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SUSTAINABILITY STATUS OF BELAT FISHING TOOLS BASED ON ECOLOGICAL, TECHNOLOGICAL AND SOCIAL ASPECTS IN MERBAU DISTRICT, RIAU PROVINCE

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ABSTRACT

This research was carried out in November 2022 in Merbau District, Meranti Islands Regency, Riau Province, to determine the sustainability status of the belat fishing gear based on ecological, social and technological aspects. The method used in this research is a survey method, while purposive sampling is used to determine respondents. Data collection was carried out through observation, interviews and documentation directly with two academics from the UNRI Faculty of Fisheries and Marine, two people from the Meranti Regency Fisheries Service, four capture fisheries entrepreneurs (traders and collectors), two fishermen group leaders, and ten fishermen. The research results show a decrease in the number of belat fishing gear every year; in 2020, the number of belat fishing gear was 65 units, and in 2022, the number of belat fishing gear was nine units. Belat fishing gear is not selective, as seen from the leverage analysis that has been carried out with a sensitivity attribute value of 40.53. Belat can catch small fish that are not yet suitable for catching. The sustainability status of belat fishing gear is seen through the attribute values of three dimensions. The sustainability index value for the ecological dimension of the belat fishing gear is 51.11, meaning it is pretty sustainable. The sustainability index value of the technological dimension in fishing using belat fishing gear is 40.53, which is classified as less sustainable. The index value of the social dimension in fishing using the belat fishing gear is 59.99, meaning it is in the reasonably sustainable category.

Keywords: Sustainability status, Belat, Ecology, Technology, Social

1. INTRODUCTION

Kepulauan Meranti Regency is a Bengkalis Regency division located on the east coast of Sumatra Island. The areas that border the Kepulauan Meranti Regency are, to the north, it borders the Malacca Strait and Bengkalis Regency; to the south, it borders Siak Regency and Pelalawan Regency; to the west, it borders Bengkalis Regency; and to the east, it borders Karimun Regency, Kepulauan Riau Province[1]. The business carried out by the local community is a capture fishery using belat fishing gear. The number of belat fishing gear in the Merbau sub-district in the last five years, namely 2016-2020, has decreased by BPS[2].

The decline in the belat fishing gear occurred due to abrasion. According to Muhtar & Meiwanda[3], the abrasion disaster that occurred has threatened and resulted in losses, both physical and non-physical. Coastal abrasion disasters must continue to be considered in terms of management, such as implementing structural and non-structural mitigation to minimize the risks arising from coastal abrasion disasters that occur. Hermawan[4] explains that in the context of fisheries management, the technology used is usually related to efforts to increase productivity and increase efficiency.

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Belat fishing gear is classified as fishing gear that can catch fish in large quantities, with various types (multi-species) and sizes of fish. The belat fishing gear is operated by intercepting and trapping fish that will return to the main river after moving laterally to the river bank or exposure to flooded tidal swamps at high tide[5].

In the development of environmentally friendly fish technology, the by-catch caught is very important for the ecological balance in the waters. Due to the multi-species and multi-gear nature of fisheries in tropical areas, it is almost impossible to create a fishing gear that only catches the target species; one method that might be used is to improve the selectivity used[6]. Because the fishing gear is still dominantly used by the fishing community, researchers are interested in conducting research on the sustainability of fishing using the belat fishing gear based on ecological, technological and social aspects in the Merbau District. The social aspect focuses on the social dimensions related to the sustainability of capture fisheries in predetermined locations with the aim of describing the lives of fishing communities as humans who must adapt to the social environment and fisheries resources as their source of life.

Social aspects need to be addressed, and serious attention is needed in efforts to manage marine fisheries' resources due to the lack of education level of fishermen. Sarmintohadi[6] state that the lives of fishing communities are expressed through their businesses, which are influenced by fishing seasons, unsupportive conditions, limited capital, and low levels of education, resulting in weak socio-economic conditions.

In this research, an evaluation of the sustainability of capture fisheries was carried out using a multi-variable method called multidimensional scaling (MDS), also known as Rapfish (Rapid Appraisal for Fisheries). This research aims to determine the sustainability status of the belat fishing gear based on ecological, social and technological aspects.

2. RESEARCH METHOD

Time and Place

This research was conducted in November 2022 in Merbau District, Kepulauan Meranti Regency, Riau Province.

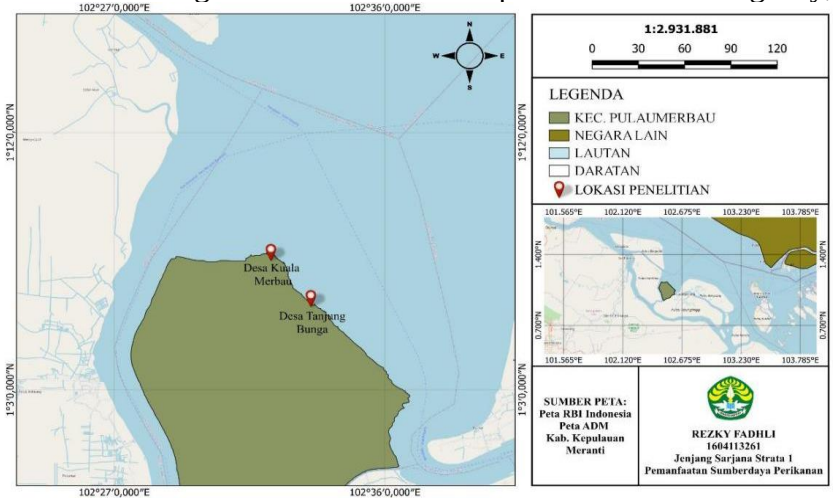

Figure 1. Research Location Map

Methods

This research was carried out using a survey method, namely direct observation in the field in Merbau District, Kepulauan Meranti Regency, Riau Province. Survey research is directed at finding and studying data from samples taken from the population so that relative events, distributions and relationships between variables are found. Survey research can be conducted on large or small populations[7].

Determination of Respondents

Respondents in this study were determined using purposive sampling. According to Kurniawan & Puspitaningtyas[7], purposive sampling is a sampling technique based on specific criteria (considerations) from members of the population. Respondents in this study can be seen in Table 1.

Data Collection

Data types and data collection methods are presented in Table 2.

Table 1. Respondent Criteria

No	Respondent	Number of people
1	Academic Faculty of Fisheries and Marine, UNRI	2
2	Meranti Regency Fisheries Service	2
3	Capture fisheries entrepreneurs (traders and collectors)	4
4	Chairman of the Fishermen's Group	2
5	Fisherman	10
Number of people		20

Table 2. Research Data Collection

No	Dimensions	Indicators/Attributes	Method of collecting data
1	Ecology	a. Level of fisheries exploitation	Interviews and secondary data
		b. Collapse rate/reduction of fishing area	interviews and secondary data
		c. Changes in types of fish caught in the last five years	interviews and secondary data
		d. Change in weight of fish caught in the last five years	Kepulauan Meranti Fisheries Service report and interview
		e. Pressure on water use	Interviews and secondary data
		f. Changes in the environment and quality of critical habitats in coastal areas	interviews and secondary data
		g. Utilization of marine tourism waters	interviews and secondary data
2	Technology	a. Fish landing place	interview
		b. Length of fishing trip	Interview
		c. Selectivity of fishing gear	interview
		d. Size of a fishing vessel	interviews
		e. Post-harvest handling	interview
		f. Type/nature of fishing gear	interview
		g. Discard and bycatch	Interviews and secondary data
		h. Proportion of fish discarded	interviews and secondary data
3	Social	a. Knowledge of the fisheries environment	interview
		b. Fisherman's education level	interview
		c. Status and frequency of conflict	interview
		d. Family participation in the use of fisheries resources	interview
		e. Frequency of meetings between residents regarding fisheries resource management	interview
		f. Implementation of work (individual or group)	interview

g.	Frequency of counseling and Interview training for fishermen

Source: Hermawan[4]

Data Analysis

Data analysis in this study used the Rapfish technique (Rapid Appraisal for Fisheries). This technique was developed by the University of British Columbia, Canada, and is used to evaluate the sustainability of fisheries in a multidisciplinary manner. Rapfish is based on an ordination technique: placing things in a sequence of measurable attributes using multidimensional scaling (MDS). In the analysis using the Rapfish technique, the ALSCAL algorithm method will be used, which is an applicable method that is available in the Excel template. The Rapfish technical analysis procedure will go through several stages, namely desk study, consultation with related experts, field verification, data tabulation and processing, and interpretation of results.

This analysis is used to determine the points in Rapfish being studied relative to two reference points. The reference points are good and evil, where there are good extreme points and bad extreme points. The positions of the points in Rapfish are numerous and complex to describe. Therefore, a technique is needed to determine the position of the points visually, known as multidimensional scaling (MDS)[4].

Next, a sensitivity analysis was carried out to see what attributes were most sensitive in contributing to the sustainability index at the research location. The influence of each attribute is seen in the form of changes in root mean square (RMS) ordination, especially on the X-axis or sustainability scale. The greater the value of the change in RMS due to the loss of a particular attribute, the more significant the role of that attribute in forming a sustainability index on a sustainability scale or, in other words, the more sensitive the attribute is in the sustainability of the Gombang capture fishery at the research location.

Monte Carlo analysis was used to evaluate the influence of random errors on the legislative process and the ordination value of the belat fisheries' sustainability system. Monte Carlo simulation is defined as any statistical sampling technique used to estimate solutions to quantitative problems. The Monte Carlo method simulates the system repeatedly, hundreds or even thousands of times, depending on the system being considered, by selecting a random value for each variable from its probability distribution. The results obtained from the simulation are a probability distribution of the values of a system as a whole. According to Kavanagh in Edwarsyah[8], Monte Carlo analysis is also helpful in studying the following things:

Regressing the formulation above is used for the alternating least squares technique, which is based on the Euclidean distance (squared distance) root and is called the ASCAL algorithm method. This method optimizes the squared distance dij to squared data (origin = 0ijk) in three dimensions (i, j, k), which is then called S-Stress with the formulation:

$$\text{Stress}=\sqrt{\frac{1}{m}\sum_{k=1}^{m}\left[\frac{\sum_i\sum_j (D_{ijk}-d_{ijk})^2}{\sum_i\sum_j d_{ijk}^2}\right]}$$

Each dimension and multi-dimensional has a stress value, which shows that the analysis is good enough if a value of 25% or 0.25 is obtained. The smaller the stress value obtained, the better the quality of the results of the analysis. In contrast to the coefficient of determination (R^2), the quality of the analysis results is better if the coefficient of determination value is more significant (closer to 1), which means that the currently selected attributes can explain close to 100% of the existing model.

3. RESULT AND DISCUSSION

Sustainability Status of Belat Gear

The results of the Rap Analysis show that the value for the technology dimension

is 40.53, meaning the value is less sustainable, while for the ecological dimension and social dimension, the values are 51.11 and 59.99, meaning the value is entirely sustainable, in line with the categorization that has been proposed by Thamrin et al.[9] in Table 3.

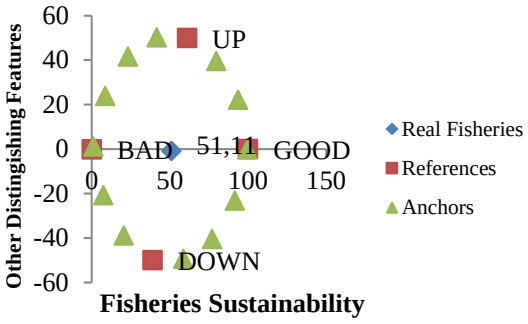

Figure 2. Rapfish Ordination Ecological Dimensions

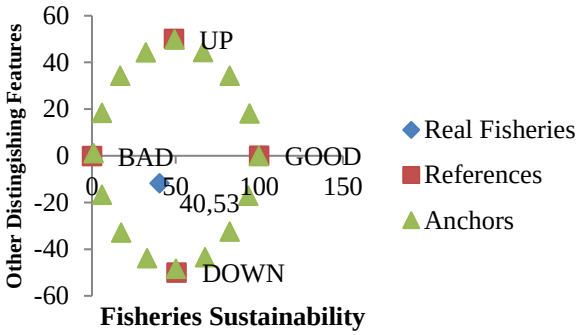

Figure 3. Technological Dimension Rapfish Ordination

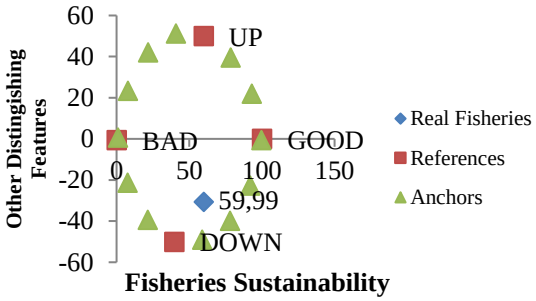

Figure 4. Rapfish Ordination Social Dimensions

Table 3. Categorization of Sustainability Status Assessment for Ecological Dimensions in Both Fishing Gears Based on Index Values from MDS Analysis Results

No	Index Value	Category
1	0.00-25.00	Bad (unsustainable)
2	25.01-50.00	Less (Less sustainable)
3	50.01-75.00	Sufficient (Sufficiently sustainable)
4	75.01-100.00	Good (very sustainable)

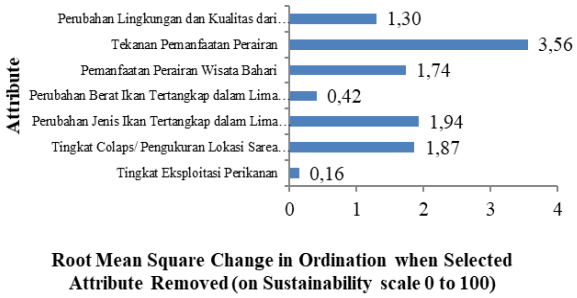

Figure 5. Attribute Sensitivity to Ecological Dimensions

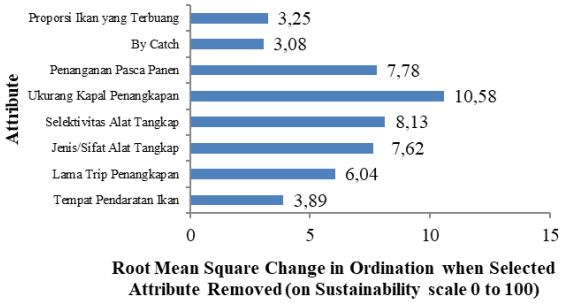

Figure 6. Attribute Sensitivity to the Technology Dimension

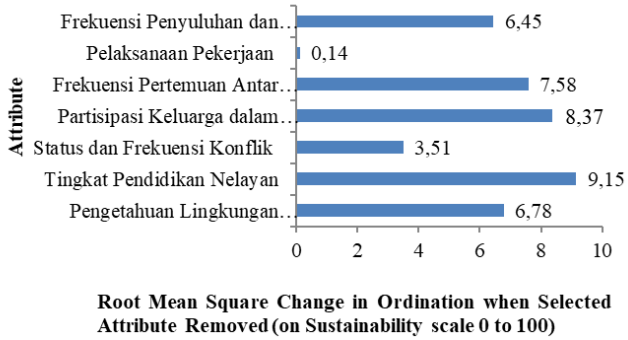

Figure 7. Attribute Sensitivity to the Social Dimension

The results of the sensitivity analysis (laverage analysis) show that in the ecological dimension, water use pressure is (3.56), this value is a sensitive value in the ecological dimension. According to Nofrianda et al.[10], belat catches have not yet reached their adult size, so policies need to be implemented regarding the operation of belat fishing gear, and it is also necessary to investigate the level of exploitation of fish resources to see whether there are signs of overfishing in the area optimally and sustainably. Furthermore, Tamarol et al.[11] said that almost all fishing gear used by fishermen in coastal waters can cause physical damage to aquatic habitats and damage to fisheries resources.

The results of the sensitivity analysis (leverage analysis) on the technological dimension are that the size of the fishing vessel is susceptible with a value of (10.58), meaning that the size of the vessel used is not suitable for this belat fishing because their function is only as a carrier but because they also have other primary jobs, namely making the ship a means of transporting goods and people around the village, in particular seasons this ship is also used in fishing operations with this belat. The net mesh size in the bag is 0.5 inches, and it does not use a device to remove non-target fish, so this belat catches almost all types of fish, and almost all of the catch is used by fishermen for the reason that it can be sold, while the discard is only around 20%. If we look at the results of the sensitivity analysis (leverage analysis) on the social dimension, namely the education level of fishermen is very sensitive with a value of (9.15). Fishermen are a part of Indonesian society and are synonymous with people living in coastal areas by managing potential fisheries resources[12]. According to Marta & Novrianto[13], fishermen are a group of people who live on the coast and are very dependent on the use of marine and coastal resources for their livelihood. They do not depend on their level of education. The results of the sensitivity analysis (average analysis) obtained the Root Mean Square (RMS) value of each ecological dimension attribute, which shows the level of influence of the attribute on the sustainability index value[14].

Determination of sensitive attributes is carried out based on the order of priority based on the results of the leverage analysis by looking at the change in the shape of the Root Mean Square (RMS). The greater the RMS change value, the more significant the role of this attribute in influencing sustainability status[15].

Monte Carlo Scatter Plot

To evaluate the effects of errors or the influence of errors, the statistical process of the three dimensions was carried out using Monte Carlo analysis, which is a statistical simulation method and the results can be seen in Figures 8, 9 and 10.

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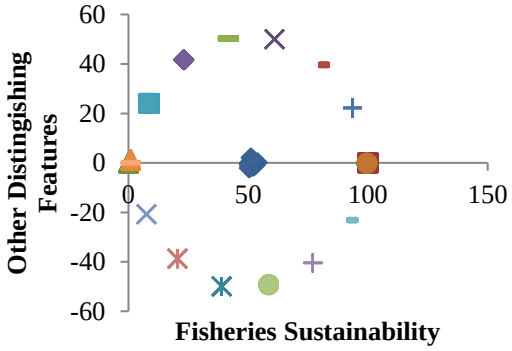

Figure 8. Ecological Dimensions Monte Carlo Scatter Plot

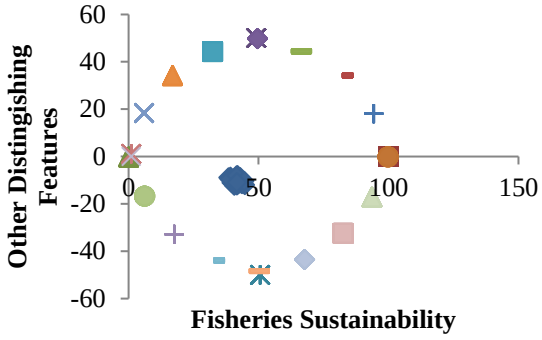

Figure 9. Technological Dimensions Monte Carlo Scatter Plot

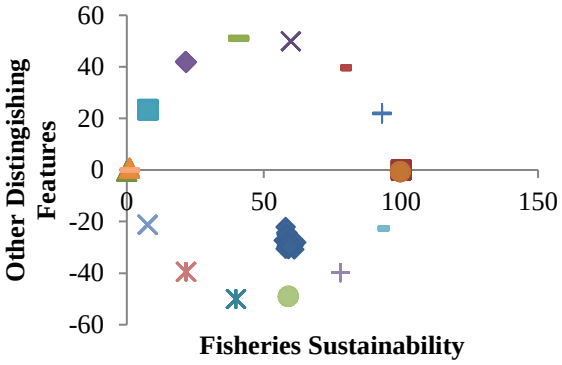

Figure 10. Monte Carlo Scatter Plot Social Dimensions

Errors or disturbances in the ordination results are indicated by points that are spread out or separated from other sets of points in the scatter plot caused by (1) the influence of errors in making attribute scores caused by a lack of information, errors in understanding the attributes or how to make attribute scores; (2) the influence of variations in scoring due to differences in opinions or assessments by different researchers; (3) stability of the repeated MDS analysis process (unstable anchor position); (4) data entry errors or missing data; and (5) the high value of "stress" as a result of analysis[16]. The results of the Monte Carlo analysis show that the points in the scatter plot are in a clustered position; this means that the results of the coordination points that have been used in determining the sustainability status of the Belat fishing gear in Merbau District are pretty stable so that errors or disturbances can be overcome.

Table 5. Stress Value and R^2

No.	Dimensions	Stress value	R^2
1	Ecology	0.14	0.95
2	Technology	0.14	0.94
3	Social	0.14	0.95

The stress value obtained from the dimensions, namely the ecological, technological and social dimensions, is smaller than 0.25. In Multidimensional Scaling (MDS) analysis, a good stress value is less than 0.25[17]. Meanwhile, the R-Square value of the three dimensions shows a value close to 1 or >90%. The closer the R^2 value is to 100%, the more confident the analysis is that all the attributes are related to the dimensions studied. According to Kavanagh[18], a good coefficient of determination (R^2) value is more than 80% or close to 100%.

Multidimensional Sustainability Status

The 3-dimensional combination value of 50.54 means that it is quite sustainable. According to the categorization provided by Thamarin et al.[9]; Nurmalina[19]; Suyitman et al.[20]. From these three dimensions, it can be seen that the technological dimension is less sustainable.

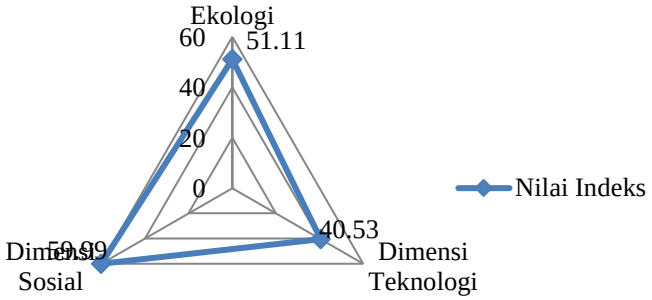

Figure 11. Kite Diagram

4. CONCLUSION

The sensitivity analysis (leverage analysis) results obtained the Root Mean Square (RMS) value of each dimension attribute. The results of the sensitivity analysis (leverage analysis) on the technological dimension are that the size of the fishing vessel is susceptible with a value of (10.58), meaning that the size of the vessel used is not following the needs of this belat fishing because its function is only as a carrier. The results of sensitivity analysis (laverage analysis) on the social dimension, namely the level of education of fishermen, are very sensitive with a value of (9.15) which influences the way fishermen manage potential fisheries resources. The results of the sensitivity analysis (leverage analysis) of the vital attribute of the ecological dimension, namely water use pressure (3.56), are good due to the increasing number of fishing gear being operated and the use of waters for other purposes such as shipping lanes. From the results of the sustainability analysis of the belat fishing gear, it was found that the Ecological dimension and social dimension were sustainable, while the technological dimension was less sustainable.

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