

Structure and sustainability status of fishermen's livelihoods in North Minahasa Regency, Indonesia

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Abstract. North Minahasa Regency has a marine sector that provides value for export activities in North Sulawesi Province by utilizing various types of biodiversity. However, the potential of abundant coastal resources is not managed optimally, resulting in minimal impact on the income of coastal fishermen. The vulnerability of traditional fishing households is an issue worth identifying from the perspective of local capacity-based development. This study aims to: (1) determine the pattern of diversity in livelihood structures and vulnerability factors, (2) establish the structure and sustainability status of fishermen's livelihoods, and (3) develop a sustainable model for fishermen's livelihoods in North Minahasa Regency. This research utilizes the rapid appraisal fisheries (RAPFISH) method and strengths, weaknesses, opportunities, and threats (SWOT) analysis to assess sustainability capabilities. Based on research results, it proved that different types of management based on location can affect the leverage aspect of each fishermen's sustainability. For a bigger range (Serei village-West Likupang District, Likupang II village-East Likupang District, and Wori village-Wori Districts), social dimensions played a huge role on maintaining sustainability because it involves many contributions from stakeholders, community group, and also fishermen themselves. While for a village scale (Kema II and Kema III villages-Kema District) main factors that can improve sustainability for a smaller area can be intervened from human dimension that include improving the quality of human resources, providing training and skills development facilities.

Key Words: capital classification, fishing households, North Sulawesi Province, Rapfish method, SWOT analysis.

Introduction. North Minahasa Regency is an integral part of North Sulawesi Province with an area of 1,059,244 km². As a regency located in a coastal area, North Minahasa has a marine sector that is no less valuable for export activities because of the many types of marine resources that are utilized and sold in the world export market such as fish, crustaceans, mollusks, and other marine resources. The abundant potential of maritime resources is not followed by an increase in the welfare of coastal communities, due to the management of marine resources that has not been maximized and is not on the side of the community, especially those who work as fishermen (Central Bureau of Statistics/BPS of North Minahasa Regency 2023).

Referring to data from the Central Statistics Agency (BPS) of North Minahasa Regency (2023), the average number of poor people is 14,651 people, of which 25.14 percent work as fishermen (3,683 people). According to Mulyasari et al (2019), problems that are often faced by other Indonesian coastal communities are also experienced by coastal fishermen in North Minahasa Regency, including: (1) high infrastructure costs, (2) high operational costs, (3) debt activities for capital purposes, (4) simple upstream-downstream technology, (5) lack of fishermen's economic institutions, (6) inadequate market access, and (6) competition with modern fishermen with the same sea catch, resulting in diversification of selling prices.

The level of vulnerability of traditional fishing households is an interesting problem to be identified in the perspective of development based on local capabilities. Longdong et al (2020) were classifying several aspects of local abilities including i) household characteristics; ii) social capital; iii) and institutional factors. Ernaningsih et al (2023) classifies the local capabilities of coastal communities consisting of (i) ecological dimension: fish caught before adulthood, special habitat, habitat damage, exploitation rate; (ii) economic dimension: market, income trends, labor sector, other income, fisheries business cooperation, fisheries business profits; (iii) social dimension: family member involvement, fisherman participation rate, fisherman conflict, education level, environmental knowledge, number of households; (iv) technology dimensions: infrastructure facilities, ship size, selectivity of fishing gear, nature of fishing gear, fishing trip length; and (v) legal/institutional dimension: decision-making mechanism, law enforcement.

The concept of sustainable livelihood approach (SLA) is a development concept. The SLA approach seeks to achieve the degree of meeting social, economic, and ecological needs in a fair and balanced manner by combining activities and utilization of existing capital in the system-life system. In the context of the SLA approach to North Minahasa Regency fishermen, several poverty vulnerabilities are reviewed from five main factors, namely; (1) human capital, (2) natural capital, (3) financial capital, (4) physical capital, and (5) social capital (Chambers & Conway 1991).

So, the sustainability analysis approach in this research aims to reveal sustainability levers by creating new indicators that can identify factors that affect the sustainability of coastal fishermen based on various aspects of capital owned by North Minahasa Regency. This is sought so that Indonesia's mission to become an independent, advanced, strong, and national interest-based maritime country (Handoko et al 2017) can be realized.

Material and Method

Description of the study sites. This research was conducted in North Minahasa Regency in five villages within four districts, namely: i) Serei village (West Likupang District), ii) Likupang II village (East Likupang District), iii) Wori village (Wori District), iv) Kema II village (Kema District), and v) Kema III village (Kema District) (Figure 1).

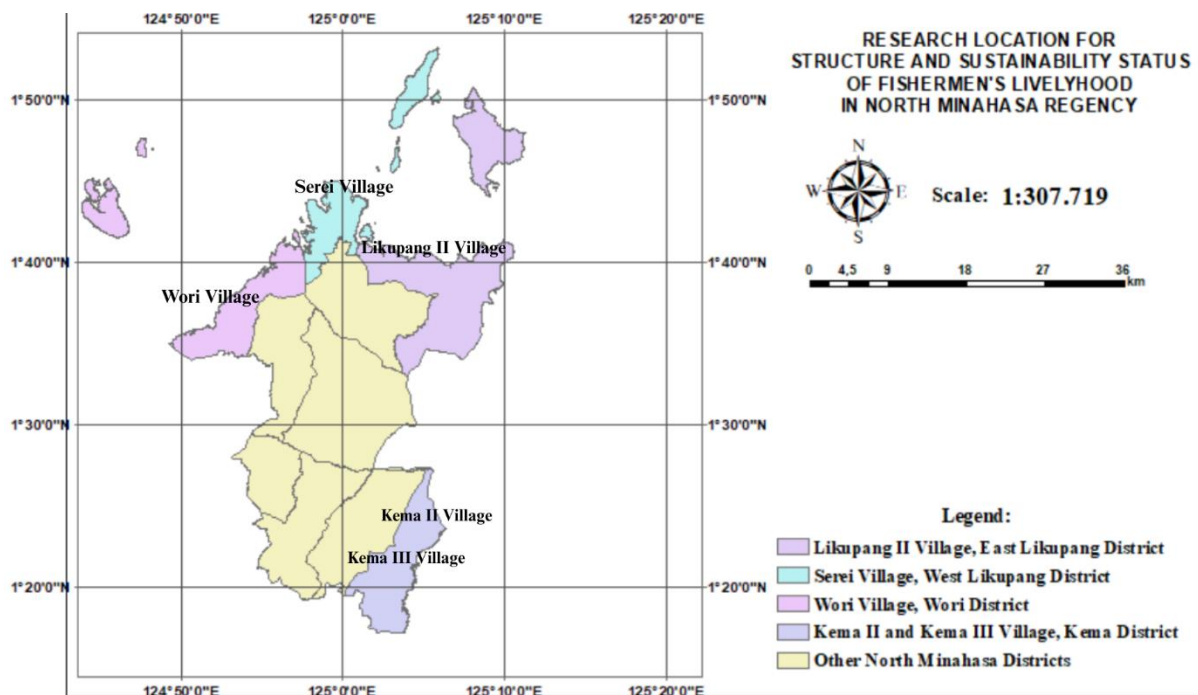


Figure 1. Map of the study area (Indonesia Geospatial Information Agency 2024).

Serei village has traditional fishermen and fishing landing places for fishermen. Likupang II village has traditional fishermen and a fish auction; Wori village has demersal fishermen

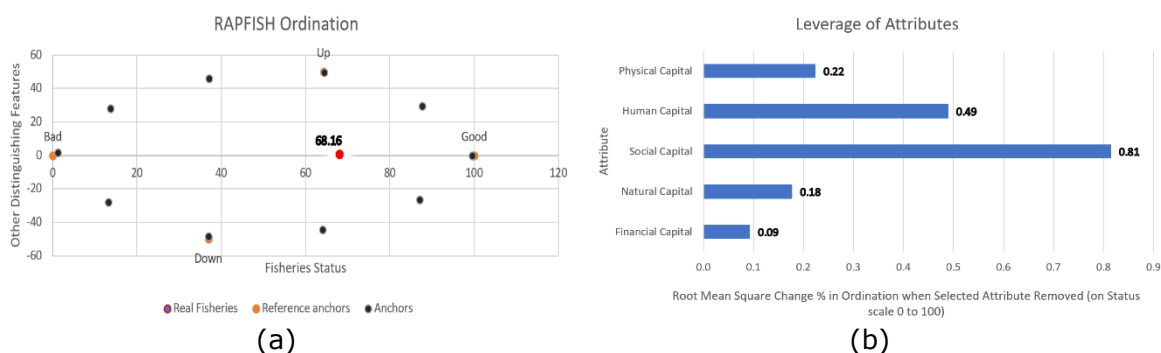
and a fish auction even though it is no longer functional. Kema II village has modern fishermen for demersal fishing, while Kema III village has modern fishermen for pelagic fishing where in this village there is the Kema Fish Fishing Base. The implementation of the research lasted for seven months, starting from February to August 2022. The types of data used in the study are primary data and secondary data. Primary data included observations, interviews and, questionnaires; meanwhile, secondary data was based on literature study related to fishermen's livelihoods. The sustainability status index shows: 1) index value: 0-25, unsustainable, 2) index value: > 25-50, less sustainable, 3) index value: > 50-75, quite sustainable, and 4) index value: > 75-100, highly sustainable (Hermawan et al 2006; Thamrin et al 2007; Nurmalina 2008; Muhsoni et al 2021).

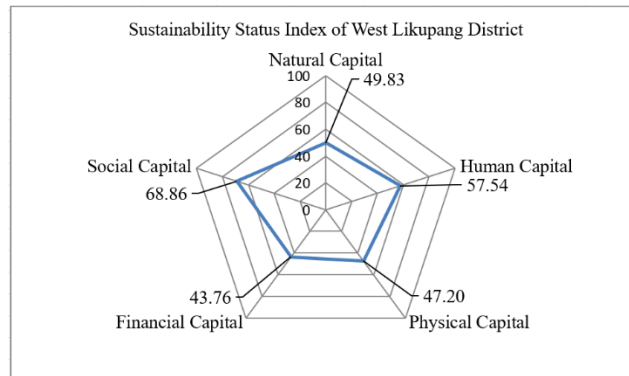
Description of methods. The analysis methods used in the study were RAPPFISH's RAP-Livelihood Analysis and SWOT analysis. RAPPFISH method was developed by Center for Fisheries, University of Columbia in 1999. This method can describe the sustainability status quickly and with fairly accuracy by analyzing marine and fishery resources. Hartono et al (2005) argued that RAPPFISH method is capable to describe the structure of Indonesia fishermen's status by utilizing attributes that are in accordance with fishermen's sustainability dimension. According to Pitcher et al (2013), recent developments in Rappfish now better integrate the ecological and human dimensions to evaluate the status of fisheries. Appraisal status targets may be sustainability, compliance with a standard or the degree to which targets are met. For assessing sustainability, six evaluation fields have been developed and refined: ecological, technological, economic, social, ethical and institutional. The RAPPFISH analysis is based on the ordination technique, which is the activity of providing a value (score) on each attribute of sustainability influence that is measurable using Multi Dimensional Scaling (MDS) including the dimensions of: natural capital, human capital, financial physical capital, and social capital. The results of the sustainability index produced by the RAPPFISH analysis were then mapped to determine alternative policy strategies with SWOT analysis. After the dimensions that affect sustainability are identified, the next step is to carry out financial analysis and logistical analysis mapping (logit) to determine the probability of the ability of North Minahasa Regency Fishermen to achieve sustainability.

Results and Discussion

Multi dimensional scaling (MDS) analysis. The results of the MDS analysis on the entire capital dimension resulted in the value of the sustainability index of Serei village of 68.1629 (Figure 2). The sustainability scale of Serei village is classified as quite sustainable (the index value is in the value range of 50-75). In the leverage diagram, it is known that social mode is a lever dimension in the sustainability of Serei village.

The sustainability of demersal fishing activities in Serei village can be categorized as quite sustainable, with the most influential dimension on sustainability being social capital. This is due to the existence of a good leadership system among the coastal fishing community of West Likupang, which is supported by a well-functioning collective representative, as well as a decision-making process that involves harmonious relationships between members of the coastal fishing community.

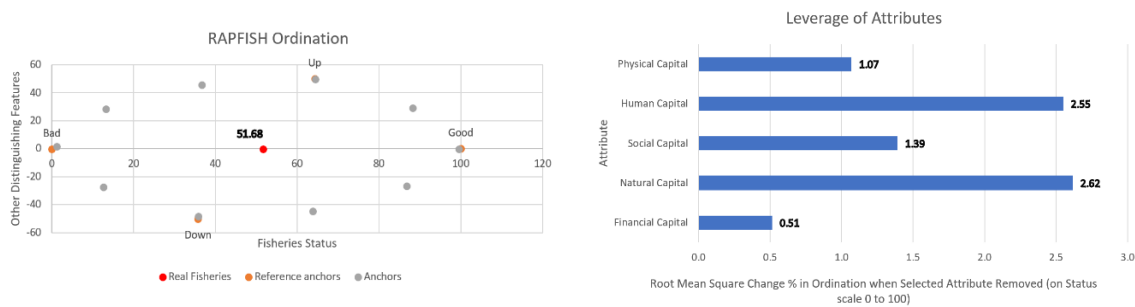




(c)

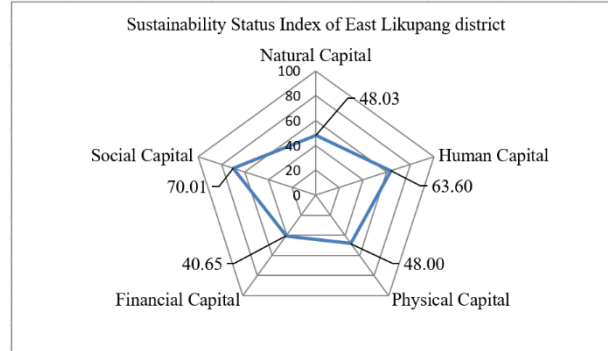
Figure 2. Serei village, West Likupang District: (a) sustainability diagram; (b) leverage diagram; (c) multi-dimension kite diagram.

The results of the MDS analysis on the entire capital dimension resulted in a sustainability index value of Likupang II village of 51.68 (Figure 3). The sustainability scale of Likupang II village is classified as quite sustainable (the index value is in the value interval of 50-75). In the leverage diagram, it is known that social mode is a lever dimension in the sustainability of Likupang II village.



(a)

(b)



(c)

Figure 3. Likupang II village, East Likupang District: (a) sustainability diagram; (b) leverage diagram; (c) multi-dimension kite diagram.

The sustainability of demersal fishermen in Likupang II village is included in the category of quite sustainable where the most sensitive dimension to sustainability is social capital. The character of fishermen who like to help each other based on trust between individuals has an effect on the contribution of a group of fishermen in collective conclusions.

The results of the MDS analysis on the entire capital dimension resulted in a Wori village sustainability index value of 53.23 (Figure 4). The sustainability scale of Wori village is classified as quite sustainable (the index value is in the value interval of 50-75). In the leverage chart, it is known that human capital is a leverage dimension in the sustainability of Wori village.

The sustainability of demersal fishermen in Wori village is included in the category of quite sustainable where the most sensitive dimensions to sustainability are social and human capital. The level of education of the fishermen supported by the high ability to work exerts influence in the life of the social group of fishermen in Wori village where every participatory conclusion is considered as best as possible in order to provide benefits to all members of the group.

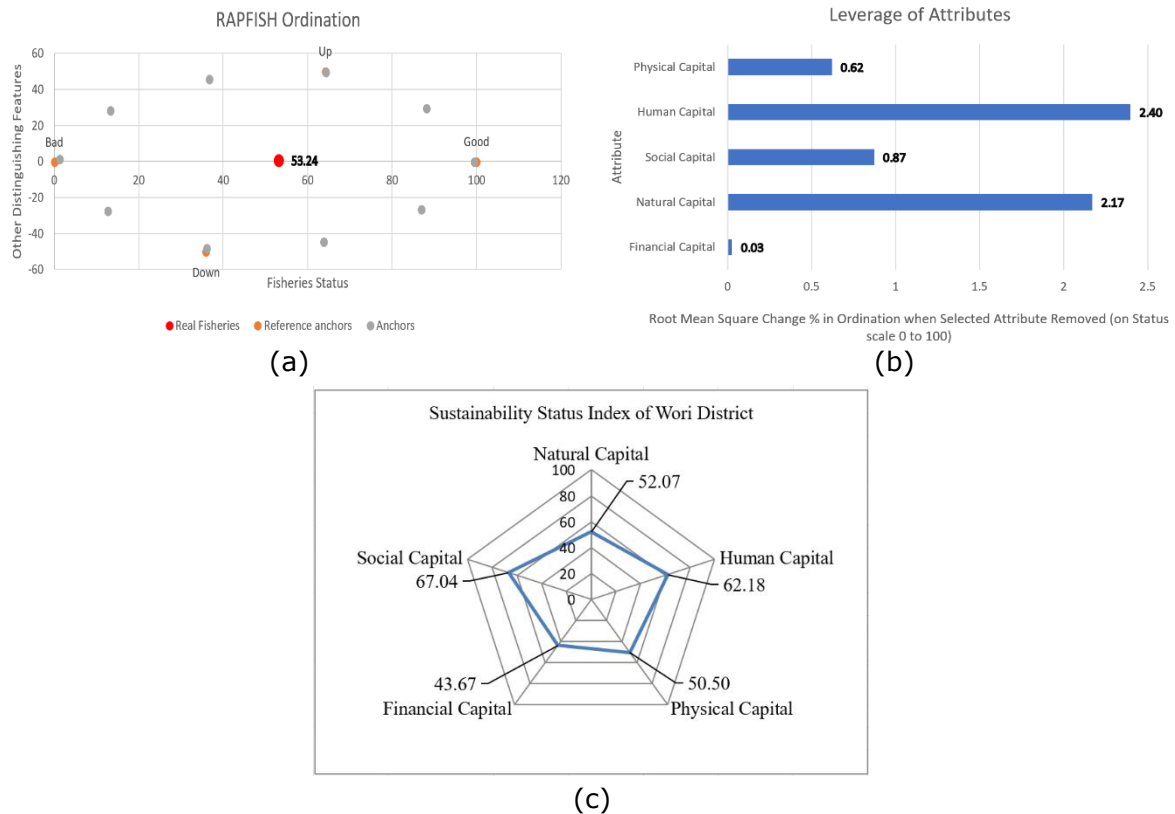
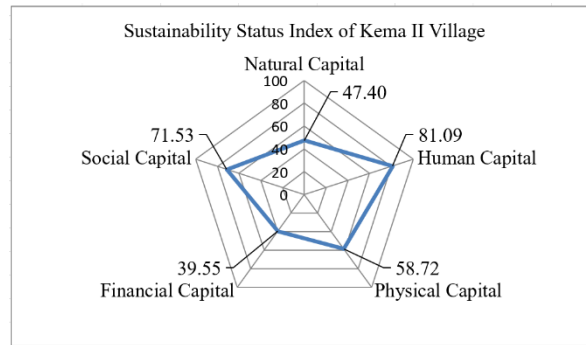


Figure 4. Wori village, Wori district: (a) sustainability diagram; (b) leverage diagram; (c) multi-dimension kite diagram.

The results of the MDS analysis on the entire capital dimension resulted in a Kema II village sustainability index value of 54.37 (Figure 5). The sustainability scale of Kema II village is classified as quite sustainable (the index value is in the value range of 50-75). In the leverage diagram, it is known that the human capital is a lever dimension in the sustainability of Kema II village.

The sustainability of demersal fishermen in Kema II village is included in the category of quite sustainable where the most sensitive dimension to sustainability is human capital followed by natural capital. Fishermen in Kema II village have balanced skills with an education level providing the ability for fishermen to take advantage of available wildlife.

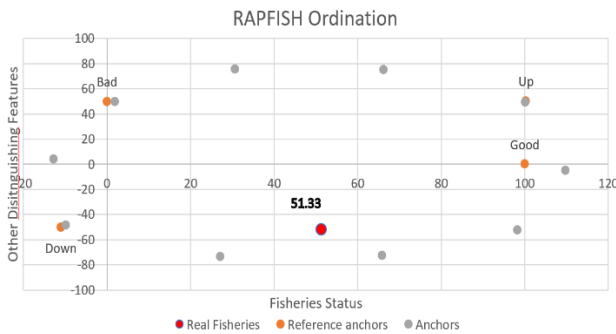




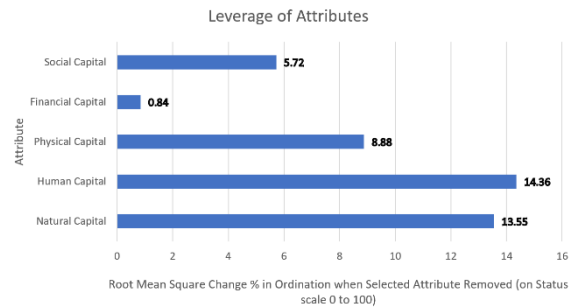
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Figure 5. Kema II village (Kema District): (a) sustainability diagram; (b) leverage diagram; (c) multi-dimension kite diagram

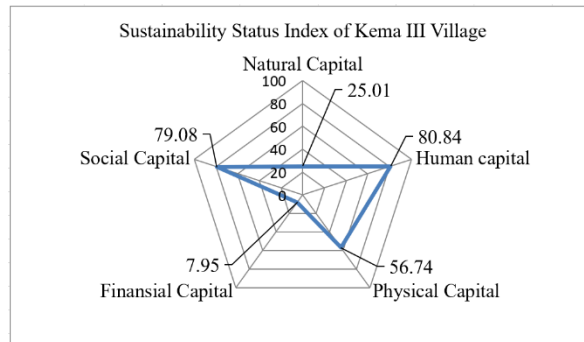
The results of the MDS analysis on the entire capital dimension resulted in a Kema III village sustainability index value of 51.33 (Figure 6). The sustainability scale of Kema III village is classified as quite sustainable (the index value is in the value interval of 50-75). In the leverage diagram, it is known that the human capital is a lever dimension in the sustainability of Kema III village.



(a)



(b)



(c)

Figure 6. Kema III village (Kema District): (a) sustainability diagram; (b) leverage diagram; (c) multi-dimension kite diagram

The sustainability of demersal fishermen in Kema III village is included in the category of quite sustainable where the most sensitive dimension to sustainability is human capital followed by natural capital. Despite the financial limitations faced by the fishermen of Kema III village, the fishermen have the skills and resources of fisheries and the environment that are able to provide biodiversity to be managed in order to generate income.

SWOT analysis results. The results of the SWOT analysis with a mix of external and internal influences on sustainability in order to make policies and activities for coastal fishermen show that Serei village has a dominant weakness compared to strengths, and threats that are greater than opportunities. The strengths consist of good relationships

between fishermen, good product quality, good coastal safety conditions, and product promotion through internet media. The weaknesses consist of limited product promotion and marketing networks, the coastal area management program is still simple and unwritten, budget limitations for the cost of facilities and infrastructure, and fishermen's equipment is still simple. The opportunities consist of regional autonomy giving flexibility to develop the potential of coastal areas, regional economic growth, product improvement by utilizing existing potentials, and technological developments. The threats consist of unstable product prices, extreme weather changes, environmental damage around coastal areas due to arbitrary fishing, natural disasters, and an increase in the number of government regulations. For Serei village, Strength minus Weakness (x-axis) was $1.582 - 2.125 = -0.543$, and Opportunity minus Threat (y-axis) was $1.185 - 2.086 = -0.901$. In the Grand Matrix Strategy, it can be seen that sustainability development is in the position of quadrant IV (defensive strategy), where there is a very unfavorable situation due to internal threats and weaknesses (Figure 7).

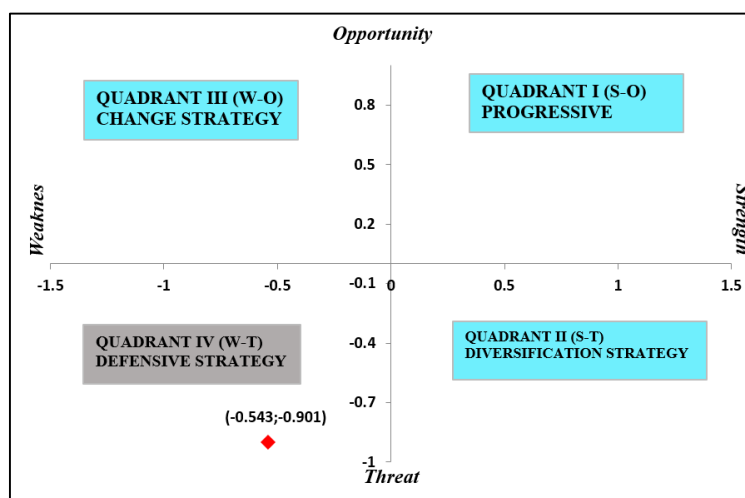


Figure 7. SWOT Grand Strategy Matrix for Serei village (West Likupang District).

The level of accessibility, economic growth of fishermen, and technological development of Serei village is still relatively low. There is still difficult accessibility, the economic development of fishermen is relatively slow, and it is difficult for fishermen to keep up with technological developments. If these problems are not immediately corrected, there will be an obstacle to the study of the development of coastal fishermen's livelihood policies in West Likupang District.

The results of the SWOT analysis with a mix of external and internal influences on sustainability in order to make policies and activities for coastal fishermen show that Likupang II village has dominant weaknesses and threats that are greater than opportunities. For Likupang II village, Strength – Weakness value (x-axis) was $1.7 - 2.245 = -0.543$ and Opportunity – Threat (y-axis) was $1.181 - 2.315 = -1.134$. In the Matrix Grand Strategy, it can be seen that sustainability development is in the position of quadrant IV (defensive strategy), where there is a very unfavorable situation due to internal threats and weaknesses (Figure 8).

Fishermen in the coastal area of Likupang II village still often fish without paying attention to the sustainability of existing resources. This results in environmental damage around the coastal area so that there needs to be education so that fishermen in East Likupang District can be educated about the correct way to fish so that there is sustainability without damaging the environment.

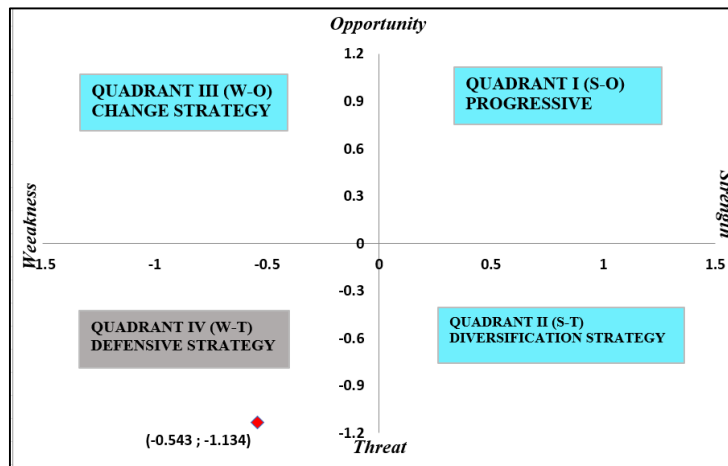


Figure 8. SWOT Grand Strategy Matrix for Likupang II village (East Likupang District).

The results of the SWOT analysis with a mix of external and internal influences on sustainability in order to make policies and activities for coastal fishermen show that Wori District has a dominant weakness compared to strengths, and threats that are greater than opportunities. For Wori village, Strength – Weakness value (x-axis) was $1.789 - 2.204 = -0.415$ and Opportunity – Threat (y-axis) was $1.219 - 2.448 = -1.229$. In the Matrix Grand Strategy, it can be seen that sustainability development is in the position of quadrant IV (defensive strategy), where there is a very unfavorable situation due to internal threats and weaknesses (Figure 9).

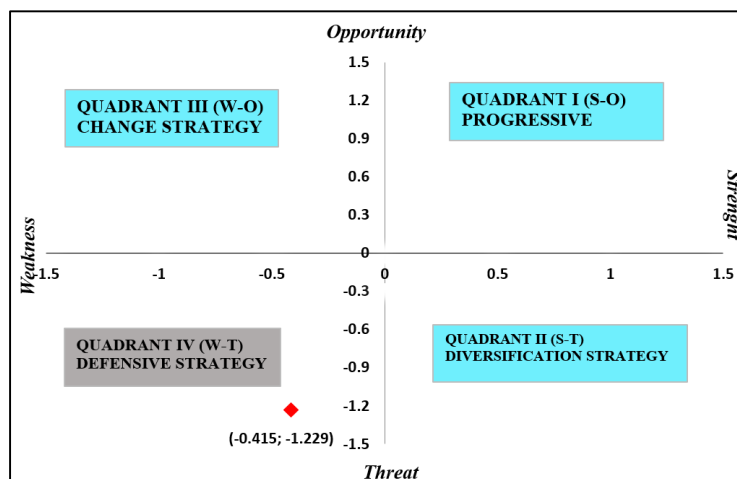


Figure 9. SWOT Grand Strategy Matrix for Wori village (Wori District).

This position highlights an unfavorable situation due to internal and external limitations. Key weaknesses include limited infrastructure, low economic capital, and dependency on traditional fishing methods, while external threats such as overfishing and environmental degradation exacerbate the situation. To address these challenges, Wori village could implement strategies that strengthen its social dimension, such as community training programs and collaborative fishing efforts, as seen in successful initiatives in the Philippines' coastal regions. Partnerships with NGOs and local government to promote sustainable practices and provide financial aid are also critical steps toward improving sustainability.

As a result of the SWOT analysis with a mix of external and internal influences on sustainability in order to make policies and follow-up activities of coastal fishermen, Kema II village has a situation where strength dominates weaknesses and succeeds in covering weaknesses that create opportunities. For Kema II village, Strength – Weakness value (x-axis) was $2.158 - 1.721 = 0.346$ and Opportunity – Threat (y-axis) was $2.257 - 1.911 = 0.417$. In the Matrix Grand Strategy, it can be seen that sustainability development is in

the position of quadrant I (progressive) where the sustainability situation has high potential (Figure 10).

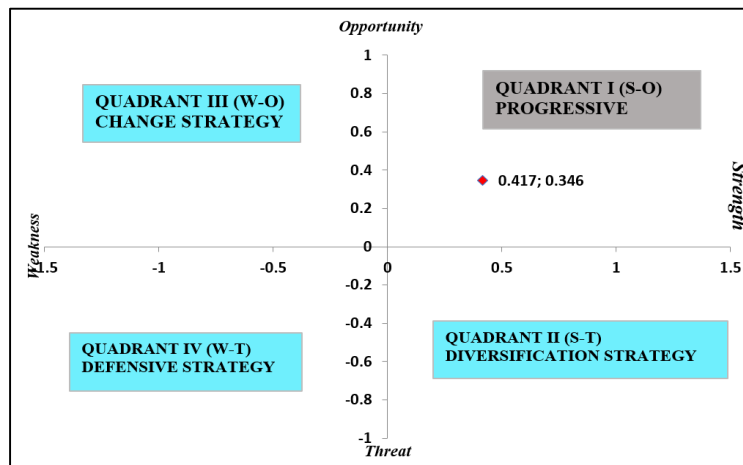


Figure 10. SWOT Grand Strategy Matrix for Kema II village (Kema District).

The strengths contributing to the sustainable livelihood of Kema II village are considerable, as evidenced by a fairly strong relationship among fishermen, the good quality and abundance of products they produce, the secure coastal environment, and the relatively efficient use of internet-based product promotion. These strengths allow Kema II village to support sustainable development and provide a foundation for policy studies focused on assisting coastal fishermen.

As a result of the SWOT analysis with a mix of external and internal influences on sustainability to make policies and follow-up activities of coastal fishermen, Kema III village has a situation of strength dominating weaknesses and succeeding in covering weaknesses that create opportunities. For Kema III village, Strength – Weakness (x-axis) was $2.800 - 1.136 = 1.665$ and Opportunity – Threat (y-axis) was $2.632 - 1.404 = 1.228$. In the Matrix Grand Strategy, it can be seen that sustainability development is in the position of quadrant I (progressive) where the sustainability situation has high potential (Figure 11).

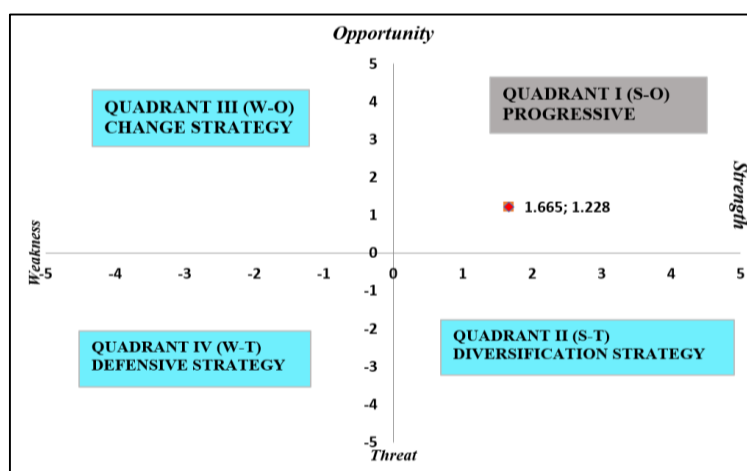


Figure 11. SWOT Grand Strategy Matrix for Kema III village (Kema District).

There is significant potential for livelihood sustainability studies to inform policy-making and support follow-up initiatives for coastal fishermen in Kema III village. Regional autonomy provides flexibility to develop the potential of coastal areas. Opportunities such as the level of accessibility, economic growth of fishermen, and technological developments are the initial pillars of the sustainable development of Kema III village. The economic growth of fishermen and the use of technological developments were due to the ease of access to capital and technology. Likewise, the next opportunity is expected to be able to

prosper the community, especially local fishermen and can contribute to economic improvement in Kema III village.

Sustainability strategy for coastal fishermen. The recommendation for the sustainability strategy of fishermen in North Minahasa Regency is based on the results of Rappfish and SWOT analysis. Recommendations are given so that the implementation of the next policy pays attention to the dimension that is very influential on North Minahasa Regency which will then increase other dimensions when the policy is right on target in the leverage dimension. There are two classifications based on the results of the research, namely (1) the dominant social dimension because the fishing community has a good leadership system, and the active participation of fishermen members in building sustainability in the State Fisheries Management Area of the Republic of Indonesia Number 716 (Serei village, Likupang II village, and Woli village); and (2) the dominant human dimension because fishermen have high skills and education in the State Fisheries Management Area of the Republic of Indonesia Number 715 (Kema II Village and Kema III Village).

The findings from Ali (2017) reveal that the sustainability of skipjack fisheries in Bone Bay, evaluated using a multi-dimensional scale, indicates low sustainability in the ecological and governance dimensions, while the economic, social, and technological dimensions are categorized as moderately sustainable. Similarly, Hidayah et al (2020) analyzed the sustainability of fisheries management in the Madura Strait across five dimensions: ecological, economic, social, technological, and institutional. The ecological, economic, and technological dimensions scored below 50, indicating low sustainability, while the social dimension was considered moderately sustainable and the institutional dimension sustainable.

Research by Putra et al (2021) on small-scale capture fisheries in Banggai Laut Regency found that the ecological and economic dimensions were sustainable, but both technological and social dimensions were unsustainable. Warningsih et al (2020) assessed anchovy sustainability using RAPPFISH and reported an index score of 42.76, categorized as less sustainable across ecological, economic, social, technological, and institutional dimensions. Chaliluddin et al (2021) found that pelagic fisheries at Ujong Serangga Port were sustainable in the ecological and social dimensions but less sustainable economically, and only moderately sustainable technologically.

Ernaningsih et al (2023) evaluated sunu grouper (*Plectropomus leopardus*) fisheries in the Spermonde Islands, reporting a sustainability index of 32.97, indicating non-sustainability. Ecological and economic aspects were unsustainable, while social and institutional dimensions were less sustainable, and the technological dimension was fairly sustainable. Zuhry et al (2023) analyzed the sustainability of the Karang Jeruk reef ecosystem, reporting the highest index in the ecological dimension (80.08), followed by technology (59.42), social (44.83), institutional (29.41), and economic (25.23).

In North Aceh, Chaliluddin et al (2023) applied RAPPFISH to assess pelagic fisheries. Results indicated the following sustainability scores: ecological (62.47 - fairly sustainable), economic (64.42 - fairly sustainable), social (46.24 - less sustainable), technology (82.77 - highly sustainable), and institutional (35.17 - less sustainable).

These studies suggest that dominant sustainability dimensions vary by fishery type, with technological, institutional, ecological, or social factors taking precedence depending on local conditions. In contrast, this study finds that in North Minahasa Regency, the dominant sustainability dimensions differ based on locality. The social dimension is dominant in three villages: Wori, Serei, and Likupang II, where strong community leadership and active participation play pivotal roles. Meanwhile, the human capital dimension is dominant in Kema II and Kema III, where fishermen exhibit high skill levels and relatively advanced education.

Conclusions. The sustainability of fishermen's livelihoods in North Minahasa Regency varies across locations and is influenced by different dominant factors. In Wori, Serei, and Likupang II villages, the social dimension - characterized by effective leadership and active

participation - is the main driver of sustainability. These areas require policy reinforcement focusing on strengthening community-based organizations and participatory governance.

On the other hand, Kema II and Kema III villages show a high degree of reliance on human capital. The fishermen in these areas benefit from higher levels of education and skill, allowing them to adapt to environmental and technological changes. Therefore, sustainability strategies in these areas should prioritize human resource development, including vocational training and educational support.

Based on the SWOT analysis, Wori, Serei, and Likupang II are positioned in quadrant IV (defensive strategy), which calls for minimizing internal weaknesses and external threats. Strategies should focus on infrastructure development, improved access to modern fishing equipment, and environmental conservation.

Conversely, Kema II and Kema III are in quadrant I (progressive strategy), indicating a favorable condition for proactive policy implementation. These villages should leverage their strengths and opportunities through enhanced digital marketing, innovation in fishery products, and capacity-building programs.

In summary, a location-specific, capital-dimension-focused approach is essential to ensure sustainable livelihood strategies for fishermen in North Minahasa Regency.

Conflict of interest. The authors declare that there is no conflict of interest.

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