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EFFECTIVENESS OF CAPTURE FISHERIES MANAGEMENT USING MULTI-DIMENSIONAL SCALING (MDS) ANALYSIS IN KENDARI WATERS, SOUTHEAST SULAWESI

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ABSTRACT This study aims to assess the effectiveness of capture fisheries management in the waters of Kendari, Southeast Sulawesi, using Multi-Dimensional Scaling (MDS). The research was conducted through field surveys and data collection from key stakeholders, including local fishermen and fisheries management authorities. The MDS method was employed to evaluate multiple sustainability dimensions such as ecological, social, and economic factors. The analysis revealed a moderate sustainability score for the fisheries management system, highlighting the need for improvements in management practices, particularly in resource allocation and community involvement. Main findings show that ecological sustainability is the most critical factor influencing fisheries management, while economic and social aspects require further attention to enhance overall sustainability. Practical implications of this research suggest that targeted interventions in management strategies, policy revisions, and stakeholder engagement are necessary to ensure long-term fisheries sustainability in the region. In conclusion, this study underscores the importance of adopting multi-dimensional approaches like MDS for comprehensive sustainability assessments and informs future policy and management practices in the fisheries sector.
Keywords: *Capture Fisheries, Sustainability, Multi-Dimensional Scaling, Fisheries Management, Ecological Sustainability, Southeast Sulawesi, Fisheries Policy*

INTRODUCTION

The sustainable management of capture fisheries in Southeast Sulawesi, particularly in Kendari's waters, has become increasingly challenging due to overfishing, environmental degradation, and inadequate management strategies. While fisheries are an important part of the local economy and food security, there is a growing concern over their ability to support long-term sustainability. The issue arises from insufficient integration of ecological, economic, and social dimensions in existing fisheries management practices, which limits the potential for effective and holistic governance. Addressing this problem requires a robust framework that can evaluate sustainability across multiple dimensions, which is where Multi-Dimensional Scaling (MDS) can play a critical role.

Several studies have used MDS and RAPFISH analysis to assess fisheries sustainability across various global regions. Alamsyah et al. (2023) employed MDS to evaluate sustainable fisheries management in Tegal City, incorporating legal and institutional aspects of fisheries governance. Similarly, Chaliluddin et al. (2023) applied RAPFISH in North Aceh to assess the sustainability status of pelagic fisheries. These studies demonstrate that MDS is an effective tool for evaluating complex sustainability dimensions, offering a comprehensive view that combines ecological, social, and economic factors. However, there remains a lack of applied MDS research focused on Southeast

Sulawesi, particularly in the context of Kendari's capture fisheries.

While previous studies have advanced the understanding of sustainability in fisheries, they have focused mainly on specific ecological or technological aspects of fisheries management. For instance, Brown et al. (2024) highlighted the sustainability of fishing tools based on ecological, technological, and social dimensions in Riau Province. Meanwhile, Farid et al. (2024) used RAPFISH to assess sustainable fisheries management for flying fish in East Java. These studies, although insightful, often focus on one dimension or do not capture the multi-faceted nature of fisheries sustainability in Southeast Sulawesi. Furthermore, the integration of social factors, such as community involvement and policy effectiveness, has often been overlooked in existing models.

Despite the significant contributions of these studies, there is a research gap regarding the application of MDS to the management of capture fisheries in Kendari. Most existing studies on fisheries sustainability in Indonesia, such as the work by Abdullah and Taeran (2021) on large pelagic fisheries in South Halmahera, have focused on particular species or ecological aspects without considering a comprehensive evaluation of fisheries sustainability across multiple dimensions. The gap lies in the lack of a holistic assessment that combines ecological, social, and economic dimensions in a unified framework like MDS, specifically in the context of Kendari's fisheries.

The objective of this study is to evaluate the effectiveness of capture fisheries management in Kendari using Multi-Dimensional Scaling (MDS). By integrating ecological, social, economic, technological, legal, and institutional dimensions, this research aims to provide a comprehensive sustainability assessment that can guide future management strategies in the region. The application of MDS will help identify key areas for improvement in the management of fisheries in Kendari and offer insights into the practical steps required to enhance sustainability in the region's fisheries sector.

METHOD

The data analysis method used in this study employs the Multi-Dimensional Scaling (MDS) approach with the Rapfish (Rapid Appraisal for Fisheries) software. All attributes collected are then analyzed multidimensionally to determine two reference points: good and bad. The sustainability analysis aims to provide an overview of the sustainability level of capture fisheries in the waters of Kendari, based on the ecological, social, economic, technological, legal, and institutional dimensions.

The dimensions used in this study refer to [10], which explains that the sustainability aspects of capture fisheries management should be reviewed from five perspectives: (1) environmental; (2) economic; (3) technological; (4) social; and (5) institutional. The attributes within each dimension are then determined based on the relevant FAO Code of Conduct [11]. Scoring is carried out by reviewing data from the annual reports of the Department of Marine Affairs and Fisheries of Kendari City. The respondents in this study are key informants from PPS Kendari, fisheries entrepreneurs, and fishing group leaders. The attributes for each dimension are outlined in the table below.

The results of the MDS analysis will be interpreted to evaluate the current state of fisheries sustainability in Kendari. The key factors influencing sustainability will be identified, and recommendations for improving management practices will be provided.

Table 1.Sustainability Attributes of Capture Fisheries Management in Kendari City Waters

No	Attribute	Score (Bad-Good)	Assessment Indicators
	A. Ecological Dimension		
1	Exploitation Status	0;1;2	FAO Scale: 0 = Overexploited; 1 = Heavily Exploited; 2 = Under Exploited
2	Primary productivity waters	0; 1; 2;	Chlorophyll-a Concentration: 0 = Very Low; 1=Moderate; 2=High
3	Distance to Fishing Ground	0; 1; 2;	Change in Distance to Fishing Ground: 0 = very far; 1 = Far; 2 = Moderate;
4	Fish catch size	0; 1; 2	Change in catch size: 0=smaller; 1=fixed; 2=gets bigger
5	Condition of coral reef ecosystem	0; 1; 2;	Percentage of live coral cover: 0=<25%; 1= 50-75%; 2=76-100%;
6	Use of tools illegal arrest	0; 1;2	Utilization of illegal fishing gear: 0=exists; 1=Little 2=None
7	Ecosystem conditions mangrove	0; 1; 2;	Density Level: 0=rare; 1=moderate; 2=dense
8	Selectivity of fishing gear	0; 1; 2	EAFM Standard: 0=low (>75%); 1=medium (50-75%); 2=high (<50%)
9	Fishing time	0; 1; 2	Change in fishing time: 0=longer; 1=stable; 2=faster
10	Diversity of fish catch	0; 1; 2;	EAFM Standard : 0=<20% (low); 1:21-50% (medium); 2:51-75% high;
11	Number of catches Wasted	0; 1; 2;	EAFM Standard: 0=>40%; 1:10-39%; 2:<10%
12	Capture fisheries production	0; 1; 2;	Production trend in the last 5 years: 0=decreasing; 1=stable; 2=increasing
B.	**Economic Dimension**		
1	Fishermen's income in the last 5 years	0; 1; 2	Income trend: 0 = Decreasing; 1 = Stagnant; 2 = Increasing
2	Number of fishermen	0; 1; 2	Growth in the number of fishermen: 0 = Decrease; 1=Staying the same; 2=Increase;
3	Average age of fishermen	0; 1; 2;	Number of fishermen per age group: 0 = >55 years; 1 = 40-54 years; 2=25-39 years;
4	Welfare of fishing communities	0; 1; 2	FAO Standard: 0= not prosperous; 1=quite prosperous; 2=very prosperous
5	Comparison of fishermen's income with UMR	0; 1 ;2	Comparison with UMR: 0 = below UMR; 1 = equal to UMR; 2 : above UMR
6	Ship ownership/ boat	0; 1:2	Ship owner: 0=owned by someone else; 1=owned by the group; 2=owned by Personal
7	Business diversification	0; 1; 2;	Other business: 0=none; 1=seasonal; 2=entrepreneur;
8	Fuel price hike	0; 1; 2	The effect of fuel prices on operational costs: 0=high; 1=medium; 2=low

No	Attribute	Score (Bad-Good)	Assessment Indicators
9	*Saving rate*	0; 1; 2	EAFM standard saving ability: 0=low (5-10% of income) 1=medium (11-15%); 2=high (16-20%)
10	Last 5 years operating costs	0; 1; 2;	Trend of increasing operational costs: 0= high (>30%); 1=high (25-29%); 2=medium (15-24%); 3=low (<15%)
C	**Social Dimension**		
1	Change of level welfare	0; 1; 2	Perception of welfare level: 0 = Decreasing; 1 = Stagnant; 2 = Increasing
2	Level of education	0; 1; 2;	Education level: 0 = no school; 1 = elementary school; 2 = junior high school - high school
3	The existence of fishermen groups	0; 1; 2	Fishermen group: 0 = none; 1 = present, not functioning; 2 = present, functioning
4	Benefits of the existence of fishermen groups	0; 1; 2	The magnitude of the benefits of the group's existence: 0= not useful; 1=quite useful; 2=very useful
5	Community empowerment program	0; 1:2	Empowerment programs by the government: 0 = never done; 1 = rarely; 2 = Often
6	Fisheries extension	0; 1:2	Frequency of fisheries extension: 0=never; 1=uncertain; 2=regular implementation
7	Government oversight	0; 1; 2;	Government oversight function: 0=none; 1=exists, not running; 2=running well
8	Compliance with regulations	0; 1; 2	Compliance level: 0=not compliant; 1=quite compliant; 2=compliant
9	Fisherman's insurance	0; 1:2	Fishermen's insurance program from the government: 0=not participating as an insurance participant; 1=a little; 2=all
10	Social conflict	0; 1; 2;	Occurrence of social conflict: 0=often occurs (>30%); 1=occurs sometimes; 2=never occurs
D	**Technology Dimension**		
1	Willingness to use technology	0; 1:2	Desire to use technology: 0 = Not willing; 1 = Undecided; 2= Willing
2	Post-harvest handling	0; 1; 2	Post-harvest technology: 0 = not used; 1 = occasionally used; 2 = often used;
3	Types of ship engines	0; 1; 2	Type of fishing gear: 0 = non-motorized; 1 = engine/outboard motor; 2 = modern engine
4	Processing of fishery products	0; 1; 2	Processing technology: 0= not processed; 1= dried/salted; 2= smoked/pindang
5	Utilization of FG information	0; 1; 2	Utilization of information: 0 = never utilized; 1 = ever utilized; 2 = always utilized
6	Technology assistance from the government	0; 1:2	Availability of government assistance: 0=never; 1=uncertain; 2=regular implementation
7	Use of FADs	0; 1; 2;	FAD utilization: 0=never use; 1=sometimes use; 2=always use
8	Utilization of navigation tools	0; 1; 2	Utilization of navigation tools: 0=never use; 1=sometimes use; 2=always use

No	Attribute	Score (Bad-Good)	Assessment Indicators
E	**Institutional Dimension**		
1	Environmental monitoring	0; 1; 2;	Supervisory function: 0 = supervision is handed over to the government; 1 = supervision by the community; 2 = collaboration between government and community
2	Government assistance for institutions	0; 1; 2	Institutional assistance: 0 = none; 1 = present, irregular; 2 = present, regular
3	Influence of local figures	0; 1; 2;3	The extent of influence of local figures: 0= no local figures; 1= no influence; 2= very influential
4	Action against illegal fishing	0; 1;2	Legal action for violations: 0 = none; 1 = yes 2 = Frequent
5	Socialization of fisheries regulations	0; 1:2	Frequency of socialization: 0 = none; 1 = yes, irregular; 2 = yes, regular
6	Benefits of fisheries management by groups	0; 1; 2;	Magnitude of benefit: 0=not useful; 1=quite useful; 2=very useful
7	Institutional development by the government	0; 1; 2	Institutional technical guidance: 0 = none; 1 = exists, irregular; 2 = exists, regular
8	Institutional conflict	0; 1; 2	Occurrence of conflict between fishing community institutions: 0 = none; 1 = sometimes occurs; 2 = never occurs

The value of the sustainability status of capture fisheries using the Raphfish method has a bad and good interval of 0-100. To facilitate the division of categories of capture fisheries status in Kendari City, the interval is divided into four categories, namely 0-25 poor sustainability status, 26-50 less sustainability status, interval 51-75 sufficient sustainability status and 76-100 good sustainability status [11]. The MDS sustainability categories are presented in table 1 below.

Table 2.MDS Sustainability Analysis Index Interval

No	**Index Hose**	**Sustainability Status**
1	0-25	Not Sustainable
2	26-50	Less Sustainable
3	51-75	Moderately Sustainable *Sustainable*)
4	76-100	Sustainable

Source:[12]

The research on the sustainability status of capture fisheries was conducted by identifying problems and collecting primary and secondary data to analyze the existing conditions of capture fisheries in Kendari City. The research was continued by analyzing the dimensions of ecology, economy, social, technology, law and institutions to determine the sustainability status of capture fisheries in Kendari City. Each dimension then obtained sensitive attributes in each dimension to determine alternative sustainable capture fisheries policies on the Kendari City Coast.

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RESULTS AND DISCUSSION

Ecological Dimension

Based on the RAPFISH ordination diagram, the ecological sustainability of capture fisheries management in the waters of Kendari is positioned at a moderate level with a score of 55.12. The "Real Fisheries" data point, represented by the blue dot, is closer to the "GOOD" reference point but still falls within the "UP" range, indicating that the ecological management of fisheries is progressing positively but still requires further improvement. The placement of this point above the "BAD" area reflects that current management practices have led to some degree of ecological sustainability, though there is still room for enhancement in areas such as fish stock conservation and habitat quality. Therefore, while the ecological sustainability of fisheries in Kendari is not yet optimal, it is on a promising trajectory, suggesting that continued efforts and adjustments are needed to reach a more sustainable status (Figure 1).

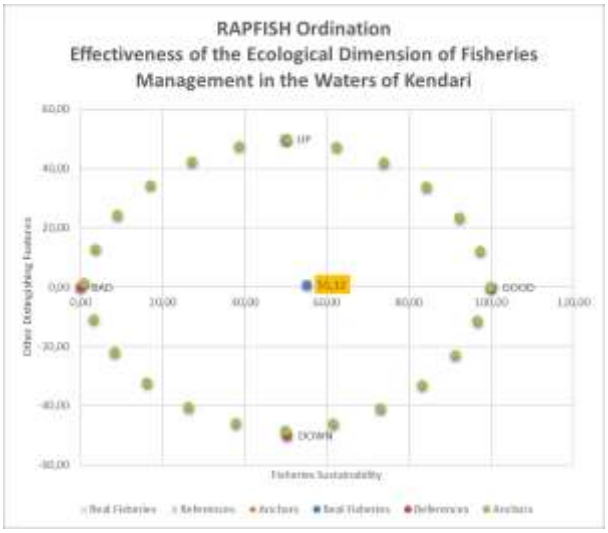

Figure 1. Effectiveness of the Ecological Dimension of Fisheries Management in the Waters of Kendari

The image below presents the Leverage of Attributes regarding the ecological dimension of fisheries management effectiveness. The chart shows the Root Mean Square Change in Ordination when a specific attribute is selected, measured on a scale of 0 to 100 for sustainability. The attributes are listed along the vertical axis, and the values on the horizontal axis represent how each attribute influences the overall sustainability ordination.

From the chart, it is evident that the attribute Use of Illegal Fishing Gear has the highest leverage with a value of 2.86. This indicates that the use of illegal fishing gear has the most significant impact on the sustainability status of fisheries in Kendari. This high value suggests that addressing the issue of illegal fishing gear could lead to substantial improvements in sustainability within the ecological dimension of fisheries management.

Other attributes with notable leverage include Mangrove Ecosystem Condition and Selectivity of Fishing Gear, with values of 0.87 and 0.86, respectively. These attributes also significantly influence sustainability but to a lesser extent than illegal fishing gear.

In contrast, attributes such as Primary Productivity and Exploitation Status have relatively low leverage with values of 0.34 and 0.84, respectively, indicating that while they are still important, they do not exert as strong an influence on the overall sustainability ordination as the more influential attributes like illegal fishing gear **(Figure 2).**

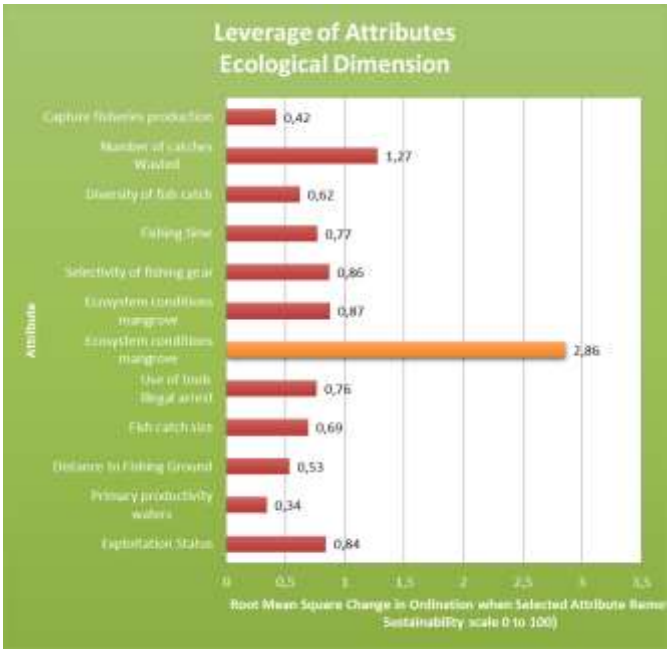

Figure 2. Leverage of Attributes Ecological Dimension

Economic Dimension

Based on the RAPFISH ordination diagram for the economic dimension (figure 3), the sustainability of capture fisheries management in the waters of Kendari is positioned at a moderate level with a score of 56.77. The "Real Fisheries" data point, represented by the blue dot, is located closer to the "GOOD" reference point, suggesting that the economic management of fisheries is moderately sustainable. However, there is still room for improvement to reach a fully sustainable status. The positioning of "Real Fisheries" above the "BAD" reference point indicates that, while the economic conditions are somewhat positive, such as profitability and market access, there are areas in need of further attention, like resource allocation and income stability for fishermen. Overall, the economic dimension of fisheries management in Kendari shows progress, but improvements are needed to optimize the economic sustainability of the fisheries.

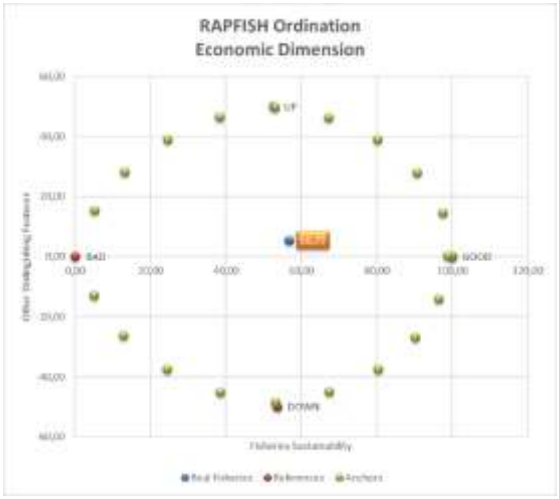

Figure 3. Effectiveness of the Economic Dimension of Fisheries Management in the Waters of Kendari

The Leverage of Attributes regarding the economic dimension of fisheries management effectiveness. The chart shows the Root Mean Square Change in Ordination when a particular attribute is selected, measured on a scale of 0 to 100 for sustainability. The attributes are listed along the vertical axis, and the values on the horizontal axis represent how each attribute influences the overall sustainability ordination. From the chart, it is evident that the attributes "Number of Fishermen" and "Average Age of Fishermen" have the highest leverage, with values of 2.17 and 2.57, respectively. This indicates that these attributes significantly influence the sustainability status of fisheries in Kendari. Specifically, the high leverage of the "Average Age of Fishermen" attribute suggests that the age structure of the fishing community plays a crucial role in the economic sustainability of the fisheries. A younger and more dynamic workforce might enhance the economic viability of the sector.

Other attributes with moderate leverage include "Ship Ownership/Boat" (1.15), "Comparison of Fishermen's Income with Regional Minimum Wage (1.09), and "Business Diversification" (1.06), indicating that these factors also significantly impact the economic sustainability but to a lesser extent than the "Number of Fishermen" and "Average Age of Fishermen." Attributes like "Welfare of Fishing Communities" (0.61), "Fishers' Income in the Last 5 Years" (0.94), "Saving Rate" (0.90), and "Fuel Price Hike" (1.00) have relatively lower leverage, meaning that while they are still important for economic sustainability, they have less impact compared to other factors. These two attributes are the primary drivers influencing the economic sustainability of fisheries in the waters of Kendari. Addressing these factors, particularly focusing on enhancing the number of younger fishermen, could have the most significant impact on improving economic sustainability in the sector (Figure 4).

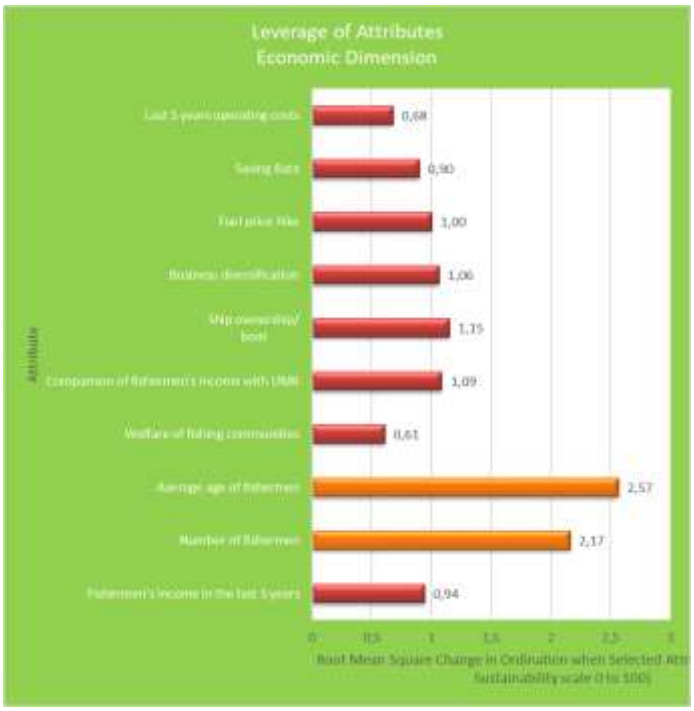

Figure 4. Leverage of Attributes Economic Dimension

Social Dimension

Based on the RAPFISH ordination diagram for the social dimension **(figure 5)**, the sustainability of capture fisheries management in the waters of Kendari is positioned at a moderate level with a score of 69.31. The "Real Fisheries" data point, represented by the blue dot, is located near the "GOOD" reference point, indicating that the social sustainability of fisheries management in Kendari is relatively strong. This suggests that social factors such as community involvement, the welfare of fishing families, and social equity are well-managed but still have room for improvement to reach optimal sustainability. The position of the data point above the "BAD" area demonstrates that the social dimension of fisheries in Kendari is on the right track, though additional efforts are needed to improve the overall social sustainability of fisheries management.

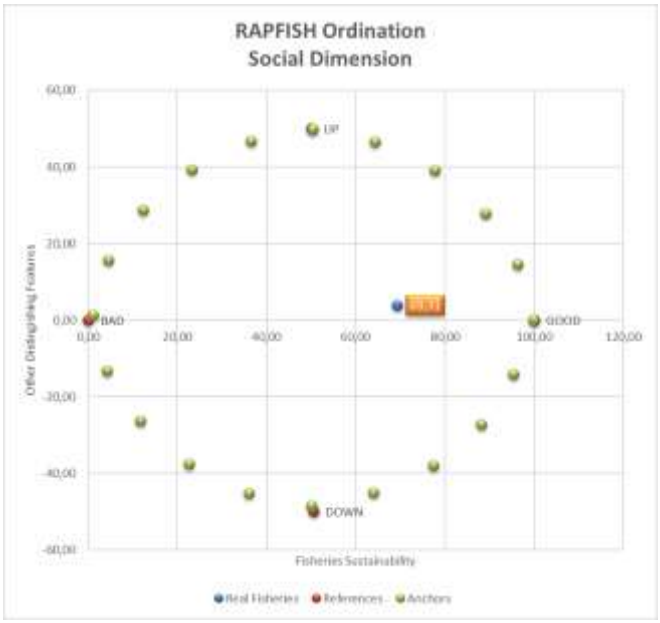

Figure 5. Effectiveness of the Social Dimension of Fisheries Management in the Waters of Kendari

The Leverage of Attributes for the social dimension of fisheries management sustainability. The chart shows the Root Mean Square Change in Ordination when each attribute is selected, measured on a scale of 0 to 100 for sustainability. The attributes are listed along the vertical axis, and the values on the horizontal axis represent how much each attribute influences the overall sustainability ordination. From the chart, it is evident that "Government Oversight" has the highest leverage with a value of 4.25, indicating that it plays the most significant role in determining the social sustainability of fisheries management. This suggests that effective government oversight, including monitoring and regulation enforcement, is crucial for ensuring that fisheries management practices are socially sustainable.

Other attributes with notable leverage include "Compliance with Regulations" (3.78), "Fisheries Extension" (3.66), and "Community Empowerment Program" (3.81), all of which also significantly influence social sustainability, but to a lesser extent compared to government oversight. These attributes reflect the importance of ensuring that fishermen follow regulations, have access to extension services, and are actively involved in community empowerment initiatives to support sustainable practices. Attributes such as "Social Conflict" (2.39) and "Change in Level of Welfare" (1.21) have lower leverage values, meaning that while they are still relevant, they have less impact on the overall sustainability of fisheries management from a social perspective.

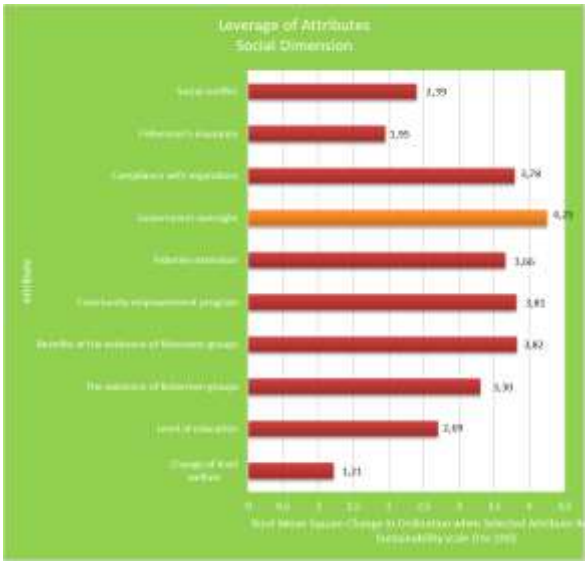

Figure 6. Leverage of Attributes Social Dimension

Technology and Infrastructure Dimension

Based on the RAPFISH ordination diagram for the Technology and Infrastructure Dimension **(figure 7)**, the sustainability of capture fisheries management in the waters of Kendari is positioned at a moderate level, with a score of 53.76. The "Real Fisheries" data point, represented by the blue dot, is located slightly below the "GOOD" reference point but still above the "BAD" area. This indicates that the technological infrastructure supporting fisheries management is somewhat effective, but there are areas that require further development to improve sustainability. The proximity of the data point to the "UP" reference point suggests that while the technology and infrastructure are not at optimal levels, there are positive trends and efforts underway to enhance these aspects. However, more improvements in infrastructure, such as access to sustainable fishing technologies, better storage facilities, and improved processing methods, are needed to move closer to achieving a higher sustainability status in this dimension.

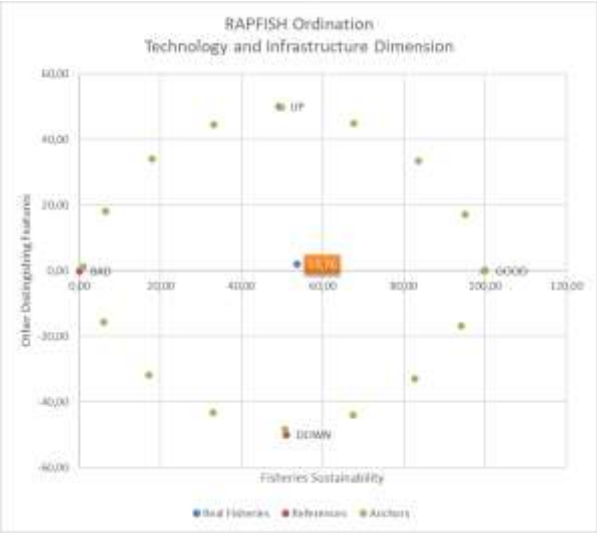

Figure 7. Effectiveness of the Technology and Infrastructure of Fisheries Management in the Waters of Kendari

The Leverage of Attributes for the Technology and Infrastructure Dimension (Figure 8) of fisheries management sustainability. The chart shows the Root Mean Square Change in Ordination when a selected attribute is considered, measured on a scale of 0 to 100 for sustainability. The attributes are listed along the vertical axis, and the values on the horizontal axis represent how much each attribute influences the overall sustainability ordination.

From the chart, it is clear that the attribute "Processing of Fishery Products" has the highest leverage with a value of 6.81, indicating that this attribute has the most significant impact on the sustainability of fisheries management. This suggests that improving the processing of fishery products, such as enhancing fish preservation techniques and processing facilities, could greatly enhance the sustainability of the sector. Following this, "Types of Ship Engines" has a leverage value of 5.29, indicating that the type and efficiency of the ship engines used in fishing operations play a significant role in the sustainability of fisheries, likely due to factors such as fuel efficiency, environmental impact, and operational costs.

Other attributes with notable leverage include "Willingness to Use Technology" (1.82), "Utilization of FG Information" (1.68), and "Technology Assistance from the Government" (1.29). These attributes show that the willingness of fishermen to adopt new technologies, the use of available fishing gear information, and the support provided by the government in terms of technological assistance are also important but have a relatively lower impact on sustainability compared to the processing of fishery products and the types of ship engines. Attributes such as "Use of FADs" (0.80) and "Post-Harvest Handling" (0.34) have lower leverage values, suggesting that while these factors are still relevant, they have less influence on the overall sustainability in the Technology and Infrastructure

Dimension of fisheries management in Kendari.

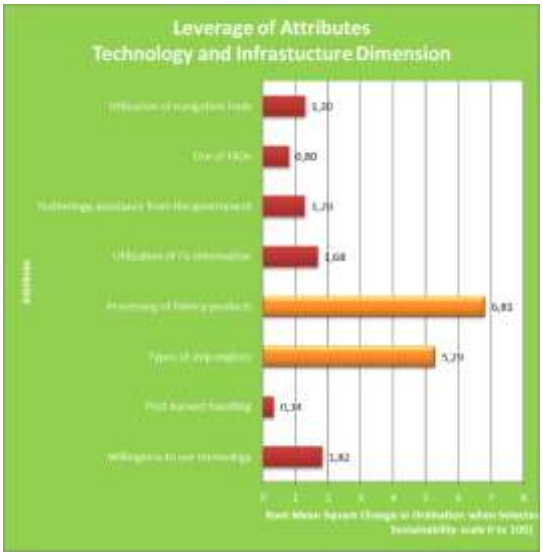

Figure 8. Leverage of Attributes Technology and Infrastructure Dimension

Institutional Dimension

Based on the RAPFISH ordination diagram for the Institutional Dimension (Figure 9), the sustainability of capture fisheries management in the waters of Kendari has a moderate score of 58.08. The "Real Fisheries" data point, represented by the blue dot, is positioned closer to the "GOOD" reference point, suggesting that the institutional framework supporting fisheries management in Kendari is relatively effective. However, it still falls short of achieving an optimal level of sustainability. The "Real Fisheries" data point being above the "BAD" area indicates that institutional aspects, such as governance, enforcement of regulations, and policy implementation, are somewhat effective, but further improvements are needed to reach a higher level of sustainability. The positioning near the "UP" reference suggests that while the institutional dimension is not yet fully optimized, there is positive movement and potential for further progress in strengthening institutional support for sustainable fisheries management in Kendari.

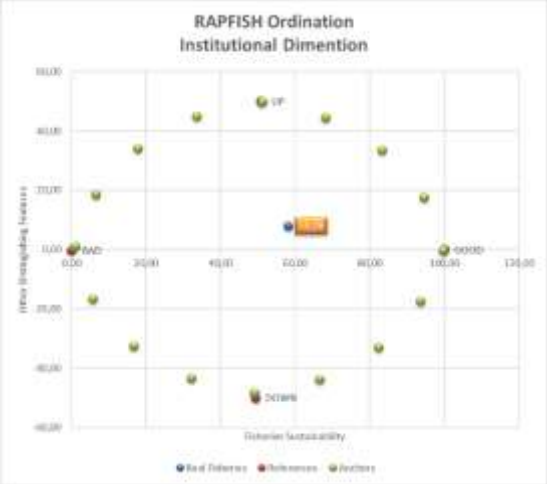

Figure 9. Effectiveness of the Institutional of Fisheries Management in the Waters of Kendari

The Leverage of Attributes for the Institutional Dimension of fisheries management sustainability. The chart displays the Root Mean Square Change in Ordination when a selected attribute is considered, measured on a scale of 0 to 100 for sustainability. The attributes are listed along the vertical axis, and the values on the horizontal axis represent the impact of each attribute on overall sustainability. From the chart, it is clear that the attribute "Action Against Illegal Fishing" has the highest leverage with a value of 4.48, indicating that this factor has the most significant influence on improving the sustainability of fisheries management. This highlights the crucial importance of addressing illegal fishing practices in enhancing institutional effectiveness and governance in fisheries management.

Another significant attribute is "Socialization of Fisheries Regulations" with a leverage value of 4.08, which suggests that educating stakeholders and ensuring awareness of fisheries regulations plays a vital role in improving institutional sustainability. These efforts can significantly enhance adherence to legal frameworks and contribute to better enforcement of sustainability practices. Other attributes with notable leverage include "Action Against Illegal Fishing" (2.24) and "Influence of Local Figures" (2.27), indicating that the enforcement of anti-illegal fishing measures and the involvement of influential local figures also play important roles in improving institutional sustainability, but with a slightly lower impact compared to the aforementioned attributes. Attributes such as "Government Assistance for Institutions" (1.97) and "Environmental Monitoring" (1.64) have lower leverage values, suggesting that while they are still relevant for improving fisheries sustainability, they have a comparatively smaller influence on the overall sustainability status of the fisheries management system in Kendari.

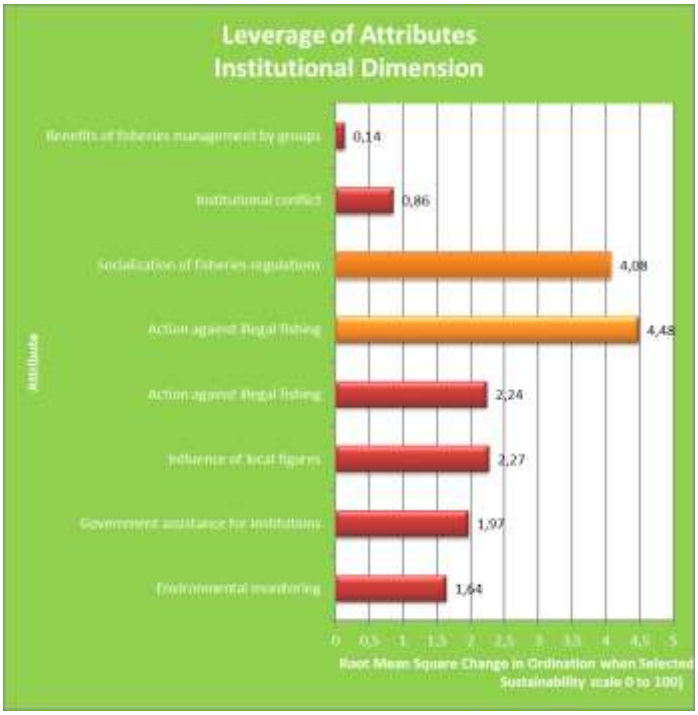

Figure 10. Leverage of Attributes Institution Dimension

Fisheries management is critical in ensuring the long-term sustainability of marine ecosystems, particularly in regions like Kendari, Southeast Sulawesi, where biodiversity is rich but faces numerous sustainability challenges. The ecological dimension of fisheries management involves monitoring fish stock health, conserving biodiversity, and protecting marine habitats, which are all essential to the viability of fisheries over the long term. This section outlines the current status of ecological sustainability in the waters of Kendari, drawing from the application of Multi-Dimensional Scaling (MDS) for a comprehensive sustainability assessment.

The health of fish stocks is a cornerstone of sustainable fisheries management. In the case of Kendari, fish stock health is significantly impacted by overfishing, habitat degradation, and the broader effects of climate change. Alamsyah et al. (2023) highlighted that overfishing in coastal areas, coupled with the depletion of key fish species, is a major factor reducing biodiversity and, consequently, fisheries productivity. Similar findings have been observed in other coastal regions, including East Java, where overfishing has led to declining fish populations and destabilized local fisheries economies (Farid et al., 2024).

For sustainable fisheries, it is imperative to regulate fishing efforts through appropriate quotas and periodic monitoring of fish populations. The implementation of sustainable fishing practices will require a combination of research and enforcement to ensure that the extraction of marine resources remains balanced with their regeneration. In Kendari, regular monitoring is vital to ensure that fish stocks are not overexploited. Establishing sustainable fishing quotas will help maintain the balance between exploitation and conservation. These measures can help reverse the negative effects of overfishing while supporting the growth and replenishment of fish populations.

The condition of marine habitats, particularly coral reefs and mangrove ecosystems, plays a crucial role in supporting fish populations. According to Purnomo et al. (2024), habitat degradation, such as the destruction of coral reefs and mangroves, poses a significant threat to fisheries sustainability. In Kendari, mangrove ecosystems, which serve as vital breeding grounds for numerous marine species, are under pressure due to coastal development, pollution, and unsustainable resource extraction.

Hidayah et al. (2024) emphasized the importance of mangroves in maintaining the ecological balance of marine environments, especially for fisheries sustainability. However, these habitats are at risk from human activities that threaten their ability to regenerate and support marine life. Addressing habitat degradation and promoting habitat restoration, especially of mangrove forests, is crucial for improving the ecological sustainability of fisheries in Kendari.

Effective environmental regulations are a key component in managing fishery resources sustainably. However, the enforcement of these regulations is critical for their success. Alamsyah et al. (2023) pointed out that while Kendari has made progress in terms of implementing environmental policies, more robust efforts are required, particularly in regulating illegal fishing practices. The use of illegal fishing gear, such as explosives and poisons, continues to be a significant problem, undermining marine ecosystems and the long-term viability of fish stocks.

The RAPFISH ordination results for Kendari indicate that ecological sustainability has made some progress but still faces substantial challenges. The study suggests that stricter enforcement of existing regulations, combined with stronger community involvement in monitoring and protecting fish stocks, would improve the ecological sustainability of fisheries.

Climate change is a global challenge affecting marine ecosystems. Rising sea temperatures, ocean acidification, and altered weather patterns are disrupting marine life, affecting fish populations, and exacerbating the challenges faced by fisheries. In Kendari, these effects are evident in the declining health of coral reefs, which are sensitive to temperature fluctuations, and in shifts in fish populations due to changes in ocean temperature and acidity (Zuhry et al., 2023).

To address these challenges, it is important to implement climate-resilient fisheries management strategies. This includes establishing marine protected areas, reducing emissions, and fostering the adaptive capacity of local fishing communities. As noted by Chrispin et al. (2022), MDS can be a useful tool for assessing the multidimensional impacts of climate change on fisheries sustainability, guiding the development of appropriate adaptive management strategies.

Multi-Dimensional Scaling (MDS) is an effective tool for evaluating the sustainability of fisheries management by assessing multiple sustainability dimensions in a unified framework. In Kendari, MDS has revealed a moderate level of ecological sustainability, indicating that while progress has been made in certain areas, more targeted interventions are needed. The application of MDS in assessing the ecological dimension highlighted the need for improvements in fish stock health and habitat conditions, with a particular focus on reducing the use of illegal fishing gear and restoring degraded habitats.

According to Chrispin et al. (2022), MDS enables a comprehensive understanding of fisheries

sustainability by considering multiple factors simultaneously, allowing for a more accurate and actionable sustainability assessment. In Kendari, MDS provides valuable insights into the effectiveness of existing management practices, guiding policymakers and fisheries managers in developing strategies to enhance sustainability.

CONCLUSION

This study assessed the effectiveness of capture fisheries management in the waters of Kendari, Southeast Sulawesi, using Multi-Dimensional Scaling (MDS). The findings show that while the fisheries management system is progressing, there are several areas for improvement across ecological, economic, social, technological, and institutional dimensions.

In the ecological dimension, the management system showed moderate sustainability, with key challenges such as the use of illegal fishing gear and habitat degradation affecting fish stocks and ecosystems. Addressing these issues is crucial for improving ecological sustainability, particularly through stricter enforcement and habitat restoration. The economic dimension also showed moderate sustainability. Factors such as the aging fishing community and fluctuating income levels for fishermen require attention. Ensuring financial stability through subsidies, income diversification, and improved access to markets will be essential for the long-term economic sustainability of the sector. The social dimension revealed relatively strong sustainability, with effective government oversight and community involvement playing key roles. However, further empowerment programs and enhanced education for fishermen are needed to promote sustainable practices across the community. In the technology and infrastructure dimension, the study highlighted the need for improved fishing technologies, post-harvest handling, and government support to enhance sustainability. Modernizing infrastructure and ensuring access to efficient tools will increase productivity and reduce environmental impact. The institutional dimension showed that better governance and regulation enforcement are essential. Strengthening institutional frameworks and improving coordination between stakeholders will help foster a more sustainable fisheries management system.

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