists, as well as developing strategies for marketing beyond local markets, can enhance the effectiveness of IMTA implementation. The use of the SWOT analysis has provided a clear framework for identifying these key factors and formulating strategies to optimize strengths while mitigating weaknesses. By leveraging the identified strengths and addressing the weaknesses, the IMTA system can be effectively established as an alternative livelihood for the Banda Islands fishing community, promoting economic, social, and environmental sustainability [10,11)].

In conclusion, while the IMTA system offers significant potential benefits, a comprehensive approach that includes education, market development, and continuous assessment is essential for its successful implementation in the Banda Islands. The SWOT analysis has provided valuable insights that will guide the strategic planning and execution of IMTA activities in this region.

The External Factors Identifications

The external factors influencing the implementation of the Integrated Multi-Trophic Aquaculture (IMTA) system in the Banda Islands were identified and analyzed using SWOT analysis. Table 3 details the identified opportunities and threats.

Opportunities

Three key opportunities were identified. The high quality of the Banda Sea waters for IMTA activities was rated with a weight of 0.39 and a score of 1.72. The availability of protected sub-zone aquaculture areas that can be used during the wave season was noted, with a weight of 0.31 and a score of 1.24.

The potential acceptance of IMTA products in local and national markets was another significant opportunity, also scoring 1.24. The total score for opportunities was calculated to be 4.20.

Threats

Several threats to the successful implementation of the IMTA system were identified. The remote location of the sub-zone aquaculture areas from residential areas poses a security risk for the cultivated organisms, with a weight of 0.18 and a score of 0.54. Unpredictable weather changes frequently occur, contributing a score of 0.84. During the east wind season, trash in the bay is carried by currents and accumulates on the shores of the sub-zone aquaculture areas, with a weight of 0.22 and a score of 0.88.

Additionally, sand and rock mining activities in the coastal areas of the Banda Marine Conservation Zone were identified as a threat, with a score of 0.80. A significant presence of pests and predators in the aquaculture areas was noted, with a score of 0.80. The total score for threats was calculated to be 3.86.

The analysis of external factors highlights significant opportunities and threats that impact the implementation of the IMTA system in the Banda Islands. The high quality of the Banda Sea waters and the protected sub-zone aquaculture areas present favorable conditions for IMTA activities, especially during the wave season [16)]. Furthermore, the potential acceptance of IMTA products in both local and national markets suggest a strong economic incentive for this aquaculture approach [17,18)].

However, several threats must be mitigated to ensure the success of the IMTA system. The remote location of the sub-zone aquaculture areas poses security challenges, requiring effective monitoring and protection strategies.

Unpredictable weather patterns and seasonal trash accumulation could impact the health and productivity of the aquaculture systems, necessitating robust waste management and contingency plans [19,20)].

Additionally, the presence of pests and predators and the impact of sand and rock mining activities on the coastal areas must be addressed through comprehensive management practices [11)].

Overall, the SWOT analysis of external factors provides valuable insights into the strategic planning necessary for the successful implementation of the IMTA system in the Banda Islands. By leveraging the identified opportunities and addressing the threats, the IMTA system can be effectively developed as a sustainable and profitable alternative livelihood for the Banda Islands fishing community, promoting economic, social, and environmental benefits [10)].

Table 3: External Factor Identification Results

Opportunities	Weight	Rating	Score
High quality of Banda Sea waters for IMTA activities	0.39	4	1.56
Protected sub-zone aquaculture areas usable during wave season	0.31	4	1.24
Potential acceptance in local and national markets	0.31	4	1.24
Total	**1.00**		**4.04**
Threats	**Weight**	**Rating**	**Score**
Remote location of sub-zone aquaculture areas reducing security for cultivated organisms	0.18	3	0.54
Frequent unpredictable weather changes	0.21	4	0.84
Seasonal trash accumulation in the bay during the east wind season	0.22	4	0.88
Sand and rock mining activities in coastal sub-zone aquaculture areas	0.20	4	0.80
Significant presence of pests and predators in the aquaculture areas	0.20	4	0.80
Total	**1.00**		**3.86**

By addressing these identified external factors through strategic planning and robust management practices, the IMTA system can be successfully implemented, providing sustainable and alternative livelihoods for the Banda Islands fishing community.

Internal and External Factors Analysis

The internal factors included strengths such as adequate land for IMTA activities, easy-to-apply IMTA techniques with higher production targets, availability of labor and natural seeds, and the presence of small fish that can be used as feed. Weaknesses identified included the novelty of the IMTA technique in the Banda Islands, a lack of understanding among aquaculturists, and the predominance of local market sales. External factors encompassed opportunities like the excellent quality of Banda Sea waters for IMTA, protected sub-zone aquaculture areas usable during wave seasons, and the potential acceptance of IMTA products in local and national markets. Threats included the remote location of sub-zone aquaculture areas, unpredictable weather changes, seasonal trash accumulation, illegal sand and rock mining activities, and a significant presence of pests and predators.

Table 4: SWOT-Based Strategies

Internal	External	Strengths	Weaknesses
Opportunities		**S-O Strategies**	**W-O Strategies**
	1. High quality of Banda Sea waters for IMTA activities	1. Community socialization and training on IMTA techniques (S1, S2, S3, O1, O3)	1. Introducing IMTA activities to the community through training and assistance (W1, W2, O2, O3)
	2. Protected sub-zone aquaculture areas usable during wave seasons	2. Mapping suitable areas for IMTA aquaculture activities (S1, O1, O2)	2. Assisting in processing IMTA aquaculture products to reach local and national markets (W1, W2, W3, O1, O3)
	3. Potential acceptance in local and national markets	3. Developing a seasonal calendar for IMTA activities (S2, S4, S5, O2)	
		4. Providing assistance in using local seeds and natural feed to minimize production costs and post-harvest handling in IMTA activities (S3, S4, S5, O3)	
threats		S-T Strategies	W-T Strategies

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	1. Remote location of sub-zone aquaculture areas reducing security for cultivated organisms	1. Conducting studies on secure locations for IMTA activities (S1, T1, T2)	1. Placing aquaculture facilities in areas close to residential areas for easier monitoring and security (W1, W2, T1, T3, T5)
	2. Frequent unpredictable weather changes	2. Forming IMTA aquaculture groups (S3, T1, T2, T3, T5)	2. Preparing adequate facilities and infrastructure to minimize the impact of pests and predators (W1, W2, W3, T1, T3)
	3. Seasonal trash accumulation in the bay during the east wind season	3. Educating the community to avoid dumping waste into the sea (S1, T3)	
	4. Sand and rock mining activities in coastal sub-zone aquaculture areas	4. Collaborating with law enforcement to stop illegal sand and rock mining in coastal areas (W1, W2, W3, T4)	
	5. Significant presence of pests and predators in the aquaculture areas		

The high quality of Banda Sea waters for Integrated Multi-Trophic Aquaculture (IMTA) activities was noted as a strength, providing a conducive environment for sustainable aquaculture practices [21)]. Additionally, the existence of protected sub-zone aquaculture areas usable during wave seasons was identified as another internal strength, ensuring the continuity of aquaculture operations despite environmental fluctuations [21,22)]. Moreover, the potential acceptance of IMTA products in local and national markets was recognized, presenting an opportunity for economic growth and market expansion [17)]. However, several weaknesses and threats were identified that could impede the success of IMTA activities. The remote location of sub-zone aquaculture areas was highlighted as a threat, reducing security for cultivated organisms and potentially exposing them to risks [23)]. Frequent and unpredictable weather changes were also acknowledged as a threat, posing challenges to the stability and predictability of aquaculture operations [24)]. Furthermore, seasonal trash accumulation in the bay during the east wind season and the significant presence of pests and predators in aquaculture areas were identified as threats to environmental sustainability and production efficiency [23,24)].

To address these challenges, a range of strategies can be implemented. Conducting studies on secure locations for IMTA activities and forming IMTA aquaculture groups were suggested as strategies to mitigate risks associated with remote locations and weather fluctuations [25)]. Additionally, educating the community to avoid dumping waste into the sea and collaborating with law enforcement to stop illegal mining activities can help minimize environmental threats and ensure the sustainability of aquaculture practices [26)]. In conclusion, while IMTA activities offer promising opportunities for economic development and sustainable aquaculture practices, it is essential to address the identified weaknesses and threats through proactive strategies and collaborative efforts involving various stakeholders. By doing so, the potential of IMTA activities to contribute to both local economies and environmental conservation can be maximized [27)].

The SWOT quadrant analysis results

The SWOT quadrant analysis results indicate that the intersection of the X and Y axes falls within quadrant I (+, +) with X value = 0.92 and Y value = 0.26. Consequently, the

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strategy utilized based on the analysis outcome is the S-O strategy, which involves leveraging strengths and opportunities. Subsequently, the SWOT quadrant analysis results are presented in Table 5 and Figure 1.

Table 5: Results of X and Y values calculation for the SWOT diagram Calculation results for the SWOT diagram X Y 0.92 0.26

Hasil perhitungan nilai untuk diagram SWOT	X	Y
	0,92	0,26

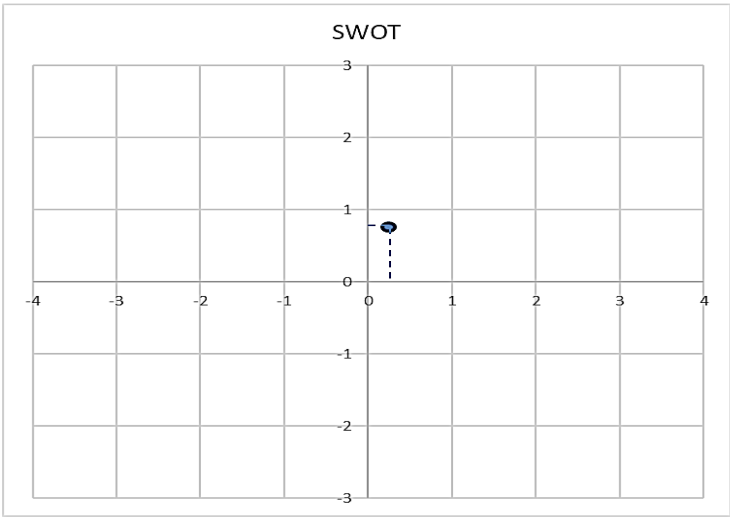

Figure 1: SWOT Quadrant Diagram

In quadrant I, where strengths and opportunities intersect, lies the potential for maximizing the utilization of internal strengths to capitalize on external opportunities. This strategic alignment allows for leveraging existing advantages to exploit favorable market conditions and external factors. By focusing on S-O strategies, organizations can enhance their competitive position and achieve sustainable growth by aligning their capabilities with market demands and opportunities. Therefore, the identification and prioritization of S-O strategies are crucial for strategic planning and decision-making, enabling organizations to effectively navigate the competitive landscape and capitalize on emerging opportunities [27)].

CONCLUSIONS

In determining IMTA strategy as an alternative livelihood for Banda fishermen, various supportive and inhibiting factors influencing the success of MPA activities in the research location must be considered. Therefore, the designated strategy should be understood by fishermen before implementation. Program managers need to comprehend social conditions, including community habits and perspectives related to MPA activities. By understanding the socio-cultural conditions of the target community, managers can plan efforts to support program success. Livelihood development strategies derived from IFAS and EFAS analysis, with weighted scores (S = 3.57; W = -2.86) and (O = 3.90; T = -3.84), respectively, with X = 0.92 and Y = 0.26.

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