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Assessment of Sustainable Management on Regional Waters Conservation Area (KKPD) Biak Numfor Regency

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Abstract

Sustainable development has become the mainstream of modern development. It is seen at the various government policies in many countries around the world and other substantial institutions. Sustainable development has three main aspects, namely: (a) economic development; (b) ecological sustain, and (c) social equity. Assessment of sustainable management on KKPD Biak Numfor uses MDS (Multi-Dimensional Scaling) approach by using Rapfish software. The data used in this study include primary and secondary data. The results of analysis obtained that the four dimensions of sustainable management of KKPD Biak Numfor were classified sustained with each ordinate value as follows; ecological dimension (59.90%), the economic dimension (57.13%), the socio-culture dimension (51.80%) and institutional dimensions (43.48%). The attributes which used as sustainability management lever had 7 (seven) attributes, included; three attributes of ecological dimension (pelagic fish stocks, water quality and abundance of reef fish), two attributes of economic dimension (tourism and aquaculture), one attribute of socio-culture dimension (ethnicity), and one attribute of institutional dimension (economic institutions).

Keywords: Sustainable management; regional waters conservation area (KKPD); MDS-Rapfish.

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1. Introduction

Sustainable development requires suitability between the pace of the development and the carrying capacity of the natural environment in ensuring the availability of natural resources assets and environmental services that is at least equal to the next generation [1]. A development activity is recognized sustainable if it is supported ecologically, economically and socially. Ecologically sustainable implies, that such activities can maintain the integrity of ecosystems, maintaining the carrying capacity of the environment and conservation of natural resources, including biological diversity (biodiversity), so it is expected that resource use to remain sustainable. Economically sustainable means that a development activity result in economic growth, preserve capital (capital maintenance), and using resources and investments efficiently. Meanwhile, socially sustainable development requires that an activity should be able to equalize the results of development, social mobility, community participation, community empowerment, social identity, and institutional development [2].

The concept of sustainable development in the past few decades is increasingly being used by many countries in the world to implement development policies both at the national and international levels. Currently, sustainability has been a core element (core element) for many government policies in many countries around the world and other substantial institutions [3]. The first concept of sustainable development was formulated in the Brundtland Report which was a congress of the World Commission on Environment and Development of the United Nations: "Sustainable development is a development that embodies the needs of the present without compromising the ability of future generations to realize their needs" [4]. In addition to future-oriented, ethically this definition is also guaranteeing the fulfillment of life between generations. According to [5], sustainable development has implications for all the dynamic balance between function maintenance (sustainability) and transformation in order to meet the necessities of life. Although there are many variations of the definition of sustainable development, including the sustainable use of coastal resources, which is widely accepted is that which rests on three pillars: economic, social, and ecological [6].

In other words, the concept of sustainable development oriented to the three dimensions of sustainability, namely: economic sustainability (profit), social sustainability (equity), the ecological sustainability (sustain). Three dimensions affect each other so that all three must be considered impartial. Stable and healthy social system; and natural resources and environment are the basis for economic activity, while the economic well-fare is a prerequisite for maintaining social stability, cultural and conservation of natural resources and the environment. According to [2], sustainable development has three main aspects, namely: (1) economic development to improve the quality of human life, namely that emphasizes human development as the center of attention; (2) development that pays attention the environment, both in the utilization of resources, protection of ecological processes, life support systems and biodiversity; (3) social development in the distribution of development advantages equitably which includes fairness between people, between generations, between countries. Furthermore, sustainable management of an archipelago ecologically according to [7], requires four conditions, they are: (1) development activities (such as ponds, agriculture, and tourism), should be placed at appropriate locations in biophysics. This requirement can be met by making the map of the suitability of land

(land suitability), including water, (2) when using the renewable resources, such as fishing in the sea, then the rate of catch should not exceed the sustainable potential stock of the fish, (3) if we dispose the waste to the island area, then the amount of waste (not B3 waste, but the kind of waste that is biodegradable) does not exceed the capacity of assimilation environment of the island, and (4) if we modify the landscape of an island (such as sand mining and reclamation) or perform construction activities in the environment of the island, especially on the seashore, such as building a dock (jetty) and hotel, it must follow the pattern of local hydrodynamics and other natural processes. Thus, the study of sustainability management KKPD Biak Numfor becomes very important in order to know the level of sustainability management that has been done so far.

2. Method

2.1. Location

The research was conducted from October 2014 to November 2015 in Biak Numfor Regency, Papua. More details as shown below.

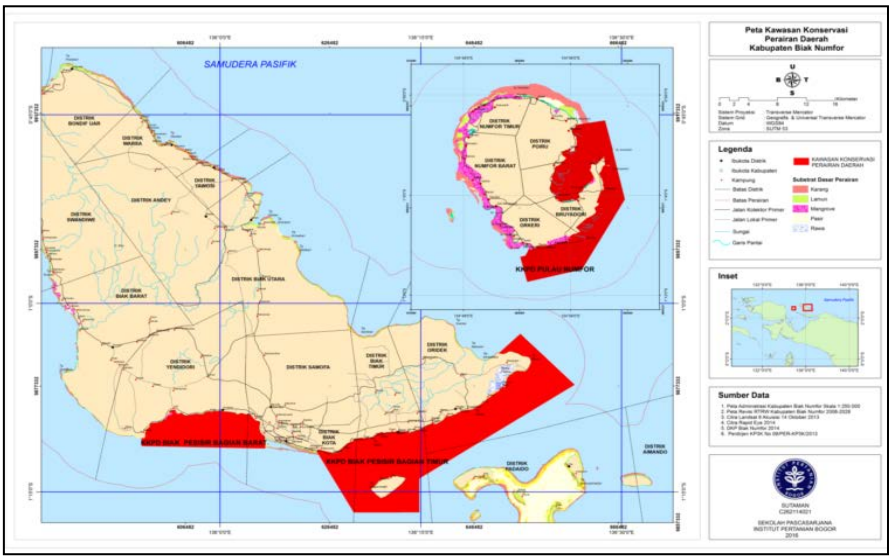

Figure 1: Map of Research Location

2.2. Data Collection Method

The data collection was done by observation, interview, and desk study with two types of data: (1) primary data collection method was done by survey approach with interview; and (2) secondary data collection methods was done with literature and other information relating to conditions in regional waters conservation area (KKPD) Biak Numfor.

2.3. Data Analysis Method

The data analysis method was done by sustainable analysis or MDS approach with Rapfish software modification (Rap_KKPD).This approach is based on the principle of Multi-Criteria Analysis (MCA) by relying

on an algorithm known as MDS algorithm [8]. Multi-Dimensional Scaling (MDS) is a statistical analysis technique that does a multidimensional transformation [8, 9, 10].

Next, the value of scores of each multidimensional attribute analyzed to determine the position of the continuous utilization of KKPD assessed relatively to two reference points, namely; the point of good and bad. To facilitate the visualization, the ordinate analysis is used. The ordination process uses Rapfish software [9]. Furthermore [8] states that MDS can present ordinate method effectively. The object or the observed point is mapped into a two or three-dimensional space so that the object or point strives as close as possible to the point of origin.

In other words, the two points or the same object is mapped into a point adjacent to one another. On the contrary, the different objects or dots are illustrated in distant points [8].

Reference [11] state that the ordination technique by configuring the distance between points in t-dimension refers to the Euclidean distances between points. The position of the sustainable dots visually will be very difficult to be imagined since there are many dimensions related. Therefore, to facilitate the visualization of this position, ordinate analysis of multi-dimensional scaling (MDS) is used, before MDS implemented, all data is standardized, which normalizes all attributes. SIMFITGO ordination process is done after scoring in each of the attributes and dimensions, as well as the determination of the main reference point ("good" and "bad").

Through analysis of MDS, then the position of the point of effectiveness can be visualized in two dimensions (vertical and horizontal axis). Through the position of the axis rotation method, such points can be projected on a horizontal line where the extremes of "bad" were given a score of 0% and the extreme point of "good" was given a score of 100%.

The position of sustainability management of KKPD Biak Numfor that will be studied is between the two extremes and the index of its sustainability can be analyzed by looking at the percentage value on the horizontal line. Analysis of sustainability management is intended to obtain a picture of the level of sustainability of waters conservation areas (KKPD) Biak Numfor. Here are the stages of operational sustainability analysis using Rapfish software, referring to [12] as follows:

- Deciding on a theme/topic of study, namely the sustainability of waters conservation areas (KKPD) Biak Numfor.
- Determine the aspect of the study, includes; ecological dimension, economic dimension, the socio-culture dimension and institutional dimensions.
- Define the attributes of each aspect of the study, include; ecological dimension (10 attributes), the economic dimension (9 attributes), the socio-culture dimension of (9 attributes) and institutional dimensions (9 attributes).
- Provide scoring (bad-good) on each attribute.
- Enter the value/score of the assessment results of each attribute into Rapfish software.
- Run Rapfish software.
- Bring up the Rap analysis (sustainability ordinate). Rap analysis is used to determine the percentage of

each dimension of sustainability management.

- Run leveraging to obtain leverage of attribute, which is a determination attribute lever of every aspect/directive use. The attribute lever is an attribute whose existence affects sensitively to increase or decrease of the sustainability status, the greater the RMS value is, the greater the role of these attributes to the sensitivity of the sustainability [9].
- Run Monte Carlo with a confidence interval of 95%. Monte Carlo analysis is used to see the effect of the error, in order to increase the confidence in the results of the analysis. The difference in results of Monte Carlo analysis is inferior to the results Rapfish Analysis (value-ordination) showing that the impact of an error scoring is relatively small. If the value of the difference between the two analyses (Monte Carlo Analysis and Analysis Rapfish <5%), the results of the analysis is not recognized as the estimated value of sustainability index.
- Showing the value squared correlation (R2) as an assessment of the accuracy (goodness of fit). Squared correlation (R2) is the square of the correlation coefficient indicates the proportion of a variant of the optimally scaled data, which was donated by multidimensional scaling procedure with a size of a match/accuracy (goodness of fit measure). The R2 shows the number/amount of various data that can be explained in the model. The squared correlation value is used to determine the proximity between perceptual map data whether the data is mapped well or not. The R2 is getting closer to 1 means the data that is increasingly mapped perfectly or in other words, the higher the value of R2 is, the better the model in explaining the variance data. [14] states that the value of R2> 80% indicates that the prediction of index model is sustained and adequate to use.
- Showing the value of stress to indicate the size mismatch (a lack of fit measure). Stress value is the inverse of the value of R2. Stress value is used to see if the results of output approaching the real situation or not. If the stress value is closer to zero, the output produced is more similar to the actual situation. The lower the value of stress, the better/fit of the model is. On the other hand, the higher the stress value is, the more the result will not fit the model. Stress value that can be tolerated is <20% [9].
- Shows the value Root Mean Square (RMS) of each dimension. The larger the RMS value is, the greater the role of these attributes to the sensitivity of the sustainability [9].
- Make a diagram of a kite (kite-diagram) of dimension on management KKPD Biak Numfor. Kite-diagram is used as a trade-off of sustainability.

An assessment of the sustainability of KKPD Biak Numfor was done with a dimensional management approach that includes; ecological dimension, economic dimension, the social dimension of cultural and institutional dimensions. More details as follows:

Indexing and managing sustainability status of KKPD Biak Numfor of each dimension and its attributes follow the concept developed by [15]. Assessment scores every aspect represented by the worst scale (bad) 0% up to the best (good) 100%. Value index of> 50% can be stated that aspects of the examination have been sustained. Conversely, if the index value <50% of these aspects have not been or are not sustainable.

Table 1: Attributes of sustainable management on KKPD Kabupaten Biak Numfor

Dimensions/Attribute	Attribute Assessment Score	Good	Bad	Indicators
Ecology				
Core zone	1; 2; 3	3	1	The maintenance of the core zone
Coral coverage	1; 2; 3	3	1	Percent live coral cover
an Abundance of reef fish	1; 2; 3	3	1	The type and reef fish stock
Seagrass condition	1; 2; 3	3	1	Level seagrass cover
Mangrove condition	1; 2; 3	3	1	Level mangrove cover
Water quality	1; 2; 3	3	1	The level of viability of aquatic biota
Pollution levels	1; 2; 3	3	1	The level of waters pollution
Potential damage of coral	1; 2; 3	3	1	Cause and condition of coral damage
Coastal abrasion	1; 2; 3	3	1	Abrasion conditions in coastal areas
Economy				
Potential of natural resources	1; 2; 3	3	1	The amount/high potential of natural
Availability of space	1; 2; 3	3	1	resources
Financial institutions	1; 2; 3	3	1	Availability of space for economic development
Capture fisheries	1; 2; 3	3	1	Presence or absence of institutions that can
Marine aquaculture	1; 2; 3	3	1	finance
Tourism	1; 2; 3	3	1	Potential catches
Alternative livelihood	1; 2; 3	3	1	Suitability and potential for development
Marketing aspects	1; 2; 3	3	1	Potential and prospects of its development
Fish processing	1; 2; 3	3	1	Potential and possible development of MPA
				The potential market among regions
				Presence or absence of fish processing
Socio-Culture				
Society participation	1; 2; 3	3	1	The level of community participation in the program KKPD
Perception and behavior	1; 2; 3	3	1	The views and behavior of the community in supporting KKPD
Understanding of society	1; 2; 3	3	1	People's understanding of KKPD
Education	1; 2; 3	3	1	The level of formal education community
Health	1; 2; 3	3	1	Health facility
Population	1; 2; 3	3	1	Population growth
Conflict	1; 2; 3	3	1	Potential conflicts in the utilization of natural resources
Ethnicity	1; 2; 3	3	1	Ethnic and tribal diversity in society
Local culture	1; 2; 3	3	1	Status of local culture
Institutional				
Management organization	1; 2; 3	3	1	The effectiveness of the management organization
Regulation	1; 2; 3	3	1	The legal basis for the implementation of policies
Rule	1; 2; 3	3	1	The policies set by the Government
Role of stakeholders	1; 2; 3	3	1	The level of awareness and participation of stakeholders
Customs rules	1; 2; 3	3	1	Presence or absence of customary rules that support KKPD
Decision-making	1; 2; 3	3	1	The level of openness in decision-making
Economic institutions	1; 2; 3	3	1	The role of economic institutions of society
Supporting infrastructure	1; 2; 3	3	1	Conditions supporting infrastructure
Law enforcement	1; 2; 3	3	1	The level of supervision, enforcement and law enforcement

Tabel 2: Index of sustainable category

Index values	Sustainable category
0 – 25	Bad; not Sustainable
26 – 50	Less; Less Sustainable
51 – 75	Enough; Sustainable enough
76 – 100	Good; very Sustainable

Sources: [15]

Results of determining the sustainability of each dimension, and then made the kite diagram, to see the trade-offs sustainability management on Regional Waters Conservation Area (KKPD) Biak Numfor.

3. Results

3.1. Ecology Sustainable

Ecological sustainability is a depiction of a level of sustainability related to the management of ecological aspect/environment at the Regional Waters Conservation Area (KKPD) Biak Numfor. Ecological dimension consists of 10 (ten) attribute management, include; a) the core zone, b) coral cover, c) the abundance of reef fish, d) stocks of pelagic fish, e) the status of the sea grass beds, f) status of mangrove, g) water quality, h) the level of contamination, i) potential damage to the reef, and j) of coastal erosion. Graph ecological sustainability ordinate, as follows:

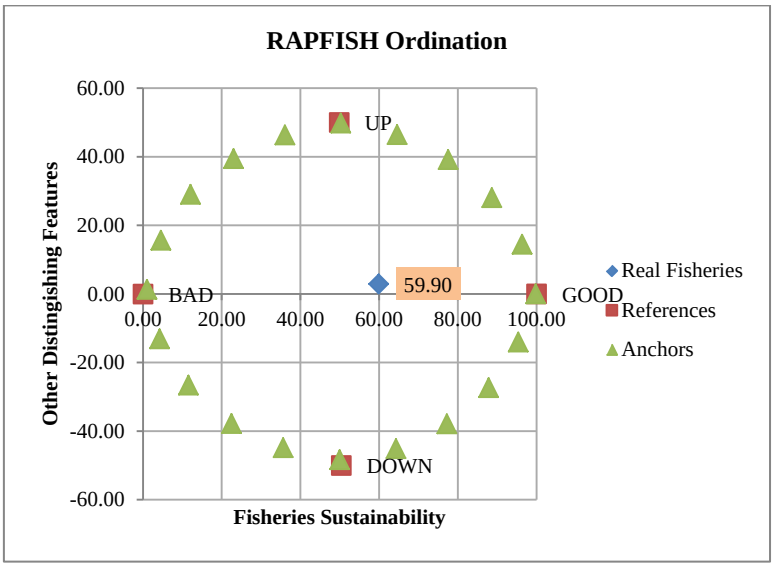

Figure 2: Graphic of ecological sustainability ordinate

The result of Rapfish analysis for the ecological sustainability had obtained an ordinate value 59.90% or categorized quite sustainable. The Rapfish analysis results are acceptable since the results of the validation test Monte Carlo values obtained by 58.99%, showing the difference is small enough around 0.91% or less than 1%.

These values indicate that the effect of the error or the impact of a scoring error is relatively small. Thus, the developed Rapfish model is able to be a probe of index values of sustainability. According to [9], the analysis of Monte Carlo simulation can be used as a method to evaluate the impact of random error in statistical analysis of this research. The same thing also expressed [8] that the Monte Carlo analysis can be an error indicator caused by scoring in every attribute, the variation of multidimensional scoring because there are different opinions, the repeated process of data analysis performed, and errors in input data or missing data. The ordinate value describes the management of KKPD Biak Numfor categorized quite well (fairly sustained) from the ecological aspect. Attributes lever of ecological sustainability are presented in the following figure:

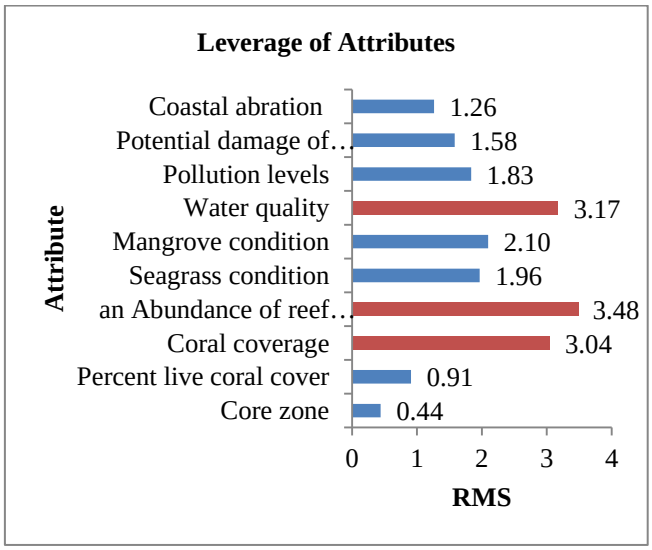

Figure 3: Graphic of attribute leverage of ecological sustainability

The results of the analysis of leverage for ecological dimension, shows that there are three (3) attributes, namely; (Pelagic fish stocks, water quality and abundance of reef fish) is a major indicator of the sustainability of the various other attributes, namely; pelagic fish stocks (RMS=3.48%), water quality (RMS=3.17%) and the abundance of reef fish (RMS=3.04%). [9] states that the RMS value indicates the magnitude of the role of each attribute to the sensitivity of the sustainability status. Secondly, it is an important indicator in sustainability management KKPD Biak Numfor.

3.2. Economy Sustainable

Economic sustainability is a depiction of the level of sustainability of the economic aspects related to the Regional Waters Conservation Area (KKPD) Biak Numfor. The economic dimension consists of 9 (nine) management attributes, include; a) the potential of natural resources, b) the availability of space, c) financial institutions, d) of fisheries, e) aquaculture, f) tourism, g) alternative livelihoods, h) marketing, and i) the processing of fishery products. Graphic of economic sustainability ordinate, as follows.

The results of the analysis obtained Rapfish for economic sustainability ordinate value or 57.13% is quite sustainable. Rapfish analysis results are acceptable since the results of the validation test obtained Monte Carlo

values by 56.57%, showing the difference is small enough around 0.56% or less than 1%. These values indicate that the effect of the error or the impact of a scoring error is relatively small. Thus, the developed Rapfish model is able to be a probe of index values of sustainability. According to [9] the analysis of Monte Carlo simulation can be used as a method to evaluate the impact of random error in statistical analysis of this research. The same thing also expressed [8] that the Monte Carlo analysis can be an error indicator caused by scoring in every attribute, the variation of multidimensional scoring because there are different opinions, the repeated process of data analysis performed, and errors in input data or missing data.

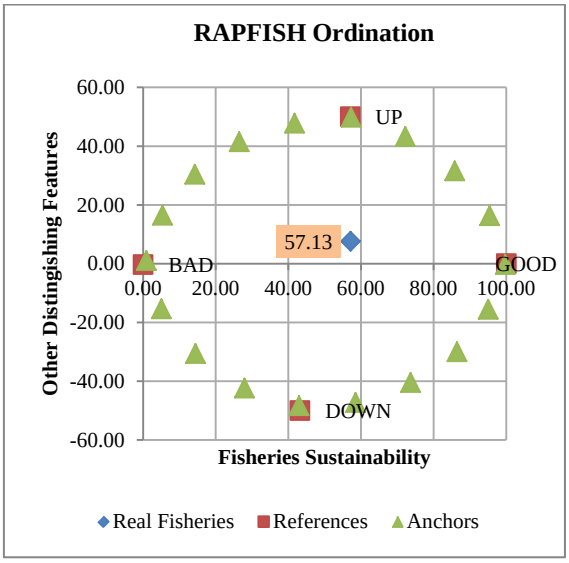

Figure 4: Graph of economic sustainability ordinate

The ordinate value describes the management of KKPD Biak Numfor is categorized very good (sustainable) in economic aspects. Attributes levers of economic sustainability are presented in the following figure:

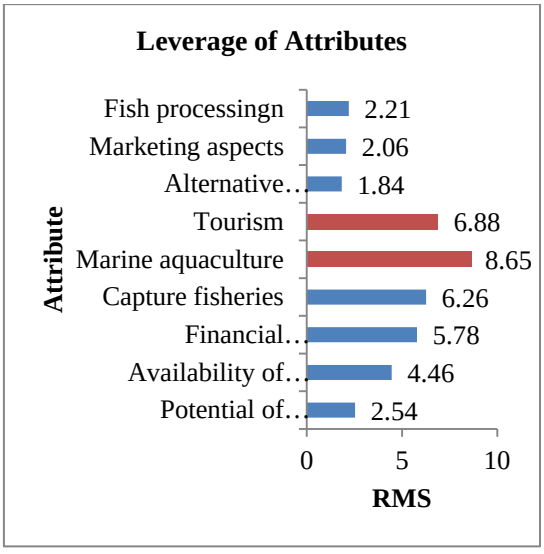

Figure 5: Graphic of attrubute leverage of economic sustainability

The results of the analysis of leverage to the economic dimension show that there are two (2) attributes that become most important sustainability indicators of other various attributes, namely; marine aquaculture (RMS=8.65%) and tourism (RMS=6.80%). [9] states that the RMS value indicates the magnitude of the role of each attribute to the sensitivity of the sustainability status. Both of these attributes become very important in the management of economic sustainability KKPD Biak Numfor. The potential and aquaculture activities, as well as tourism, become a very important aspect of the economy, in particular, to increase the income of local communities.

3.3. Socio-Culture Sustainable

Socio-cultural sustainability is a depiction of the level of sustainability of socio-cultural aspects related to the Regional Waters Conservation Area (KKPD) Biak Numfor. The social dimension of culture consists of 9 (nine) management attributes, include; a) participation, b) perception and behavior, c) understanding of the community, d) education, e) health, f) population, g) conflict, h) ethnic, and i) the local culture. Graph soci-culture sustainability ordinate, as follows:

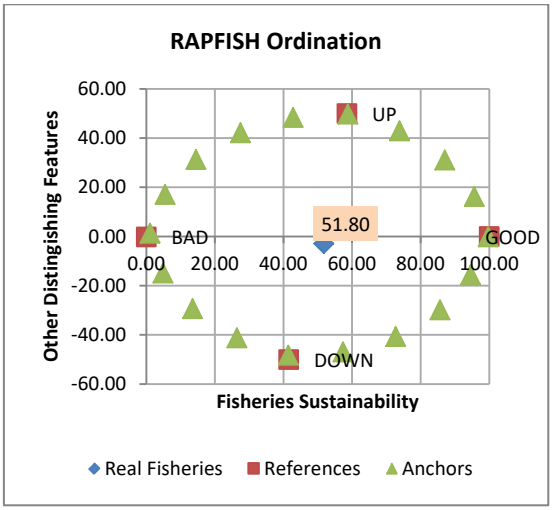

Figure 6: Graph socio-cultural sustainability ordinate

The Rapfish analysis results for the socio-cultural sustainability obtained an ordinate value 51.80% is quite sustainable. The Rapfish analysis results are acceptable given the results of the validation test Monte Carlo values obtained by 51.57%, which shows the difference very small which is 0.23% or less than 1%. These values indicate that the effect of the error or the impact of a scoring error is relatively small. Thus, the developed Rapfish model is able to be a probe of index values of sustainability. According [9], the analysis of Monte Carlo simulation can be used as a method to evaluate the impact of random error in statistical analysis of this research. The same thing also expressed [8] that the Monte Carlo analysis can be an error indicator caused by scoring in every attribute, the variation of multidimensional scoring because there are different opinions, the repeated process of data analysis performed, and errors in input data or missing data. The ordinate value describes the management of KKPD Biak Numfor is categorized good (sustainable) on socio-cultural aspects of socio-cultural sustainability attributes lever presented in the following figure:

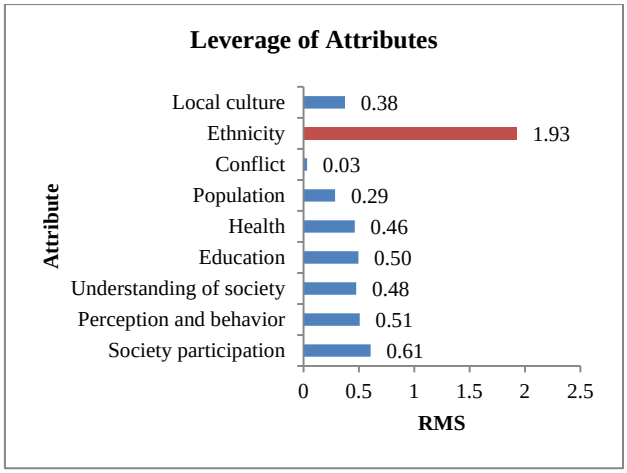

Figure 7: Graphic of attribute leverage of socio-cultural sustainability

Leverage analysis results to the socio-culture dimension of, shows that there is 1 (one) attribute that becomes most important sustainability indicators from a variety of other attributes that ethnic (RMS=1.93%). [9] states that the RMS value indicates the magnitude of the role of each attribute to the sensitivity of the sustainability status. The emergence of ethnicity as a lever attribute because one of the peculiarities of Papua, in general, is related to ethnicity. Ethnicity in Papua, including in the area of Biak Numfor have a very important role, especially related to natural resource management, including coastal and marine ecosystems.

3.4. Institutional Sustainable

Institutional sustainability is a depiction of a level of sustainability-related aspects of institutional management at the Regional Waters Conservation Area (KKPD) Biak Numfor. Institutional dimension consists of 9 (nine) attribute management, include; a) management organization, b) regulations, c) rules, d) the role of stakeholders, e) customs rules, f) decision, g) economic institute, h) supporting infrastructure, and i) enforcement. Graphic of institutional sustainability ordinate, as follows:

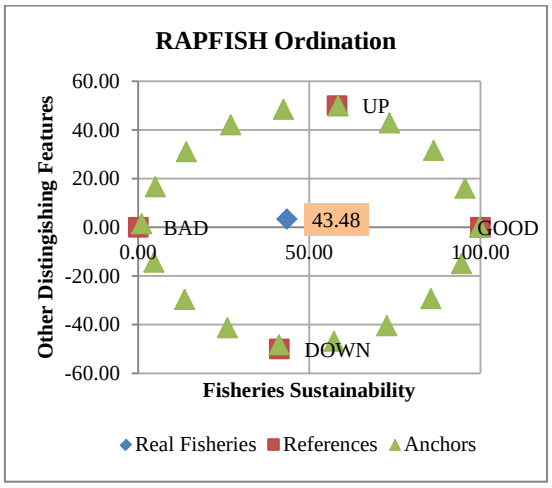

Figure 8: Graphic of institutional sustainability ordinate

The results of Rapfish analysis for institutional sustainability ordinate values obtained 43.34% or classified as less sustainable. The Rapfish analysis results are acceptable given the results of the validation test Monte Carlo values obtained by 43.67%, showing the difference is the relatively small difference that is 0.33% or less than 1%. These values indicate that the effect of the error or the impact of a scoring error is relatively small. Thus, the developed Rapfish model is able to be a probe of index values of sustainability. According to [9], the analysis of Monte Carlo simulation can be used as a method to evaluate the impact of random error in statistical analysis of this research. The same thing also expressed [8] that the Monte Carlo analysis can be an error indicator caused by scoring in every attribute, the variation of multidimensional scoring because there are different opinions, the repeated process of data analysis performed, and errors in input data or missing data. The ordinate value describes the management of KKPD Biak Numfor categorized less sustainable than institutional aspects. Attributes of lever institutional sustainability are presented in the following figure:

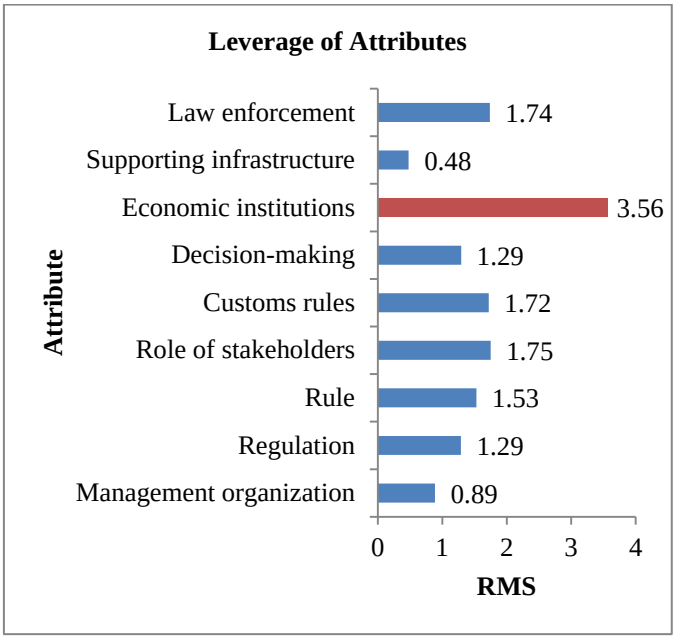

Figure 9: Graphic of attribute leverage of institutional sustainability

The results of the analysis of leverage for institutional dimensions found that there is only one (1) attributes that become most important sustainability indicators of various other attributes, namely economic institutions (RMS=3.56%). [9] states that the RMS value indicates the magnitude of the role of each attribute to the sensitivity of the sustainability status. Institutional economics is essential considering the constraints of funding or financing in activities or programs, as well as management of KKPD Biak Numfor which will cause the management constrained.

4. Conclusion

Based on the results of analysis and discussion, some conclusions as follows:

- Sustainability management of KKPD Biak Numfor is generally categorized quite sustainable with

ordinate values of ecological dimension (59.90%), the economic dimension (57.13%), the socio-culture dimension (51.80%) and institutional dimension (43.48%).

- There are 7 (seven) attributes used as the attribute of management sustainability levers of KKPD Biak Numfor, include; three attributes of ecological dimension (pelagic fish stocks, waters quality and abundance of reef fish), two attributes of the economic dimension (aquaculture and tourism), one attribute of socio-culture dimension of (ethnicity), as well as one attribute of institutional dimension (economic institutions).

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