

Status of Sustainability of Vaname Shrimp (*Litopenaeus vannamei*) in Kayu Ara Permai Village, Sungai Apit Subdistrict, Siak Regency



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ABSTRACT: This research was carried out in Kayu Ara Permai Village, Sungai Apit Subdistrict, Siak Regency on March 21, 2024 with the aim of analyzing the sustainability status of the vannamei shrimp pond business and determining the most sensitive attributes in the sustainability of the vannamei shrimp pond business. The research method used in this study is a survey method by making direct observations in the field (observation) by interviewing a number of Vannamei shrimp pond owners in Kayu Ara Permai Village as respondents. The population in this study is the Fisheries Service, extension workers, community leaders, Vannamei shrimp pond owners, and Vannamei shrimp pond technicians, which totals 10 people. The data obtained was analyzed with RAPFISH to explain the ecological, economic, technological, social and institutional dimensions that include sustainability attributes through several analyses including: *multidimensional scaling* (MDS) and *Leverage analysis*. The sustainability status of the vannamei shrimp pond business in Kayu Ara Permai Village is in the category of quite sustainable with a value of 57.50. The highest value lies in the technological dimension of 84.59 (good sustainable), then the ecological dimension of 67.62 (moderately sustainable), the economic dimension of 59.69 (moderately sustainable), the social dimension of 56.42 (moderately sustainable), and the lowest is the institutional dimension of 19.24 (moderately sustainable). The leverage attributes of the five dimensions that are the most sensitive and have high leverage in influencing the sustainability status of the vannamei shrimp pond business in Kayu Ara Permai Village include climate, marketing area, fry market support, participation of family members and the existence of the cultivation group.

KEYWORDS: Sustainability status, leverage attributes, RAPFISH, vannamei shrimp, pond business

INTRODUCTION

Sustainability is a state of continuity where the usefulness obtained from an object or resource in the future is not reduced compared to today. Sustainability is a complex problem because it includes various aspects or dimensions of sustainability, such as ecological, social, economic, technological and institutional dimensions. Sustainability assessments that only focus on one dimension turn out to result in inequality or adverse consequences in other dimensions (Nurdinsyah et al., 2020).

Sustainable aquaculture is derived from the general definition of sustainability which means the use of aquaculture resources aimed at meeting the needs of the current generation and at the same time ensuring that future generations can continue to utilize these resources (WCED, 1987). FAO further explained that sustainable aquaculture must meet the conditions of not damaging the environment, technically appropriate, economically beneficial and socially acceptable to the user community (Widjaja, 2019).

According to Maharani et al., (2009) shrimp is one of the high-quality animal protein source food ingredients that is very popular with domestic and foreign consumers because it has a very savory taste and lower cholesterol levels than mammals. Therefore, many Indonesian fish farmers and farmers have switched to vannamei shrimp so that the vannamei shrimp commodity is growing rapidly in Indonesia. In general, vannamei shrimp grow in coastal areas, mangrove areas in coastal areas will cause environmental changes, one of which can be a decrease in the ecological function of coastal areas which will affect the sustainability of pond aquaculture businesses cultivated by local communities.

Vannamei shrimp have specific characteristics such as growing faster than other shrimp species with a period of 120 days which allows them to be stocked at high density. In addition, this species is more resistant to environmental conditions and diseases than other shrimp species, and is quite popular in the international market (Herawati et al., 2020).

Vannamei shrimp ponds in Siak Regency in Kayu Ara Permai Village were established in 2018, vannamei shrimp ponds in Kayu Ara Permai Village started producing vannamei shrimp in 2021 until now. Based on the results of interviews with vannamei shrimp pond managers at the time of the pre-research survey, vannamei shrimp production in 2021 was approximately 118.8 tons and in 2022 vannamei shrimp production increased to approximately 132.7 tons with a percentage increase in production of 13.9%.

Status of Sustainability of Vaname Shrimp (*Litopenaeus vannamei*) in Kayu Ara Permai Village, Sungai Apit Subdistrict, Siak Regency

Kayu Ara Permai Village is a village located in Sungai Apit Subdistrict, Siak Regency, Riau Province. Kayu Ara Permai Village is a village located on the Siak River Coast that has a vannamei shrimp pond business, in general, the livelihood of the residents of Kayu Ara Permai Village is as farmers.

The vannamei shrimp pond business in Kayu Ara Permai Village causes various environmental impacts, especially shrimp waste. The development of vannamei shrimp ponds has caused an increase in shrimp waste. Waste produced from shrimp ponds is liquid waste that comes from unconsumed shrimp feed residues and shrimp manure. Poor waste management can cause water quality to decrease, so it can affect the survival of aquatic biota around shrimp ponds. Common problems that occur in the vannamei shrimp pond business are declining ecological functions, land conversion, water pollution, and declining water quality.

The problems of the vannamei shrimp pond business faced in Kayu Ara Permai Village, which are diverse, have an impact on the sustainability of the vannamei shrimp pond business. It is necessary to conduct a sustainability analysis of factors and variables related to the vannamei shrimp pond business in Kayu Ara Permai Village which aims to determine the sustainability status of the vannamei shrimp pond business. The purpose of this research is to analyze the sustainability status of the vannamei shrimp pond business, Determine the most sensitive attributes in the sustainability of the vannamei shrimp pond business.

RESEARCH METHODOLOGY

This research was carried out on March 21-29, 2024. This research is located in Kayu Ara Permai Village, Sungai Apit District, Siak Regency. This location was chosen deliberately (*purposive*) with the consideration that this area is a producer of Vannamei shrimp which is located in Kayu Ara Permai Village, Sungai Apit District, Siak Regency. The research method used in this study is the survey method. The population in this study is the Fisheries Service, extension workers, community leaders, Vannamei shrimp pond owners, and Vannamei shrimp pond technicians, which totals 10 people. The determination of respondents is in accordance with the desired circumstances and the existence of good communication skills in filling out the questionnaire (Cikitha *et al.*, 2018). The criteria for the respondents selected in this study consisted of 8 people, namely 1 person from the Siak Regency Fisheries Office, 1 community leader, 4 Vannamei shrimp pond owners and 3 Vannamei shrimp pond technicians. The data obtained was analyzed with RAPFISH to explain the ecological, economic, technological, social and institutional dimensions that include sustainability attributes through several analyses, including:

1. *Multidimensional Scaling Analysis (MDS)*

According to Andriani *et al.*, (2018) to conduct data analysis with multidimensional scaling (MDS), values that describe the level of similarity or level of dissimilarity between objects are used, called proximity, which is divided into similarity and dissimilarity. The stages of multidimensional scaling (MDS) analysis of the Vannamei shrimp pond business using the Rapfish method are as follows:

A. Identification and Determination of Attributes

The determination of attributes in each dimension is compiled based on indicators that are related to fisheries sustainability as required in the FAO Code of Conduct and has been formulated by Pitcher & Preikshot (2001).

B. Scoring and Scoring

Scoring is done by ranking each attribute. The creation of the score refers to the Rapfish technique used by (Susilo, 2003) *deep* Kumalah (2017) is a score given in the form of a bad value which reflects the most unfavorable management conditions and vice versa a good score reflects the most favorable management conditions.

C. *Analisis Monte Carlo*

According to Kavanagh (2004) in Kumalah (2017) stated that monte carlo analysis is useful for studying: the influence of attribute score errors caused by lack of information, misunderstanding of attributes or how attribute scores are made, the effect of variations in scoring due to differences of opinion or assessment by different researchers, the stability of the repeated MDS analysis process (unstable ancor position), data entry errors or the presence of missing data (missing data) and high stress values of the analysis results.

D. Preparation of Sustainability Index Scale

The preparation of the Vannamei money pond management sustainability index scale was adopted in the class interval used by Suryana *et al.*, (2012) where the class interval value from 0 - 100 is divided into 4 categories that describe the status of the sustainability index.

Table 1. Sustainability Status Index Categories

Index	Category
0-25	Bad
26-50	Less
51-75	Enough
76-100	Good

Source: Suryana *et al.*, (2012)

Status of Sustainability of Vaname Shrimp (*Litopenaeus vannamei*) in Kayu Ara Permai Village, Sungai Apit Subdistrict, Siak Regency

2. Analisis Leverage

Leverage analysis aims to determine the relationship of each attribute to the sustainability status of the vannamei shrimp pond business. This analysis can show which attributes are considered to have the most good/bad influence on sustainability status. The determination of sensitive attributes is carried out based on the order of priority by looking at the Root Mean Square (RMS) value of the coordination on the X-axis.

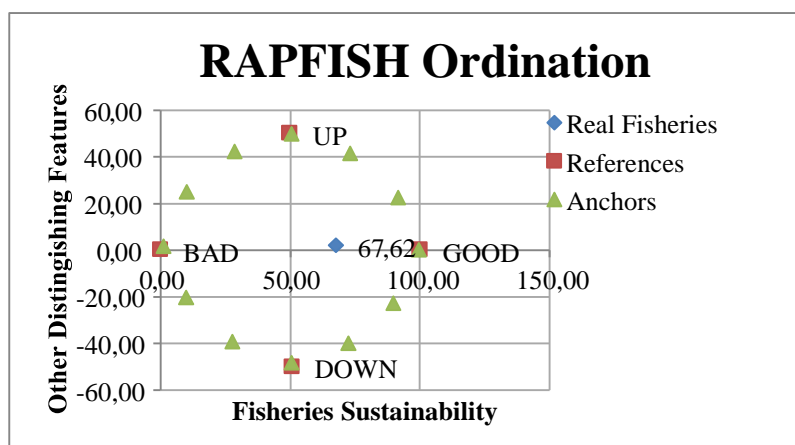
RESULTS AND DISCUSSION

Kayu Ara Permai Village is one of the villages located in Sungai Apit District, Siak Regency. Geographically, Ara Permai Wooden Village is located at the coordinate point 1020185809 BT and 10095133 LU with a land area of 12,000 Ha and bordering on: North: Sea of Bengkalis Regency, South : Sungai Kayu Village Fig, West: Meranti Regency Sea and East: Sungai Apit Village, Teluk Batil, Tanjung Kuras

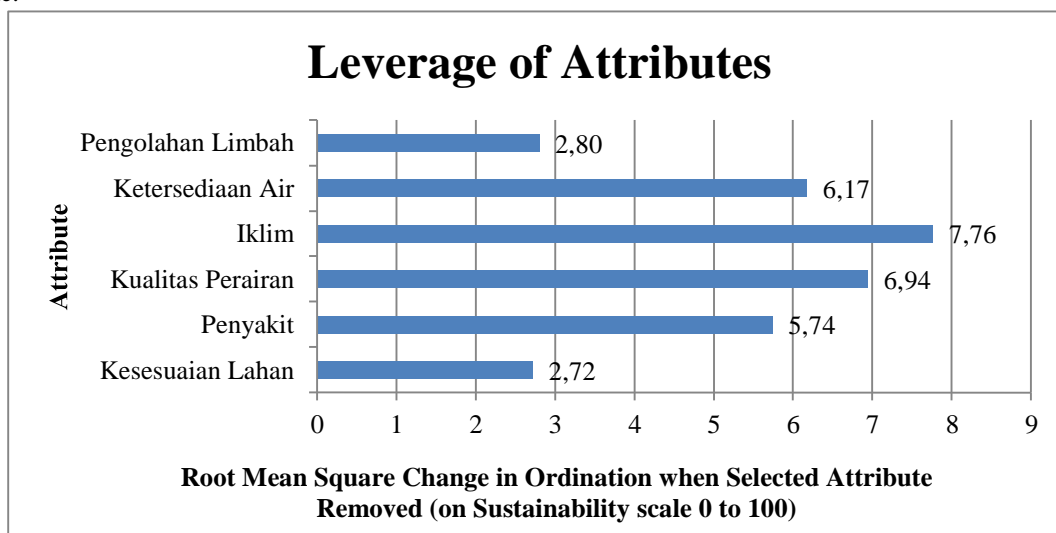
1. Ecological Dimension

The ecological dimension was chosen to reflect how the activities of natural resource utilization and the environment in Kayu Ara Permai Village have an ecological impact on the sustainability of the resource itself. A practice of utilizing natural resources and the environment that exceeds its carrying capacity will lead to the unsustainability of these activities. The level of exploitation or exploitation pressure will limit the opportunity for the development of the utilization of fishery resources (Susilo, 2003).

Ecological sustainability focuses on the preservation of natural resources and the environment, waste management, and cultivation methods. Sustainability of aquaculture based on ecological dimensions is an important factor in the sustainability of vannamei shrimp pond cultivation business. Vannamei shrimp ponds are highly dependent on the ecological conditions around them.



Base on the Figure 1, the results of the *Multidimensional Scaling* (MDS) analysis using RAPFISH in the ecological dimension obtained the sustainability index value of the Vannamei shrimp pond in Kayu Ara Permai Village of 67.62. These results show that the sustainability status of the Vannamei shrimp pond in Kayu Ara Permai Village is in the category of quite sustainable. This is in accordance with the opinion of Suryana *et al.*, (2012) in accordance with Table 1 that the index value of 51-75 is categorized as quite sustainable.

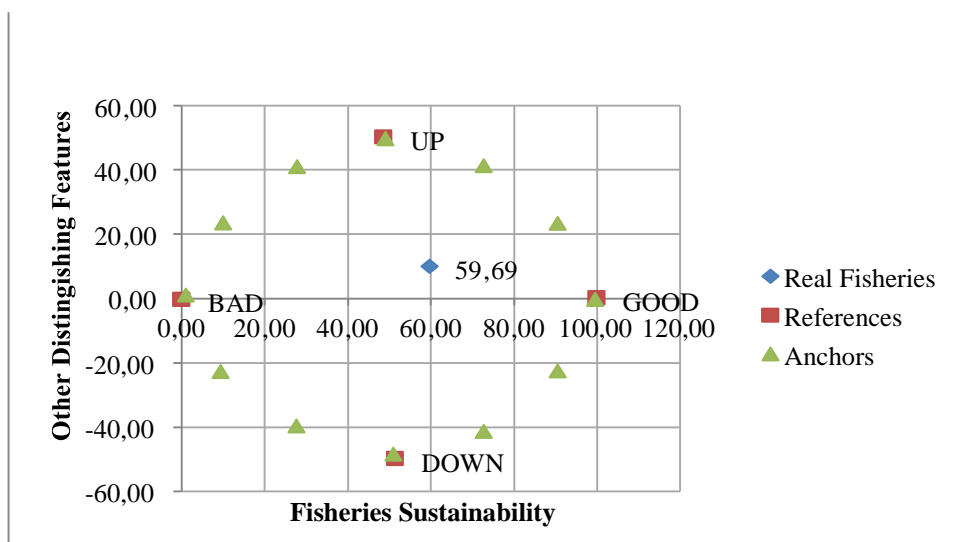


Status of Sustainability of Vaname Shrimp (*Litopenaeus vannamei*) in Kayu Ara Permai Village, Sungai Apit Subdistrict, Siak Regency

Based on the Figure 2, it is known that the attributes with the highest RMS value are climate with an RMS value of 7.76, water quality with an RMS value of 6.94 and water availability with an RMS value of 6.17. The three attributes with the highest RMS value are referred to as leverage attributes, which means they are identified as having poor or poor conditions. The improvement in the condition of the three attributes will affect the sustainability index of the vannamei shrimp pond business in Kayu Ara Permai Village, so that the priority of improvement must be aimed at the three attributes, while the three attributes with the lowest RMS value indicate that the condition of the three attributes is good enough and does not need to be prioritized for improvement.

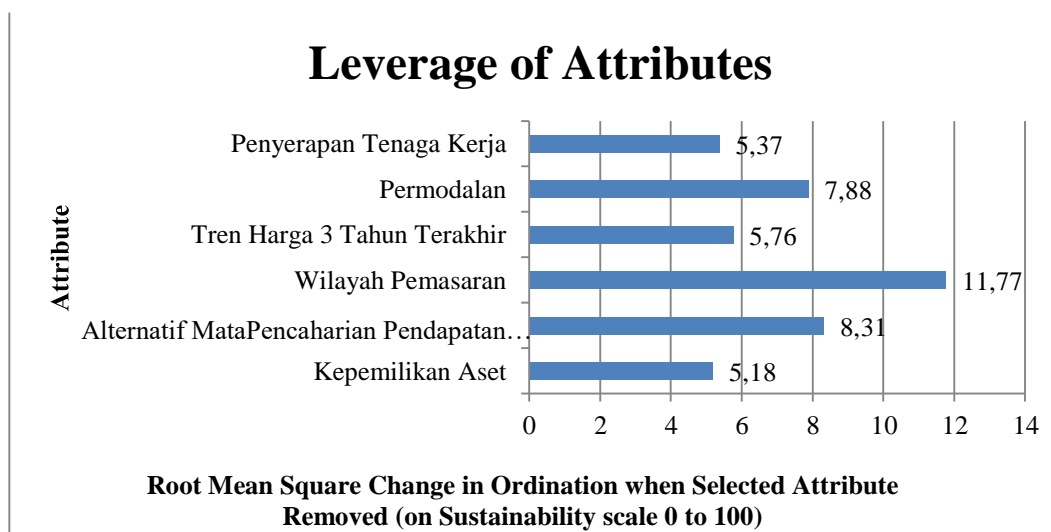
2. Economic Dimension

The vannamei shrimp pond cultivation business is expected to provide benefits to an even and continuous increase in community income, thereby providing economic value for pond entrepreneurs and village communities who work in ponds. The economic dimension is one of the important factors in the sustainability of vannamei shrimp farming. Intensive system vannamei shrimp cultivation is a solution to maintain the existing job fields in Kayu Ara Permai Village, especially as a source of community income.



RAPFISH Ordination

Based on Figure 3, the results of the *Multidimensional Scaling* (MDS) analysis using RAPFISH in the economic dimension obtained the value of the vannamei shrimp pond business sustainability index in Kayu Ara Permai Village of 59.69. These results show that the sustainability status of vannamei shrimp ponds in Kayu Ara Permai Village is in the category of quite sustainable. This is in accordance with the opinion of Suryana *et al.*, (2012). In Table 3, the index value of 51-75 is categorized as quite sustainable. The sustainability index is above the index is quite sustainable, this shows that the vannamei shrimp pond business still provides economic benefits and benefits for the surrounding community.

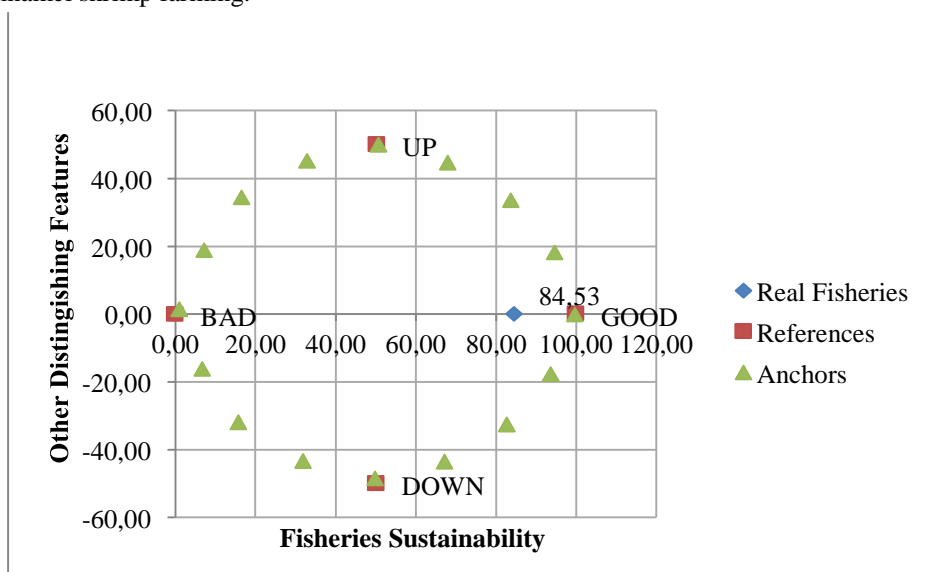


Status of Sustainability of Vaname Shrimp (*Litopenaeus vannamei*) in Kayu Ara Permai Village, Sungai Apit Subdistrict, Siak Regency

Based on Figure 4, it is known that the attributes with the highest RMS value are marketing areas with a value of RMS 11.77, alternative income livelihoods other than cultivation with a value of RMS 8.31 and capital value of RMS of 7.88. The three attributes with the highest RMS value are referred to as leverage attributes, which means they are identified as having poor or poor conditions. The improvement in the condition of the three attributes will affect the sustainability index of the vannamei shrimp pond business area of Kayu Ara Permai Village so that the priority of improvement must be aimed at the three attributes, while the three attributes with the lowest RMS value indicate that the condition of the three attributes is good enough and does not need to be prioritized to be improved.

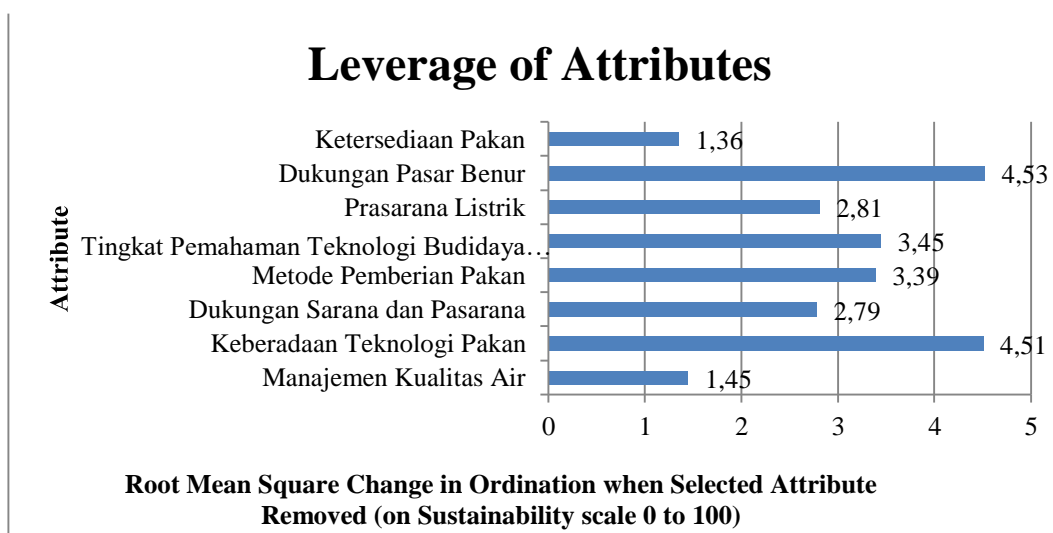
3. Technology Dimension

Good technology is technology that can support vannamei shrimp cultivation activities in the long term and sustainably. Technological improvements are expected to increase the productivity of fishery products by maintaining and even increasing the carrying capacity of a cultivation area so that shrimp farming businesses can be sustainable (Yuni *et al.*, 2018). The attributes of the technological dimension are focused on the attributes that are considered to have a direct and indirect influence on the level of sustainability of vannamei shrimp farming.



RAPFISH Ordination

Based on Figure 5, the results of the Multidimensional Scaling (MDS) analysis using RAPFISH in the technological dimension obtained a value of 84.53 for the sustainability index of the vannamei shrimp pond business in Kayu Ara Permai Village. These results show that the sustainability status of the Vannamei shrimp pond in Kayu Ara Permai Village is in the category of good sustainable. This is in accordance with the opinion of Suryana *et al.*, (2012). In Table 1, the index value of 76-100 is categorized as good sustainable. The sustainability index is above the good sustainable index, this shows that during the process of cultivating the vannamei shrimp pond business, technology is used well.

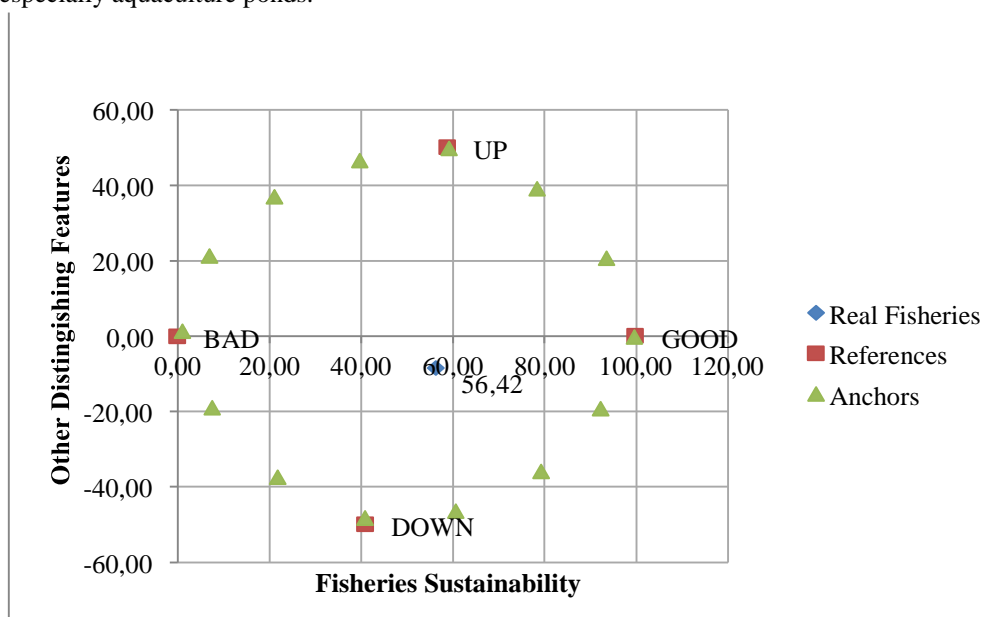


Status of Sustainability of Vaname Shrimp (*Litopenaeus vannamei*) in Kayu Ara Permai Village, Sungai Apit Subdistrict, Siak Regency

Based on Figure 6, It is known that the leverage attributes in the technology dimension are fry market support with an RMS value of 4.53, the existence of feed technology with an RMS value of 4.51 and the level of understanding of aquaculture technology with an RMS value of 3.45. The three attributes with the highest RMS value are referred to as leverage attributes, which means they are identified as having poor or poor conditions.

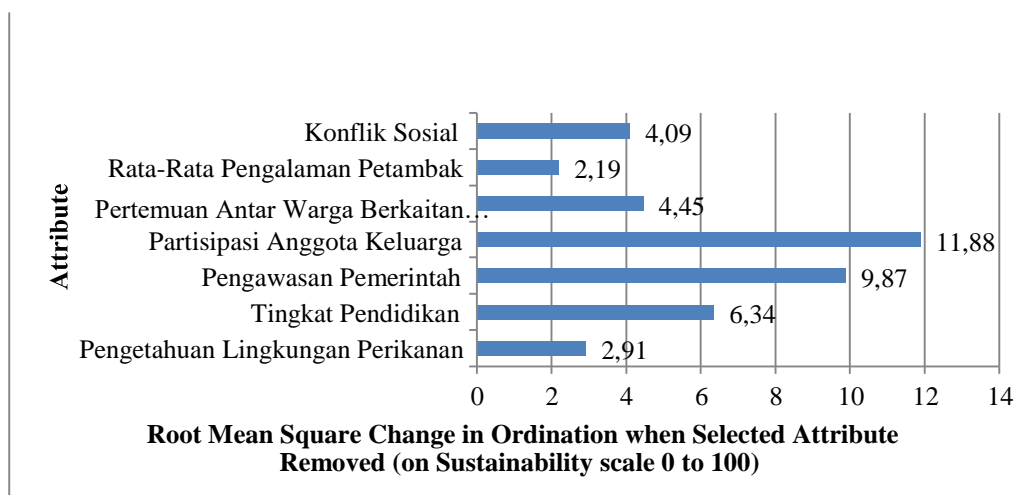
4. Social Dimension

In general, the people of Kayu Ara Permai Village are mostly Muslims and the majority are Malays, other communities have Batak, Minang and Javanese tribes. The social status of Kayu Ara Permai Village is also of course different. This diversity must be united in order to maintain harmony between communities. The social dimension is one of the important factors in the sustainability of vannamei shrimp farming. The social life of the people of Kayu Ara Permai Village is closely related to the coastal area of eastern Sumatra Island, especially aquaculture ponds.



RAPFISH Ordination

Based on Figure 7, the results of the *Multidimensional Scaling* (MDS) analysis using RAPFISH in the social dimension obtained the sustainability index value of vannamei shrimp ponds in Kayu Ara Permai Village of 56.42. These results show that the sustainability status of the Vannamei shrimp pond in Kayu Ara Permai Village is in the category of quite sustainable. This is in accordance with the opinion of Suryana *et al.*, (2012) in accordance with Table 1 that the index value of 51-75 is categorized as quite sustainable.



Leverage of Attributes

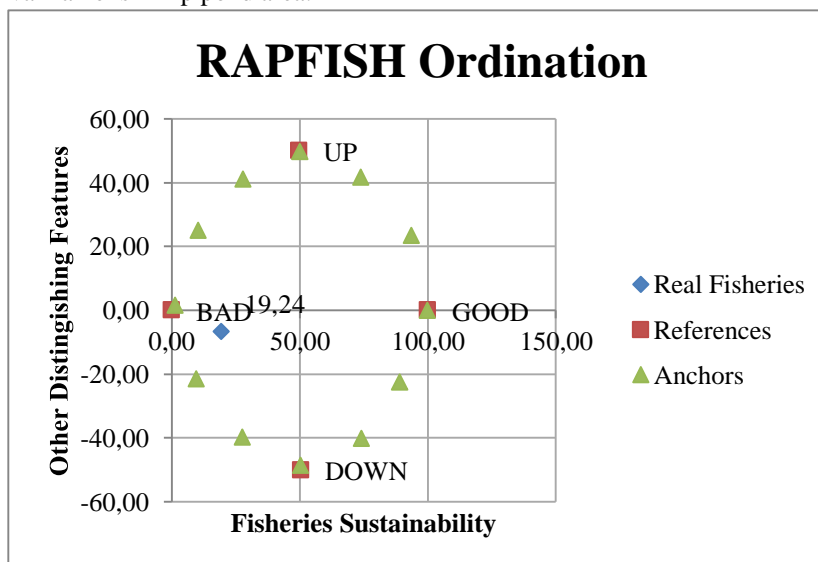
Based on Figure 8, it is known that the leverage attributes in the social dimension are the participation of family members with an RMS value of 11.88, government supervision with an RMS value of 9.87 and the level of education with an RMS value of

Status of Sustainability of Vaname Shrimp (*Litopenaeus vannamei*) in Kayu Ara Permai Village, Sungai Apit Subdistrict, Siak Regency

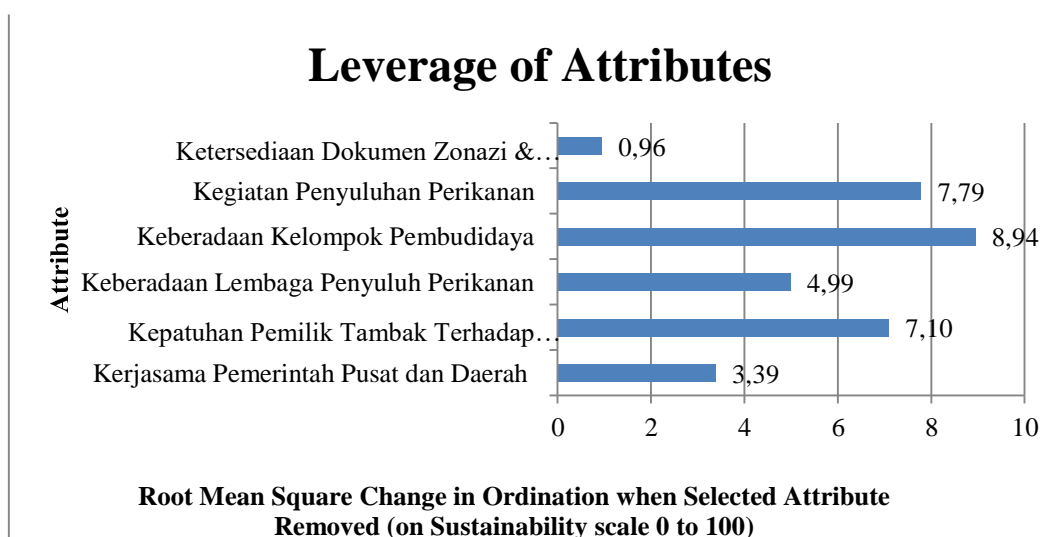
6.34 The three attributes with the highest RMS value are referred to as leverage attributes which means that they are identified as having poor or bad conditions.

5. Institutional Dimension

The institutional dimension is highly dependent on the way the institutional order, community rights, and rules are made or formulated and reflects how far the level of enforcement and compliance can encourage the sustainable use of natural resources and the environment of the vannamei shrimp pond area.



Based on Figure 9, it is known that the sustainability index of the institutional dimension is 19.24% which shows that the sustainability level of the vannamei shrimp pond in Kayu Ara Permai Village is less sustainable. Meanwhile, the stress value obtained is 0.14 which is included in the perfect category because it is less than 0.25 and the R² value obtained is 0.91 (close to 1) which shows that the model formed is good and no additional attributes are needed because the attributes used have represented the properties of the observed object. The value of the sustainability index in the institutional dimension is low because the score and condition of the attribute research location are not good enough, so the resulting index is in the condition of the vannamei shrimp pond in Kayu Ara Permai Village is not sustainable.



Based on Figure 10, it is known that the leverage attributes in the institutional dimension are the existence of a group of cultivators with an RMS value of 8.94, fisheries extension activities with an RMS value of 7.79 and the level of compliance of pond owners with regulations with an RMS value of 7.10. The three attributes with the highest RMS value are referred to as leverage attributes which means they are identified as having poor or bad conditions.

Status of Sustainability of Vaname Shrimp (*Litopenaeus vannamei*) in Kayu Ara Permai Village, Sungai Apit Subdistrict, Siak Regency

6. Goodness of Fit

Value *stress* shows the proportion of variance described by the model. In RAPFISH, a good model is indicated by a value *stress* which is less than 0.25 and if *stress* higher than 0.25, the MDS result has low accuracy. The smaller the value *stress* obtained means that the quality of the analysis results produced is better. In contrast to the R value² (determination coefficient), the quality of the analysis results is better if the value of R² (coefficient of determination) or getting greater or closer to 1 or >90% (Khairunnisa, 2017). Value *stress* and R² ecological, economic, technological, social and institutional dimensions can be seen in Table 9:

Table 2. Statistical Measurement Stress and r-squared values with MDS

It	Dimension	Stress	R-squared (%)
1	Ecology	0.14	0.93
2	Economics	0.14	0.93
3	Technology	0.13	0.93
4	Social	0.14	0.93
5	Institutional	0.14	0.91

Based on Table 2, the *stress value* obtained from five dimensions, namely the ecological, economic, social, technological and institutional dimensions, is smaller than 0.25 so that it can be said to be in the category of perfect suitability. As for R² of the five dimensions, it shows a value close to 1 or >90%, which means that the attributes contained in the dimension can explain and give recommendations to the system being studied.

CONCLUSION

1. The sustainability status of the vannamei shrimp pond business in Kayu Ara Permai Village is in the category of quite sustainable with a value of 57.50. The highest value lies in the technological dimension of 84.59 (good sustainable), then the ecological dimension of 67.62 (moderately sustainable), the economic dimension of 59.69 (moderately sustainable), the social dimension of 56.42 (moderately sustainable), and the lowest is the institutional dimension of 19.24 (moderately sustainable).
2. The leverage attributes of the five dimensions that are the most sensitive and have high leverage in influencing the sustainability status of the vannamei shrimp pond business in Kayu Ara Permai Village include climate, marketing area, fry market support, participation of family members and the existence of the cultivation group.

SUGGESTION

1. It needs to be paid attention periodically so that in the next few years the sustainability status remains in good condition, especially in the dimension that has a poor sustainable status, namely the institutional dimension, it needs to be underlined to become an object of attention that must be improved so that the potential of this dimension can be optimized in the management of the vannamei shrimp pond business in Kayu Ara Permai Village .
2. Sensitive attributes that include: climate, marketing area, fry market support, family member participation, and the existence of cultivator groups are attributes that are very important to be considered and improved by every *stakeholder* , both in the form of policies and programs that are able to have a positive impact on all of these sensitive attributes.

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Status of Sustainability of Vaname Shrimp (*Litopenaeus vannamei*) in Kayu Ara Permai Village, Sungai Apit Subdistrict, Siak Regency

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