Sustainability analysis of pelagic fisheries using purse seine at Ujong Serangga Fishing Port, Aceh, Indonesia

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Abstract. Analysis of the sustainability of pelagic fisheries using purse seine at the Ujong Serangga fishing port is an analysis to determine the level of fisheries sustainability by maintaining a balance between the level of exploitation and the level of utilization of fish resources. The purpose of this study was to determine the sustainability of pelagic fisheries and the most influential factors on the sustainability of pelagic fisheries. This study applied descriptive method with a survey technique. The analysis used is RAPFISH (Rapid Appraisal for Fisheries). The results of the RAPFISH analysis show that the ecological dimension is at a moderate level of sustainability, the economic dimension is at a less sustainable level, the social dimension is at a sustainable level, while the technological dimension is at a moderately sustainable level. Fishing catch that affect the sustainability of pelagic fisheries with purse seine are the ecological dimension by catch. The economic dimension, assistance from the government with a score of 18.27 and attributes of working capital sources. The social dimension, fisherman's education and the technological dimension, pre-sale management.

1. Introduction
Capture fisheries in Indonesia have a major role in world capture fisheries production. This is stated in FAO (2018), which states that Indonesia contributed 7.19\% (6.54 million tons) to the world's catch products in 2016. Current fisheries production has doubled since the 1960s to 179 million tonnes in 2018. Globally, the capture fisheries and aquaculture sectors have contributed significantly to food security and nutrition which can be seen from Indonesia's national fishery production in the fourth quarter [1, 2]. Fish resources in the fisheries management area are quite abundant and are one of the
natural resources that are the basic capital for Indonesia's future development and future economic growth. One area that has abundant fish resources, is southwest Aceh District waters.

Aceh is an area surrounded by oceans and rich in biological resources that have the potential to be developed. The total length of Aceh's coastline reaches 2,310 km and has a sea area of 295,370 km². Southwest Aceh District is located between 03°34'24"–04°05'37" North Latitude and 96°34'57"–97°09'19" East Longitude with an area of 1,882.05 km² [3]. Southwest Aceh can be developed as an integrated fishery because it has the potential of diverse fish resources. Southwest Aceh has 5 fishing ports and one of them is the Ujung Serangga Insect fishing port [4].

The Ujung Serangga fishing port is one of the fishing ports located in the West-South Aceh fisheries management area, namely in the Fisheries Management Area 572. According to the Central Statistics Agency (2020) the total fishery production at the Ujong Serangga fishing port in 2019 amounted to 6,486 tons of which consisting of capture fisheries 6,161 tons and aquaculture 315,000 tons, with a total fisherman of 2,287, fishery production at the Ujong Serangga fishing port is increasing from year to year. Based on the results of the study, information was obtained that the most catches landed at the Ujong Serangga fishing port were pelagic fish using purse seine. The purse seine is a very effective fishing tool for catching pelagic fish [5].

The continuous use of fish resources results in excessive fishing resulting in depletion of fish resources [6, 7]. For this reason, good governance is needed as a requirement for sustainable natural resource management [8, 9]. Fishery sustainability can be seen from several dimensions, namely the ecological, economic, social and technological dimensions [10]. Therefore, research on the sustainability of pelagic fisheries is important to explain and at the same time find solutions in maintaining the sustainability of pelagic fisheries against purse seines. This study aims to determine the sustainability of pelagic fisheries with purse seine based on ecological, economic, social and technological dimensions.

2. Material and Methods

2.1 Time and Research Location
This research was conducted in February 2021 at the fishing port of Ujong Serangga fishing port, Southwest Aceh District. The complete research location is presented in Figure 1 below:

![Figure 1. Research location.](image)

2.2 Method of Collecting Data
The method used in this research is descriptive quantitative method with survey and interview techniques. The data used in this study consisted of primary and secondary data. The number of purse seine sampled in this study was 13 units of the 26 available purse seine units [11]. Determination of respondents is done by using purposive sampling method. Purposive sampling is sampling based on the
considerations of the researcher in accordance with the objectives of the researcher so that it is expected to be able to answer research problems [12].

2.3 Data Analysis

The analysis used in this study is the RAPFISH (Rapid Appraisal for Fisheries) analysis, which is a fishery rapid assessment analysis. Dimensions used in rapfish analysis include; ecology, economy, social and technology [13, 14, 15, 16]. In this study, most of the attributes and indicators discussed to define pelagic fisheries at the Ujong Serangga fishing port are indicators that reflect the current condition of pelagic fisheries in that location. Rapfish analysis includes Rapfish analysis, leverage analysis, and Monte-Carlo analysis. Kite diagrams are used to describe the sustainability status in a multi-dimensional way, namely by comparing the performance of each dimension. Subsequently, the index and its sustainability status were compiled (Table 1). The attributes of each dimension as well as good and bad criteria refer to the concepts, as well as opinions from experts and stakeholders related to the system being studied [17].

| No | Index Value | Rating | Sustainability Category |
|----|-------------|--------|-------------------------|
| 1. | 0-25        | Poor   | Not Sustainable         |
| 2. | 25-50       | Less   | Less Sustainable        |
| 3. | 50-75       | Enough | Fairly sustainablep     |
| 4. | 75-100      | Good   | Highly sustainable      |

3. Result and Discussion

The results of each attribute research using a measurable scale and consistent criteria [15]. Based on data collected from field identification and interview of respondents.

3.1. Ecological dimension

Analysis of the sustainability of pelagic fisheries captured with purse seine in Ujong Serangga fishing port on the ecological dimension, based on 7 attributes. The seven attributes are based on the code of conduct for responsible fisheries and adapted to the needs of research sites to support precautionary approach. The seven attributes in question are includes selectivity of fishing gear, not damaging habitats by-catch, impact on diversity, not endangering protected fish, leaving ghost fishing and changing the type of fish caught.

The purpose of ordination analysis to determine the relative position of each fishery activity against ordination that is in the good range with a value of 100, and bad (bad) with a value of zero. Furthermore, the ecological dimension value is plotted in the ordination image (Figure 4). The stress value in this dimension is 13.49% with $R^2$ at 94.45%. If the coefficient of determination $>80\%$ or close to 100%, then it can be concluded to have high accuracy and if the value of stress $<0.25$ or $<25\%$. Stress value is interpreted as a measure to see the accuracy of the results obtained whether it is close to the original data (goodness of fit). The analysis, which was intended to see the level of stability of the ordination analysis results, was conducted with Monte-Carlo simulations. This Monte-Carlo simulation is intended to look at the degree of perturbation interference to the value of ordination. Monte-Carlo's simulation results for the ecological dimension in this study can be seen in scatter-plot form in Figure 4.
Leverage analysis of all attributes used in the ecological dimension, showing the highest value of 12.40 for the by catch attribute and the lowest value of 0.31 for the ghost fishing abandon attribute, etc. This analysis is meant to be to determined the sensitivity from decreasing attributes towards sustainability score. The results of leverage analysis for the whole attributes on ecological dimension, shown on figure 5.

3.2. Economical dimension

Economical dimension reflects the management practice that influence the economical sustainability from fishermen’s fisheries activities. Economical dimension analysis based on 7 attributes. It’s based on the profil level (financial analysis and feasibility) such as: the catch has a good market value, the quality of the fish caught, the capital source, government assistance, efforts to support the capture, profit and marketing of catches. If the economic dimension value is plotted in the ordination image, it looks like Figure 6. The stress value in this dimension is 14.46% with $R^2$ at 93.29%, this indicates having a high accuracy close to the original data (goodness of fit). The analysis, which was intended to see the level of stability of the ordination analysis results, was conducted with Monte-Carlo simulations. This Monte-Carlo simulation is intended to look at the degree of perturbation interference to the value of ordination. Monte-Carlo simulation results for the economic dimension in this study can be seen in scatter-plot form in Figure 7.
Leverage analysis of all attributes or indicators is used in the economic dimension, shows that the highest value is 18.27 for the government assistance attribute and 11.15 for the lowest value is 1.67 for the marketing attribute of the catch. Leverage analysis results for all attributes in the economic dimension, presented in Figure 8.

3.3. Social dimension

The social dimension reflects how fisheries management impacts the sustainability of a particular fishery community. Social analysis is based on 9 attributes. It is consist of: legally the tool is legal, the participation of the fishing family, the experience of fishermen, the working status of fishermen, the level of education of fishermen, conflict, the environment of fishing catch and the acceptance of fishermen to the fishing trawler ring. When the value of the social dimension is plotted in the ordination image, it looks like figure 9. The stress value in this dimension is 13.33% with R² at 95.22%, this indicates having a high accuracy close to the original data (goodness of fit). The analysis, which was
intended to see the level of stability of the ordination analysis results, was conducted with Monte Carlo simulations. This Monte Carlo simulation is intended to look at the degree of perturbation interference to the value of ordination. Monte Carlo simulation results for the social dimension in the scatter plot at figure 10.

![RAPFISH Ordination](image)

**Figure 8.** Results of ordination point analysis for social dimension.

![RAPFISH Ordination - Monte Carlo Scatter Plot](image)

**Figure 9.** Results of Monte-Carlo analysis of social dimension.

Leverage analysis of all attributes used in the social dimension, showed the highest value of 7.28 for the attribute of the fisher’s education level and the lowest value of 0.08 for the attribute of the acceptance of fishermen to the purse seine. The results of leverage analysis for all attributes in the social dimension can be seen in figure 11.

![Leverage to attributes](image)

**Figure 10.** Analysis of social dimensions and sensitive factors that affect social sustainability.

### 3.4. Technological Dimension

The dimensions of fishing technology reflect the reliability and appropriateness of fishing technology. Technology dimension analysis is based on 8 attributes. The eight attributes are made such as: gt size of the ship, length of trip, use of compass, handling on board, use of fishfender, pre-sale management, fish landing site and length of nets. Furthermore, the results of ordination analysis using the score of each attribute on the technology dimension of fishery activities at the research site. If the dimension value of the technology at that is plotted in the ordination image, it looks like Figure 12. The stress value in this dimension is 13.32% with $R^2$ of 95.05%, this indicates having a high accuracy close to the original data (goodness of fit). The analysis, which was intended to see the level of stability of the ordination analysis results, was conducted with Monte-Carlo simulations. This Monte-Carlo simulation is intended to look
at the degree of perturbation interference to the value of ordination. Monte-Carlo simulation results for the technological dimensions in this study can be seen in scatter-plot form in Figure 13.

Leverage analysis of all attributes used in the technology dimension, showing the highest value of 9.62 for pre-sale management attributes and the lowest value of 2.76 for compass usage attributes in capture operations. Leverage analysis results for all attributes in the technology dimension are presented in Figure 14.

3.5. Sustainability Index in Kite Diagram

There are four dimensions analyzed by the Rapfish method from these four dimensions, the highest is the social dimension of 77.43; then the technological dimension 57.02, the ecological dimension 68.33, the last is the economic dimension 48.86.

Based on the results of the analysis of ecological dimensions of the ecological dimensions of pelagic fishery activities sustainability conditions with purse seine in Ujong Serangga fishing port is at a fairly sustainable level with a score of 68.33. However, this is different from which are less sustainable due to over fishing and fishing in coral reef areas resulting in habitat destruction and decreased fish resources [18, 19]. Based on the results of leverage analysis, it is known that 1 out of 7 attributes used in the ecological dimension, has given a very dominant influence on the sustainability of pelagic fisheries in Ujong Serangga Fishing port. The attribute is a by-catch with a score (12.40). According to the research of purse seine is an environmentally friendly fishing gear but in terms of by-catch this fishing gear has
a low value [20]. This indicates that the by-catch attribute is a positive attribute in pelagic fishing gear. In 1995 the FAO distributed provisions as an international instrument in realizing sustainable fisheries development known as the code of conduct for responsible fisheries used as a based on the results of leverage analysis, it is known that 1 out of 7 attributes used in the ecological dimension, has given a very dominant influence on the sustainability of pelagic fisheries in Ujong Serangga. The attribute is a by-catch with a score (12.40). According to the research of purse seine is an environmentally friendly fishing gear but in terms of by-catch this fishing gear has a low value. This indicates that the by-catch attribute is a positive attribute in pelagic fishing gear. In 1995 the FAO distributed provisions as an international instrument in realizing sustainable fisheries development known as the code of conduct for responsible fisheries used as a guideline fishery activity responsibly which in this guideline states that the fewer catches by-catch the catch, the more selective the catch.

The results of the ordination analysis of economic dimensions were obtained that the economic dimension was at a less sustainable level with a score of 48.86. This is similar to which is at a less sustainable level [21, 22]. Based on the results of leverage analysis, it is known that 2 out of 7 attributes used in the economic dimension, has given a very dominant influence on the sustainability of pelagic fisheries in Ujong Serangga fishing port. The two attributes in question are the attributes of assistance from the government with a score of 18.27 (still expecting assistance from the government) and the attributes of working capital sources that are with a score of 15.82 (working capital obtained from arrest businesses such as benches). Here it can be known that fishermen in Ujong Serangga fishing port still lack capital resources and still expect assistance from the government in supporting catching activities. This suggests that economically pelagic fishery activities in Ujong Serangga fishing port are still less sustainable [23]. Efforts that can be made to overcome the fishermen's economic problems in order to achieve sustainable fisheries are to focus attention on efforts to increase prosperity as much as possible within the limits of capital availability and technological capabilities. According to fishermen's cooperatives are also one solution, as one of the local economic institutional systems of coastal communities, which can serve as a joint forum in supporting the business development of fishermen [24]. Credit and insurance are steps that need to be taken to produce better results for the local fish trading and processing sector [25, 26].

The results of the ordination analysis of social dimensions were obtained that the social dimension is at a sustainable level with a score of 77.43. This is similar to the research; whose sustainability status is at a sustainable level [27]. But unlike, whose sustainability status is at a fairly sustainable level, where this is influenced by frequent social conflicts between fishermen and low understanding of the selectivity of fishing gear used to affect sustainability in the social dimension [28, 18]. Based on the results of leverage analysis, it is known that 1 of the 9 attributes used in the economic dimension, has given a very dominant influence on the sustainability of small pelagic fisheries in Ujong Serangga.
fishing port. The attribute in question is the attribute of fishermen's education with a score of 7.28, this is because fishermen in Ujong Serangga fishing port are educated in junior high and elementary school so that the adoption of fishermen to the sustainability of technology is still lacking. Residents of coastal communities who mostly work as traditional fishermen, generally have the same characteristics that are less educated according to research conducted from 50 traditional fishermen studied most of the traditional fishermen are only elementary school educated as much as (55%), even as many as 35% of respondents claimed to be completely unfamiliar with school [24].

The results of the analysis of ordination of technology dimensions are at a fairly sustainable level with a score of 57.02 whose sustainability status is at a fairly sustainable level. This is similar to research [29, 18]. A score of 47.26 which is at a less sustainable status caused by the use of destructive and non-selective fishing gear However [19]. Based on the results of leverage analysis, it is known that 1 of the 8 attributes used in the technology dimension has had a very dominant influence on the sustainability of pelagic fisheries in Ujong Serangga fishing port. The attribute in question is the attribute of pre-sale management with a score of 11.76, where the landed fish is still intact and there is no special handling of the catch of the purse seine such as the disposal of stomach contents and gills in the fish [30]. Handling fish on board the ship plays an important role to minimize the occurrence of physical damage to fish such as the release of stomach contents and gills in fish to minimize the occurrence of decay in fish.

4. Conclusion
Sustainability of pelagic fisheries with purse seine in Ujong Serangga fishing port on the ecological dimension is at a sufficient level of sustainability with a score of 68.33, the economic dimension is at a level of less sustainability with a score of 48.86, the social dimension is at a sustainable level with a score of 77.43, while the technology dimension is at a fairly sustainable level with a score of 57.02. Attributes that give a dominant influence on the sustainability of pelagic fisheries with purse seine is the ecological dimension, the by-catch of which is with a score (12.40). Economic dimension, assistance from the government with a score of 18.27 and attributes of working capital sources with a score of 15.82. Social dimension, fishermen's education with a score of 7.28 and technology dimension, pre-sale management with a score of 9.62.

Acknowledgments
The author expressed his gratitude to Bapak Chalid Hardani as Head of Southwest Aceh Office, Mr. Heriadi as Head of Capture Fisheries, Mr. Hasanuddin as Panglima Laot of Southwest Aceh District, Mr. Ari Gunawan as Coordinator of Ujong Serangga fishing port and Mr. Erliswar (KM. Zikra), Mr. Arman (KM. Sinar Malaya), Mr. Andi Brata Yuda (KM. Barona), Mr. Samsuar (KM. Bintang Pagi), Mr. Zulfi (KM. Sogun), Mr. Maifuddin (KM. Keube Utok), Mr. Saiful (KM. Tarzan Laut), Mr. Samsuar (KM. Henni), Mr. Amir (KM. Camar Limbo), Mr. Martunis (KM. Samudra), Mr. Ardi Parman (KM. SukaBaru), Mr. Abu Bakar (KM Hira Buana), Mr. Ali (KM. Mulia) as a Purse seine fisherman in UjongSerangga fishing port who has helped researchers in research.

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