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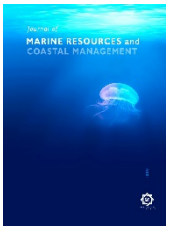

Assessment of sustainability of lobster fisheries in Dampar Beach, Lumajang Regency, East Java, Indonesia

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ABSTRACT

Dampar Beach is one of the area in Lumajang which has abundant fisheries resources and lobster is one of export commodities. Nowadays, increased trade and local market demand led to an increase in lobster sales and will lead to a decrease in lobster stocks. Therefore, a sustainability analysis is needed in managing these fishery resources. This study aims to determine the level of sustainability of lobster fisheries in Dampar Beach, Lumajang in four dimensions, i.e. economic, social, ecological, and technological dimension. The sustainable management strategy of lobster fisheries also determined and discussed. The research method for the analysis of sustainability status uses RAPFISH (Rapid Appraisal for Fisheries Sustainability). This type of research uses a descriptive method with a quantitative approach. The results showed that the sustainability index value of the economic and technology dimension are 39.29% and 48.79%, respectively (less sustainable). The social and ecological dimension are 60.44% and 50.72%, respectively (enough sustainable). The strategies for lobster fisheries at Dampar Beach, Lumajang should focus more on attributes that have high leverage, especially on the social, economy, and ecology dimensions. The utilization of lobster resources in a sustainable manner is basically the goal of management which guarantees the level of resource utilization that does not damage or exceed its recovery capacity, so that it can serving the living needs of present and future generations.

Keywords: lobster, sustainability index, strategy, RAPFISH

INTRODUCTION

Lumajang Regency is one of the regencies in East Java Province which has natural resources in the form of extensive capture fisheries where these assets have the potential to be used ideally and effectively [1]. Lumajang Regency has fishery commodities, one of which is lobster. Lobsters are invertebrate animals from the Arthropoda phylum that live and breed in water [2]. In marine fisheries, it is known that there are two types of shrimp i.e. penaeids and lobsters. Both of these species have a high selling value that makes them have high economic value as well.

Increased trade and local market demand led to an increase in lobster sales. On the other hand, a significant increase in sales will lead to a decrease in lobster stocks, species extinction, as well as an imbalance between the proportions of males and females, as well as other natural perspectives [3]. Catching lobsters, which are suspected to have occurred a lot in several areas, has reduced the number of lobsters [4].

Sustainable fishery is an attempt to combine social, economic and ecological objectives. Appropriate development and promotion of fisheries can also be achieved through appropriate, attractive and effective fisheries management, which is basically characterized by expanding personal satisfaction and human assistance from the government as well as maintaining the management of fish assets and welfare, as well as ecosystems. Sustainable development is the result of the interaction of various dimensions of sustainability. The three important dimensions that are often used as references are economic, social and environmental [6]. Evaluation of fisheries conditions combines four perspectives, i.e. economic, social, technological, and ecological perspectives [7].

Lobster has a high price. This high price resulted in limited production volume. In addition, the demand for lobsters in lobster-supplying countries is still not met, as a result the nominal lobsters are increasing every year. This is a good opportunity that can be utilized by fisher and cultivators, especially lobster shrimp, to build a lobster shrimp development organization [8].

Currently, existing regulations have been reviewed, such as the rules that have been set regarding the prohibition of catching lobsters under 8 cm in size. Therefore, an analysis of good and sustainable management is needed in accordance with the rules for lobsters catching. This study aims to assess the lobsters fisheries in a sustainable manner in Lumajang Regency.

METHODS

Study Site

This research was conducted in Dampar Beach, Pasirian District, Bades Village, Lumajang Regency. This research was carried out during December 2020 to December 2021. The map of the research location is shown in Figure-1.

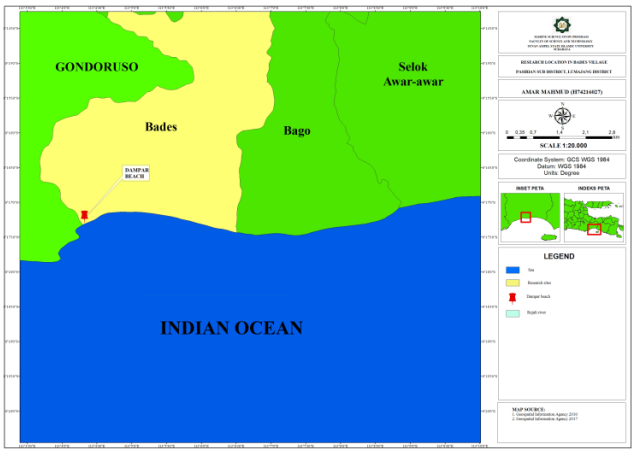

Figure-1. Map of the research location

Data Collection

The data collected during this study consisted of four categories, i.e. economic, social, ecological and technological data. The type of data collected is in the form of primary and secondary data. Primary data collection was carried out using the method of observation and direct measurement in the field, i.e. structured interviews and questionnaire. Quantitative questionnaire answer items are shown in Table-1. Secondary data collection was carried out through a literature study by collecting all information related to the research objectives, both from journals, books, and from various research-related institutions.

Table-1. Quantitative quesionnaire answer items

No	Description	Score
1	Agree / always / very positive	3
2	Agree / often / positive	2
3	Disagree / almost never / negative	1
4	Strongly disagree / never	0

The primary data collection focused on the sustainability aspects of lobster capture fisheries in Dampar Beach, Lumajang which include: (1) Economic dimension: the average income of fisher, other income outside the fishing effort, restrictions on fishing efforts, and the number of subsidies; (2) Social dimension: conflict status, education level, environmental knowledge, and the fishery socialization; (3) Ecological dimensions: type and size of lobster caught, fisheries waste, and fishing grounds; and (4) Technological dimensions: side effects of fishing gear, vessel size, fishing aids, selectivity of fishing gear, length of time at sea, and the ability to increase vessel capacity.

This type of research is social descriptive. Descriptive technique is a strategy used to describe a research result but has not been used for a broader purpose [9]. The number of respondents was determined using a purposive sampling technique. Samples for complete populations with generally similar qualities and are seen as a description of the population [10]. The number of samples determined by Slovin's formula [11] as shown in Equation (1).

The sample of this research is fisher in Dampar Beach. There are 78 active fisher who are members of the four Dampar Village Joint Fisheries Business Groups (Kelompok Usaha Bersama Nelayan/KUBN), these groups are: Samudera Abadi, Mina Samudera, Laut Biru, and Langgeng Samudera. The number of respondents in this research was calculated using Equation (1).

$$n = \frac{N}{1+N(e)^2} \quad (1)$$

where n is number of samples, N is total of population, e is margin of error (5%).

Data Analysis

To assess the sustainability of the lobster fisheries in Dampar Beach Lumajang, an analysis of four dimensions was carried out which included: (1) economy; (2) social; (3) ecology; and (4) technology using the RAPFISH method. RAPFISH (Rapid Appraisal for Fisheries) is an analytical method for evaluating the sustainability of fisheries in a multidisciplinary manner based on ordination techniques with Multi-Dimensional Scaling (MDS). MDS is a statistical technique that tries to change multidimensionality into lower dimensions [12]. Each dimension has attributes related to sustainability with the assessment criteria as presented in Table-2. The index value of sustainability is equal in four categories where the estimated numerical value for each dimension is expressed on a scale of *bad* (0) to the *good* (3). The index value of sustainability then used to determine the sustainability status of lobster fisheries management (Table-3).

RESULTS AND DISCUSSIONS

Characteristics of Respondents

This study involved 65 respondents of lobster fisher of varying ages. The ages greatly affected fishery productivity. The number of respondents by age is shown in Table-4. Education level can be used as a benchmark to measure a person's knowledge, including knowledge related to environment. The educational level also related to the social dimension. The number of respondents based on education presented in Table-5.

Experience as a fisher is a factor that greatly influences a fisher's ability to prepare and manage his catch, for example how to increase the number of catches, knowing the direction of the wind and the right time to go to sea so that the catch is abundant. The duration of fisher's work (Table-6) shows that fishing is one of the most promising livelihoods for the community so that the longer the fisher's working duration, the lobster catching business can also meet their daily needs.

In addition, fisher's side income needs to be known. This is related to increasing the welfare of his family with other/side jobs, apart from catching fish in the sea, such as: processing/selling fish, farming/gardening, ponds cultivator, livestock farming, trading in non-fish commodities, and others. The number of respondents based on side jobs presented in Table-7.

Table-2. Attributes of each dimension

Atribute	Indicator	Good	Bad
Economy Dimension			
Average income of fisher	(0) ≤ Rp. 1,000,000; (1) Rp. 1,000,000 – Rp. 2,000,000; (2) Rp. 2,000.000 - Rp3,000,000; (3) > Rp. 3,000,000	3	0
Other income outside of fishing	(0) None; (1) Part time job; (2) Seasonal job; (3) Full time job	3	0
Restriction of fishing	(0) No limitation; (1) A little limitations; (2) Some limitations; (3) So many limitations	3	0
The amount of subsidies	(0) None; (1) A little; (2) Many; (3) A huge amount	3	0
Lobster market	(0) Local market; (1) National market; (2) International market	3	0
Labor absorption	(0) None; (1) Low; (2) Moderate; (3) High	3	0
Social Dimension			
Conflict status	(0) Very often; (1) Often; (2) A little; (3) None	3	0
Level of education	(0) Did not finish elementary scool; (1) Elementary scool; (2) Junior high scool; 3) Senior high scool	3	0
Environmental knowledge	(0) Low; (1) Enough; (2) High;(3) Very high	3	0
Fishing socialization	(0) None; (1) Rarely; (2) Often; (3) Very often	3	0
Income from fishing	(0) A huge amount; 1) A lot; 2) Some/balanced; 3) None	3	0
The role of the fishery sector	(0) None; (1) Some; (2) A lot; (3) Very much	3	0
Ecology Dimension			
Odor of water	(0) Stinks; (1) Unpleasant odor; (2) Rather unpleasant odor; (3) Odorless	3	0
Rubbish	(0) None; (1) Some; (2) A lot; (3) Very much	3	0
By-catch and discard	(0) A huge amount; 1) A lot; 2) Some/balanced; (3) None	3	0
The size of the lobster caught	(0) Smaller; (1) Slightly smaller; (2) Unchanged; 3) Bigger	3	0
Range of fishing grounds	(0) < 4 miles; (1) 4 miles; (2) ≤ 12 miles; (3) ≥ 12 miles	3	0
Types of lobster caught	(0) None; (1) Some; (2) A lot; (3) Very much	3	0
Technology Dimension			
Fishing gear side effects	(0) A huge effects; (1) A lot; (2) Some; (3) None	3	0
Ship size	(0) < 5 m; (1) 5-10 m; (2) 10-15 m; (3) 15-20 m	3	0
Fishing aids	(0) None; (1) Some; (2) A lot; (3) Very much	3	0
Fishing gear selectivity	(0) Less selective; (1) Rather selective; (2) Selective; (3) Very selective	3	0
Time at sea	(0) 2-6 hours; (1) 6-10 hours; (2) 10-15 hours; (3) 15-20 hours	3	0
Ability to increase ship capacity	(0) Very small, (1) Small; (2) Big; (3) Very big	3	0

Table-3. Sustainability index categories

No	Index Value	Category
1	0 - 25	Bad/Not Sustainable
2	>25 - 50	Less Sustainable
3	>50 - 75	Enough Sustainable
4	>75 - 100	Good/Very Sustainable

Table-4. Characteristics of respondents by age

No	Age (Years)	Number of Respondents	%
1	21-30	5	7,69
2	31-40	22	33,85
3	41-50	26	40,00
4	51-60	8	12,31
5	>61	4	6,15
Total		65	100

Sustainability of Lobster Fisheries

Economic Dimension

Based on the RAPFISH analysis which was strengthened by the MONTE CARLO analysis, the value of the sustainability status of the lobster fisheries in the economic dimension was 39.20 (Figures-2 and 3). This result shows that the economic dimension of lobster fisheries sustainability status is in the less sustainable category (score between >25-50). Furthermore, based on the results of LEVERAGE analysis on the economic dimension, there are two attributes that have high leverage, i.e. the amount of subsidies of 5.82 and the average income of fisher of 3.09 (Figure-4).

The sustainability status of the lobsters fisheries in the Dampar Beach, Lumajang, requires government subsidy program, both related to fuel subsidies and the provision of low-interest capital. Therefore, from an economic dimension, to improve the sustainability status of the lobster fisheries, a policy to improve the trading system that is more pro-fisher is needed.

Table-5. Characteristics of respondents based on education

No	Education	Number of Respondents	%
1	Not completed in primary school	12	18,46
2	Primary school	42	64,62
3	Junior high school	9	13,85
4	Senior high school	2	3,08
Total		65	100

Table-6. Characteristics of respondents based on experience as a fisher

No	Experience (Years)	Number of Respondents	%
1	5-14	30	46,15
2	15-24	26	40,00
3	25-34	7	10,77
4	>34	2	3,08
Total		65	100

Table-7. Characteristics of respondents based on side jobs

No	Job	Number of Respondents	%
1	Fisher	5	7,69
2	Gardener	27	41,54
3	Farmer	18	27,69
4	Other	15	23,08
Total		65	100

The provision of subsidies in the fisheries sector needs to be considered because in the short term it can increase the production rate of lobster catches. However, in the long term, the subsidy can cause a decrease in the production of lobster catches due to overfishing. Therefore, the government must be more careful in providing assistance funds that are empowering to fishing communities. The subsidy program that is suitable to be applied to fishing communities is the development of the fleet, as well as the modernization of fishing gear that remains environmentally friendly.

In addition, the average income of fisher is greatly influenced by many things, such as the climate and the type of lobster caught. Increasing the average income of fisher can be done by training fisher and fisher's wives to get additional income, providing business capital to individuals and groups so that it can be used to increase income.

Social Dimension

The RAPFISH analysis which is strengthened by the MONTE CARLO analysis on the social dimension shows the value of the sustainability status of the lobster fisheries at 60.44% (Figures 5 and 6), i.e. in the enough sustainable category.

Conflicts between fisher in the Dampar Beach area are very rare. These conditions make a good contribution to the status of lobster fisheries sustainability. Efforts to strengthen or establish good communication, such as *gotong royong* or mutual cooperation, still need to be carried out between existing fisher groups.

Furthermore, the results of the LEVERAGE analysis on the social dimension show that there are 2 attributes that have high leverage, i.e. the educational level of 13.74 and fisher's knowledge of the environment at 12.46 (Figure 7). This shows that in order to improve the sustainability status of the social dimension, future policy formulation efforts need to pay attention to and consider these two attributes.

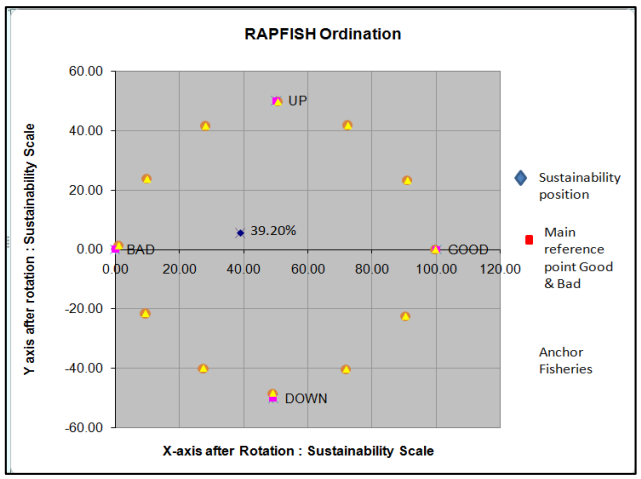

Figure-2. The sustainability status of the economic dimension of the lobster fisheries in the Dampar Beach area by RAPFISH analysis

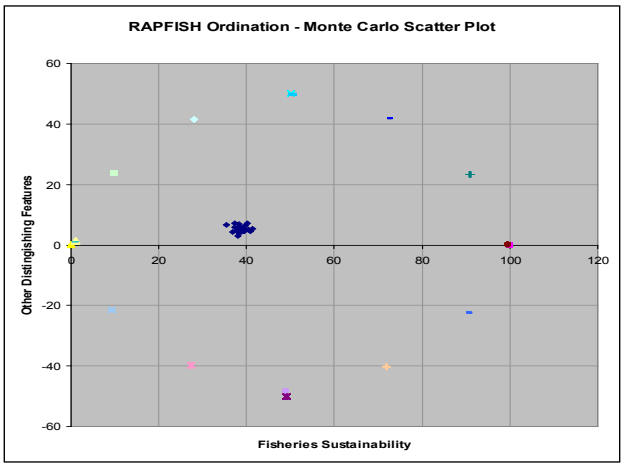

Figure-3. The sustainability status of the economic dimension of the lobster fisheries in the Dampar Beach area by MONTE CARLO analysis.

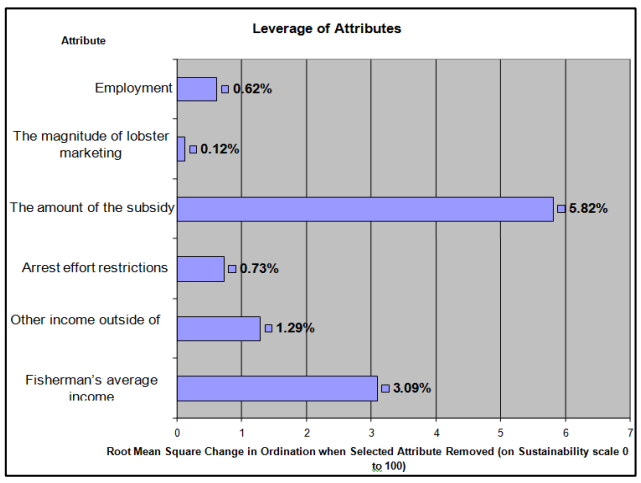

Figure-4. The results of LEVERAGE analysis on the economic dimension of the lobster fisheries in the Dampar Beach area

Formal education for fisher is especially needed related to the presence of new technology in fishing activities. The government can provide low-cost fisheries vocational schools or educational assistance in the form of scholarships for fisher's families. In addition, fisher's knowledge about the environment must always be improved. Increasing fisher's knowledge about the environment can be done by conducting outreach and workshops about the environment.

Ecological Dimension

The value of the sustainability status of the lobster fisheries on the ecological dimension was 50.72 based on the RAPFISH analysis which was strengthened by the MONTE CARLO analysis (Figures-8 and 9). This indicates that the sustainability status of the ecological dimension of lobster fisheries is in the enough sustainable category.

Based on the results of LEVERAGE analysis on the ecological dimension, there are two attributes that have high leverage, i.e. the odor of the waters of 4.62 and fishing area of 3.17 (Figure-10). The odor of water can be a sign of water pollution. The local government can carry out periodic monitoring so that the condition of the waters is maintained. In addition, the government can work together with the community regarding cleanliness in both coastal and marine areas.

Lobster fishing areas in the Dampar Beach area in the last 5-10 years have not experienced significant changes and tend to be the same, i.e. within a range of 0-4 miles from the coastline. Catching lobsters in the Dampar Beach area by small-scale fisher is one day fishing, meaning the catch time is only around 6-10 hours.

Setting fishing areas can be done by determining fishing zoning. Determination of fishing zoning can avoid resource extinction and ensure sustainability in its use. Zoning can be done by compiling a map of permitted fishing areas or prohibited fishing areas.

Technological Dimension

Figures-11 shows the results of the RAPFISH analysis on the technological dimension which was strengthened by the MONTE CARLO analysis (Figure-12). The value of the sustainability status of the lobster fisheries on the technological dimension was 48.79. This shows that the sustainability status of the technological dimension lobster fisheries is in the less sustainable category. Figure-13 shows the results of LEVERAGE analysis on the technology dimension. There are two attributes that have high leverage, i.e. high tool selectivity of 2.20 and fishing aids of 1.84.

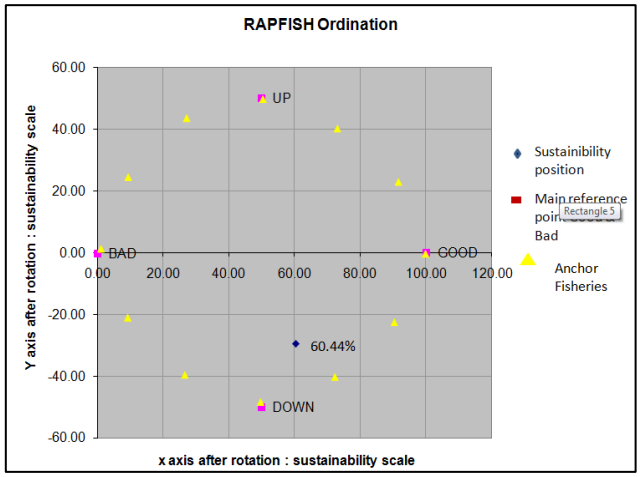

Figure-5. The sustainability status of the social dimension of lobster fisheries in the Dampar Beach area by RAPFISH analysis

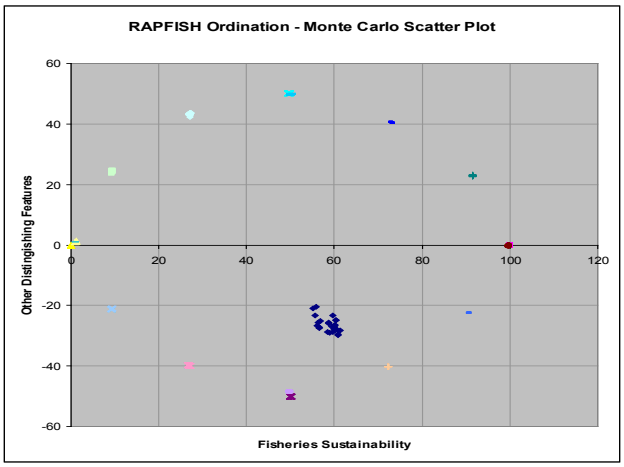

Figure-6. The sustainability status of the social dimension of lobster fisheries in the Dampar Beach area by MONTE CARLO analysis

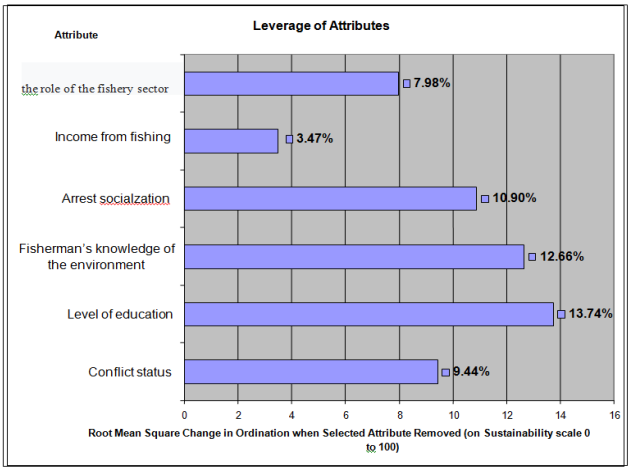

Figure-7. The results of LEVERAGE analysis on the social dimension of the lobster fisheries in the Dampar Beach area

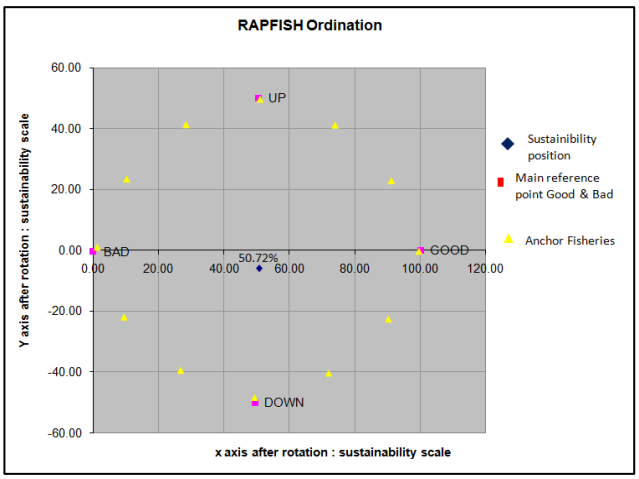

Figure-8. The sustainability status of the ecological dimension of the lobster fisheries in the Dampar Beach area by RAPFISH analysis

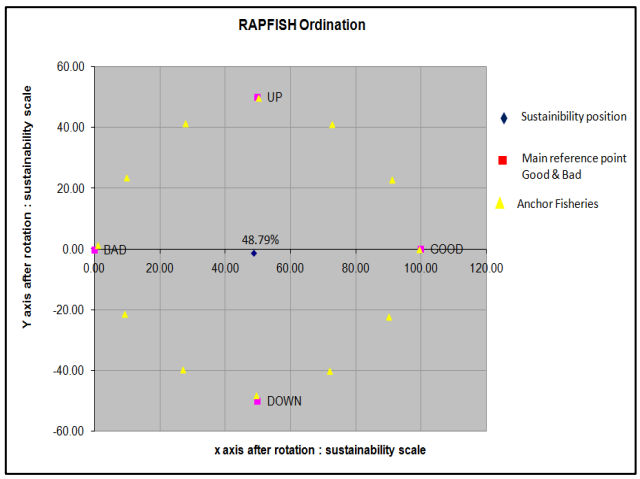

Figure-11. The sustainability status of lobster fisheries of the technology dimension in the Dampar Beach area with RAPFISH analysis

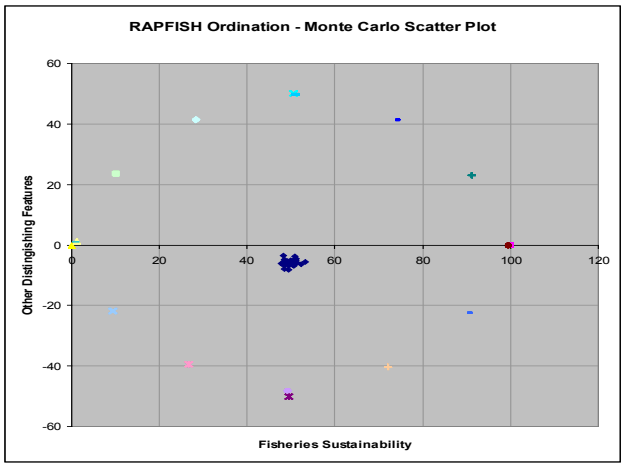

Figure-9. The sustainability status of the ecological dimension of the lobster fisheries in the Dampar Beach area by MONTE CARLO analysis.

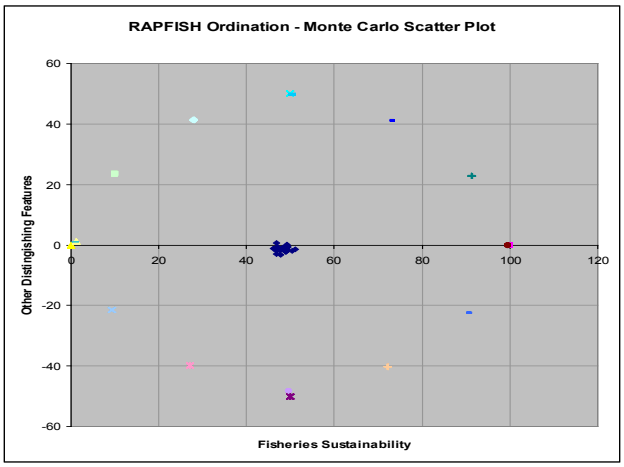

Figure-12. The sustainability status of lobster fisheries of the technology dimension in the Dampar Beach area with MONTE CARLO analysis

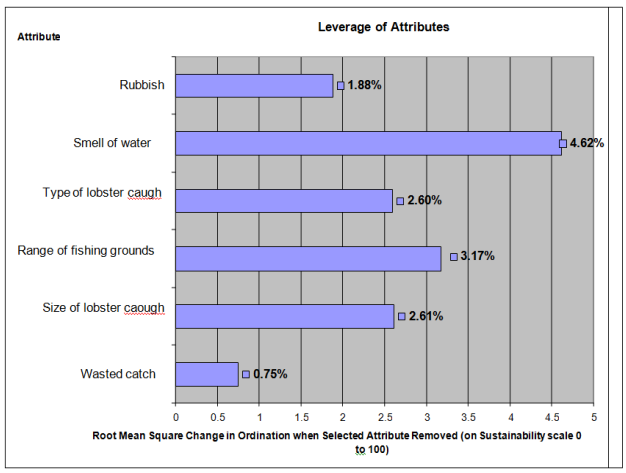

Figure-10. The results of LEVERAGE analysis on the ecological dimension of the lobster fisheries in the Dampar Beach area

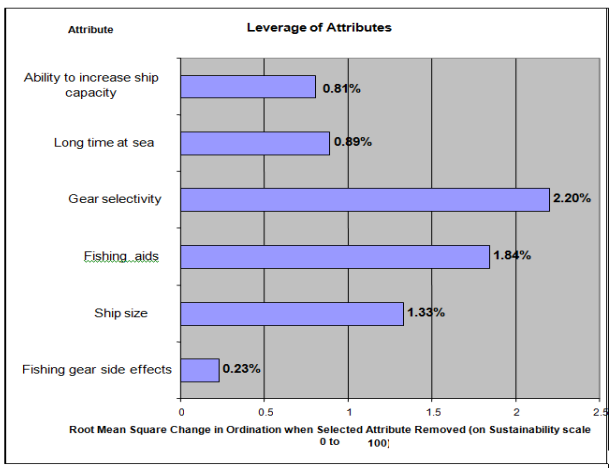

Figure-13. The results of LEVERAGE analysis on the technology dimension of the lobster fisheries in the Dampar Beach area

The fishing gear used to catch lobsters in the Dampar coastal area is less selective because when catching lobsters, fish of various sizes and types are also caught. On the other hand, fishing aids are no longer permitted to be used. Socialization through posters or other media needs to be done so that fisher can find out information related to the prohibition of using fishing aids. The two main attributes of this technological dimension, i.e. selectivity of fishing gear and fishing aid, make a contribution to the status of sustainability and need to be considered.

Kite Charts

The sustainability status values from the RAPFISH analysis from each dimension are then positioned into a kite charts, as presented in Figure-14. Based on Figure-14, it can be seen that the kite chart consists of four dimensions, i.e. the economic, social, ecological, and technological dimensions of the lobster fisheries on the Dampar Beach, Lumajang Regency, which is dominated by the social dimension of 60.44.

The next step is to determine the feasibility of the results of the study. Table-8 shows the value of "stress" (a measure of discrepancy) and the coefficient of determination (R^2). This value serves to determine whether or not additional attributes are needed to accurately reflect the dimensions studied (close to actual conditions). Each dimension has a "stress" value below 0.25. The value of "stress" below 0.25 indicates that the results obtained are good. It is also known that the coefficient of determination (R^2) is close to 1 (Table-8) which shows good analysis results [13].

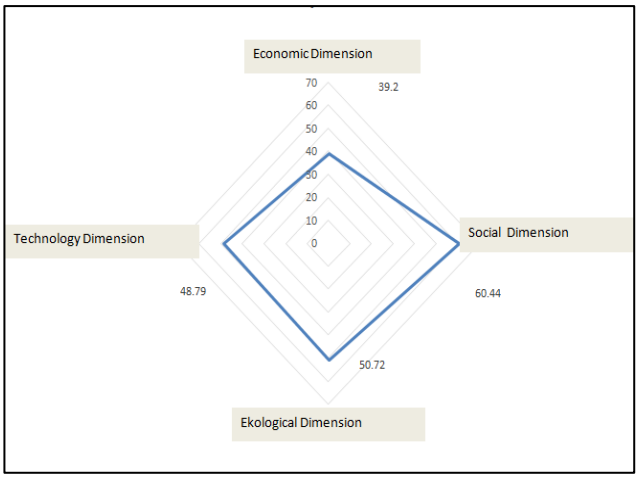

Figure-14. Kite chart of lobster sustainability index value in the Dampar Beach area

Table-8. Results of RAPFISH analysis of stress values and coefficient of determination (R^2)

Statistical Value	Economy	Social	Ecology	Technology
Stress	0.16	0.14	0.16	0.17
R^2	0.94	0.94	0.94	0.93

The sustainability status of the lobster fisheries in Dampar Beach Lumajang Regency are then grouped into the leveraging factors of each dimension used (Table-9). The leveraging factors from the analysis of the RAPFISH method are problems that can affect the sustainability status of the lobster fishery. Therefore, the factors that become leverage will be used as references or priorities in formulating existing policies.

Table-9. Leveraging factors of RAPFISH analysis results

No	Dimension	Leverage Factor	Value
1	Social	Level of education	13.74
2	Social	Fisher's knowledge of the environment	12.46
3	Economy	The amount of the subsidy	5.82
4	Ecology	Odor of water	4.62
5	Ecology	Fishing grounds	3.17
6	Economy	The average income of fisher	3.09
7	Technology	Selectivity of fishing gear	2.20
8	Technology	Fishing aids	1.84

The formulation of the sustainability index is then expected to be able to solve existing problems, especially in the lobster fisheries sector in the economic, social, ecological, and technological fields in order to create a sustainable development of lobster fisheries on the Dampar Beach, Lumajang. The following table presents the leveraging factors for each dimension.

CONCLUSIONS

The value of the sustainability index of the economic and technology dimension of lobster fisheries in the Dampar Beach, Lumajang Regency, East Java are 39.20% and 48.79%, respectively (less sustainable status). Then, the value of the sustainability index of the social and ecology dimension of lobster fisheries in the Dampar Beach are 60.44% and 50.72%, respectively, so it has a enough sustainable status.

The policy for lobster fisheries at Dampar Beach should focus more on attributes that have high leverage, especially on the social, economy, and ecology dimensions without neglecting other attributes. To further improve the sustainability status of lobster fisheries at Dampar Beach, the priority efforts that need to be implemented include: (1) improving the knowledge, skills and attitudes of the fisher and local community through outreach and training activities, (2) increasing public awareness and participation in terms of sustainable management of lobster resources, (3) the number of subsidies can be carried out by developing a fleet, as well as modernizing fishing gear that remains environmentally friendly, (4) training fisher and fisher's wives to obtain additional income, (5) providing business capital to individuals and groups so that they can be used to increase income, (6) water pollution monitoring regularly and beach clean-up.

In addition, so that the management of lobster commodities in Dampar Beach, Lumajang Regency, can be carried out in a sustainable manner, it is suggested for further research to add other dimensions such as ethical dimensions. The utilization of lobster resources in a sustainable manner is basically the goal of management which guarantees the level of resource utilization that does not damage or exceed its recovery capacity, so that it can serving the living needs of present and future generations.

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