Sustainability index of the seaweed farmers household economy in Serewe Bay, West Nusa Tenggara, Indonesia

Achmad Zamroni1*, Tenny Apriliani1, Lathifatul Rosyidah1, Irwan Muliawan1 and Katsumori Hatanaka2

1Research Center for Marine and Fisheries Socio Economics, Republic of Indonesia Gdg. Balitbang KP I 4th floor, Jl. Pasir Putih I Ancol Timur, North Jakarta
2Tokyo University of Agriculture, Tokyo, Japan 1-1-1 Sakuragaoka, Setagaya-ku, Tokyo 156-8502, Japan

*Email: roni_socio@yahoo.com

Abstract. The economic behavior of household seaweed farmers in Serewe Bay can be a direct or indirect stimulus that affects behavioral changes and increase work productivity. The objectives of this research were: (1) to examine the characteristics of the seaweed farming business; (2) to analyze the economic sustainability index; and (3) Formulating alternative livelihoods strategy for seaweed farming. The study was conducted from February to December 2018 in Serewe Bay, Jerowaru District, East Lombok District, West Nusa Tenggara Province using a structured questionnaire. Data were analyzed using the Sustainable Livelihood Approach as well as financial analysis. The finding shows that about 80% of the people in Serewe Bay utilize coastal resources for marine cultivation. E. cottonii seaweed cultivation dominates in marine and fisheries households. The household economic sustainability index (iKERT) of seaweed farmers in Serewe Village is relatively low (32.56). This is due to the low index of human, financial, and physical capitals, and basic infrastructure facilities for the people in Serewe Village to the marketing area. Therefore, there are main aspects to be concerned to improve household economy sustainability, namely infrastructure, role of local economy institutions, change the mind of seaweed farmers to be smart businessmen, and improving the asset management and investment.

1. Introduction
Sustainability has many dimensions that are all important for the sustainable livelihoods approach. There are several indicators that indicate that the economy will sustain since when: 1) the economy might be elastic in the face of shock events and outside pressures; 2) the economy does not depend on the aid and outside support (or if it depends, the aid itself economically and institutionally must be sustainable); 3) maintain long-term productivity of natural resources; and 4) the economy do not harm the livelihood and/or forfeit the choices of livelihood that are open for others. In fisheries business, there are 4 (four) factors that affect change in business, namely structure and cost of business, labor, technology, and business productivity. In addition, ownership of production factors and wealth by a household that can ultimately affect the level of income and household consumption. In principle, income and expenses are the same. The revenue reached by a certain period of time is always the same as the expenditure of that timeframe. The amount of individual income will depend on the amount of productive assistance of the person or factor concerned in the production process.
This aspect of the business will be controlled through the price of the input, output, and fish production. Besides business aspects, monitoring of household income will be conducted through periodic data collection, including business income and household income. Institutional aspects can be seen at the rural level to review capital institutions, production inputs, labor, and marketing. Each household or household group has a different pattern or structure of consumption and expenditure. The structure of household expenditure can also be used as an indicator of the welfare level of households.

Socio-economics discrepancy is still visible in the life of coastal communities. It has contributed to the widespread distribution of poverty in the coastal villages. Fishermen's household economic behavior can be a direct or indirect stimulus that can cause behavioral change to work or business productivity (output) by utilizing resources in marine and coastal environments. Structural poverty pressures that hit traditional fishing lives are actually caused by complex factors [1], which is the fluctuations of fish seasons, the limitation of human resources, capital, and access, the exploitative fish trade network against fishermen as a producer, the negative impact of fisheries modernization that has led to excessive exploitation of marine resources. Those conditions are still continuing up to present, and further impacts that are deeply destroyed by fishermen is the decline in their income level and the difficulty of obtaining a catch. According to Kusnadi [2], various studies related to the welfare of living among fishermen have shown that poverty and socio-economic gaps or income inequality are crucial issues faced and not easily addressed.

Therefore, the forming unit of fisheries household economic is the domestic business that needs to get attention, including the role of household members and household expenditure patterns. These elements greatly affect the success of fisheries household enterprises that, in the end, can determine the sustainability of the fisheries household economy. Therefore, the purpose of this study is; 1) to assess the characteristics of marine and fisheries resources the utilization; 2) to describe the characteristics of marine and fisheries business, and 3) formulating the sustainability strategy model of marine and fisheries households economy.

2. Methodology

2.1. Duration and Study Area

The study was conducted during February – December 2018 in Serewe Village, Jerowaru District, West Nusa Tenggara Province – Indonesia. Seriwe Village is located in the southern part of Jerowaru district, which has an area of 14.67 Km² or 10.27% of the district area. The Serewe Village of Seriwe has a territorial boundary in the north is Pemongkong Village and the west of Kwang Rundun Village while the south and east are bordered by the Indian Ocean waters and the Seriwe Bay.

2.2. Data Collection

The types of data were collected in this study consist of secondary data and primary data. The primary data was collected through interviews and in-depth interviews with seaweed farmers and their families as respondents in this research. The primary data retrieval is conducted by using structured questionnaires to households representing the specified stratification of respondents. Secondary data collected in the form of fisheries statistical data issued by related agencies such as statistical beareu, marine and fisheries office as well as other reports related to this research.

The selection of household samples is carried out with a random sampling method (stratified random sampling). The purpose of stratification is to obtain representative data based on certain levels. The stratification of seaweed farmers is based on the area of farming, namely micro-scale or less than 7 Ha, and small scale with an area of 7 – 14 Ha. The selection of samples is generally expected to represent the business conditions of seaweed cultivation. The study uses the Slovin formula to determine the number of samples [3], as follows:

\[
n = \frac{N}{1 + Ne^2}
\]

Where:
The requirement to use this formula is to specify what the error tolerance. The error tolerance is expressed by percentages. The smaller error tolerance will be more accurate; the sample illustrates the population.

2.3. Data Analysis
The data analysis methods used to achieve these research objectives are consist of; description analysis, financial analysis, household economic sustainability index analysis, and sustainability strategy analysis.

2.3.1. Descriptive analysis
This analysis is used in the framework of interpreting the socio-economic development of rural communities in the marine and fisheries sectors including an overview of the research area, the dynamics of marine and fisheries enterprises, the structure and distribution of household income, the dynamics of expenditure and household consumption, and the conditions of marine and fisheries household economy.

2.3.2. Financial Analysis
Analysis of financial aspects is an analysis to determine the feasibility of the executed business, including:

1) The advantage (π), aims to measure the business activity that is currently successful or not. This analysis can be used to determine the amount of profit gained from a business activity [4]. The formula used to calculate the profit is:

\[ \pi = TR - TC \]  \hspace{1cm} (2)

Description:
- \( \pi \): Profit
- \( TR \): Total Revenue
- \( TC \): Total Cost

2) The Revenue cost ratio (R/C ratio), used to determine the extent of the results obtained from business activities during a certain period, is profitable [4]. The R/C calculation is done with the formula:

\[ \frac{R}{C} = \frac{TR}{TC} \]  \hspace{1cm} (3)

Description:
- \( R \): revenue;
- \( C \): Expense

2.3.3. Sustainable Livelihoods Index Analysis
The development of indicators used in calculating the index generally refers to the sustainable livelihoods Framework developed by Departement for International Development (DFID) [5]. Based on the framework, livelihoods are influenced by five capital assets, i.e., financial capital, natural capital, human resources capital, social capital, and physical capital. These five aspects are important to be seen in particular to recognize the livelihood relationship with factors affecting the vulnerability of the community to its livelihood. However, the selection of indicators should also pay attention to data availability and the ease of data collection needed; then, it can be applied more massive. The selection of indicators is also possible that can connect between the micro indicator and macro indicator so that it can be drawn a general conclusion.

Economic Sustainability Index of marine and fisheries households or abbreviated to \( ikert \) is a model formulated to calculate the economic sustainability index of marine households and fisheries with a sustainable approach livelihood based on five major capital namely; Natural Capital (\( Ixa \)), Human
capital ($ix_0$), financial capital ($ix_u$), physical capital ($ix_f$), and social capital ($ix_s$). The symbol $i$ in $iKERT$ indicates a dynamism, which means the main capital that builds the model is still possible to be modified in accordance with the contextual review of sustainability. According to Saragih [6], the meaning of 'livelihood' includes assets or capital (natural, human, financial, social, and physical), activities in which access to assets is mediated by institutions and social relations) which together dictate the results obtained by individuals and family.

The phases of the calculation of $ikert$ include 1) data collection and information: Data collection and information are conducted through survey activities, in-depth interviews as well as focus group discussion (FGD). The data that has been collected is then validated, and verification is spacious, then done data input and digitization of data in Excel format. 2) Capital Determination/dimension: the $iKERT$ counter adopted the sustainable livelihood approach, which uses five major capital, namely natural capital, human capital, financial capital, physical capital, and social capital; 3) determination of indicators: each of the capital is then formulated the indicator of the capital. 4) composite index analysis of 5 capitals: the determination of the constituent weights in each of the indicators on the 5 capital using priority weights (eigenvalue Methods); and 5) counting models of the marine household and Fisheries Economic Sustainability Index ($ikert$): From each of the 5-model composite index is then formulated with the $ikert$ model.

Analysis of $ikert$ is calculated with the following formula:

$$iKERT_i = 0.3 \text{IX}_A_i + 0.2 \text{IX}_O_i + 0.2 \text{IX}_U_i + 0.2 \text{IX}_F_i + 0.1 \text{IX}_S_i$$  \hspace{1cm} (4)$$

Value of 0.3; 0.2; and 0.1 based on results based on the results of the factual analysis in the field through survey and observation activities, analysis content of various references/literature/secondary data to capital forming and assessment (expert judgment) from experts based on experience in group discussion activities.

With the availability of data indicator than the index to be obtained for natural Capital (IXA), Human capital (IXO), financial capital (IXU), physical capital (IXF) and social capital (IXS) is the following formula:

$$\text{IX}_A_i = w_1 \text{XA}_1 + w_2 \text{XA}_2 + w_3 \text{XA}_3,$$ \hspace{1cm} (5)

$$\text{IX}_O_i = w_4 \text{XO}_1 + w_5 \text{XO}_2 + w_6 \text{XO}_3 + w_7 \text{XO}_4,$$ \hspace{1cm} (6)

$$\text{IX}_U_i = w_8 \text{XU}_1 + w_9 \text{XU}_2 + w_{10} \text{XU}_3 + w_{11} \text{XU}_4 + w_{12} \text{XU}_5,$$ \hspace{1cm} (7)

$$\text{IX}_F_i = w_{13} \text{XF}_1 + w_{14} \text{XF}_2 + w_{15} \text{XF}_3,$$ \hspace{1cm} (8)

$$\text{IX}_S_i = w_{16} \text{XS}_1 + w_{17} \text{XS}_2 + w_{18} \text{XS}_3 + w_{19} \text{XS}_3.$$ \hspace{1cm} (9)

In the formula, $w$ is the balance obtained by the results of the priority weight analysis (eigenvalue Method). Individual $w$-equipoise is the assumed coefficient that can represent natural, human, financial, physical, and social conditions. The stages and process of counting $iKERT$ can be seen in Figure 1.

In measuring this index, the formula will use the weighing factor and scores to obtain the value of the domestic sustainability index of marine fisheries. The weighing figure is in the range $0 – 1$, with the total amount of the weighted number equal to 1 (one). The total amount of this balance is already in accordance with the priority weight rule (eigenvalue method). While the score is within 1 – 3 range, the determinations of various inputs including the result of focus group discussion (FGD) with community leaders, researchers and other sympathizers, literature and expert in contributing to the determination of the score.
3. Results and Discussions

3.1. Characteristics and Utilization of Marine and fisheries resources

Seriwe Village consists of three sub-villages, namely the Seriwe, Temodo, and the Kaliantan, with a total population in the year 2016 recorded 3,478 inhabitants. The average age of the population of Seriwe Village is dominated by the age range of 18 – 56 years, both male and female, with the education level of elementary school. The source of water used by the community of the Seriwe Village is to use a pond of 84 units, a rainwater reservoir of 32 units, and buy water using the tree on private parties as many as 5 units recorded is utilized by the population as many as 1,171 inhabitants.

All fishermen of the Seriwe Village have used multiple fishing gears. The use of the fishing equipment is adjusted to the cycle of the fishing season. Fishermen of Seriwe Village include daily fishermen who have a day fishing trip. The fishing ground is around Serewe Bay, Tanjung Ringgit, to Sumbawa Island. Fishermen are also do fishing more than a day is four days per trip. The Seriwe Village has support to the economy of East Lombok district as the flagship base in the processing sector, which contributes 17% based on the average value of location quotient (LQ), especially for seaweed processing industry [7].

Figure 1. iKERT Analysis Framework
The fishery group in the Seriwe Village is mostly a seaweed farmers group. The total number of seaweed farmer groups in this village is 36 groups with the number of members of a group is 20 people of each. Technical seaweed farming is adjusted to the tide and depth conditions in some seaweed cultivation locations in the Seriwe Bay. The techniques of seaweed farming used by seaweed farmers consist of the raft, fixed bottom longline, and floating longline. Farmers in Semerang Village uses a raft system, fixed bottom, and floating longline, while the Seriwe Sub Village uses longline and Patok, and Kalianstan Sub Village has only used the fixes bottom due to the big waves occur in this area. The water depth factor is also affected the technical seaweed farming used. The fixed bottom technique is used for a depth of 5-10 meters, the raft is used in the water depths of 10-15 meters, and floating longline depths of water can be over 15 meters.

Table 1. The seasonal calendar of seaweed farming in Serewe Village

| Description                     | Months |
|---------------------------------|--------|
| Moss                            | ***    |
| Baronang/fish attack            | I ***  |
| Ice-Ice disease attack          | *** I  |
| Planting seaweed (spinowms sp)  | *** ***|
| Planting seaweed (e.cottoni)    | I I I *** *** *** I I I I |

Source: Primary Data processed (2018)
Description
*: Low Intensity
**: Moderate intensity
***: High Intensity

Table 2. Seasonal calendar of fishing activity in Seriwe Village

| Items                           | Months |
|---------------------------------|--------|
| Catching octopus                | * * * * * * * * * * * * * * |
| Catching Lobster                | * * * * * * * * * * * * * * |
| The arrest of Cob              | * * * * * * * * * * * * * * |
| Big wave rainy season           | *** *** * * * * * * * * * * * |

Source: Primary Data processed (2018)
Description
*: Low Intensity
**: Moderate intensity
***: High Intensity

Seaweed farming technique carried out by the community has each respective advantage. Using a raft requires one quintal of seeds that can produce 2-3 quintals of wet seaweed or about 60 kilograms of dried seaweed. Floating longline requires a minimum of 1 ton of seeds and can produce 2-3 tons of wet seaweed. The use of seeds in different cultivation methods affects the amount of capital used by seaweed farmers. Based on this, it can be concluded that the method of seaweed cultivation with the use of a raft requires less cost than the longline. Therefore, seaweed farmers can conduct seaweed cultivation in accordance with the amount of capital owned. Seaweed farmers with minimal capital can cultivate using the raft method, while people who have sufficient capital can use longline and fixed bottom technology.

The problem faced by seaweed farmers in Seriwe Village is the presence of moss that can interfere with the growth of seaweed, fish predator, and diseases (called “aiz-ais”) during the transitional season. The seaweed farming business in Kalianstan Sub Village is also threatened by tourism development.
3.2. Marine and Fisheries Activities
Nizar [8] explained that business development could be done by looking at several aspects, namely technical aspects, economic aspects, social aspects, financial aspects, and management aspects. Analysis of the sustainability index in Serewe Village shows that the highest-value of capital is natural capital (76.09), and the lowest capital is physical capital (23.95). Meanwhile, the index of human capital is 43.58, the index of financial capital is 41.49, and the index financial capital is about 30.17 (Figure 2).

\[ \text{iKERT} \text{ Category:} \\
\text{Low: } \text{iKERT} < 50 \\
\text{Moderate: } 50 \geq \text{Directly} \leq 75 \\
\text{Height: } \text{iKERT} > 75 \]

Figure 2. The Value of each capital of \text{iKERT} in Serewe Village, East Lombok District, West Nusa Tenggara Province

Figure 2 shows that only the natural capital index has a high value. In the meantime, four other capitals consist of human capital, financial, physical, and social have a lower value. It means that the four low-value capitals are currently difficult to support the sustainability of marine and fisheries' household economy. In fact, the natural condition in Serewe Village is still in good condition to support the community economy. In the physical indicator, the condition of public transportation access, access to health service and education service, as well as a production input, are still low. In the financial indicator, the community of Serewe Village mostly depends on the single income source, namely seaweed farming. They also have difficulties in managing government assistance, deposits, loans, and income. The consequence, they are not able to do self-investment when restarting a business.

4. Discussions
4.1. The strategy for Marine and Fisheries household Economic Sustainability
Widodo [9] describes a number of alternative strategies to increase income through a livelihood-based economic strategy in the fisheries and non-fisheries sector and social strategies.

The efforts to improve household business sustainability of seaweed farmers in Serewe Village can be seen from five capital of business sustainability index (Figure 3). Figure 3 below shows that the natural dimension is very strong in influencing the business sustainability marine and fisheries household economy but has not yet been supported by the other four capitals, especially the physical capital index.
There are several strategies that can be done to safeguard or improve the sustainability of marine and fishery household economy in the Serewe village are as follows:

(a) Improvement the physical infrastructure 
(b) Improvement of local economic institutional role.
(c) Changing seaweed farmer mindset to implementing “smart” business concept.
(d) Improving management skill for their asset and investment.

In general, the community is aware that the decline in the quality and quantity of natural resources is due to continuous exploitation [10]. Regarding natural capital, the strategy used is the management of planting season. The activities that can be done include temporary closing for the damaged location of the coral reefs, complying with the zoning area, arranging the development area along coastline and hilly areas. The strategy for human capital that can be proposed such as improving the quality of human resources and create alternative livelihood activities. This is in line with Ngadi [11] that income and livelihoods as important aspects of household life because income determines the ability of households to meet their needs. Then, the activities that can be done include the training on fisheries products processing, engine reparation, fishing equipment utilization, tourism services, English language course, food processing. However, Farah and Erlinda [12] argued that the qualitative dimension of human capital is obtained through education, training, and health. In addition, Anwar [13] emphasized the contribution of human capital can be analyzed from two perspectives, namely micro and macro. Micro viewpoint views that human capital is part of the production function in individuals, which is further related to the quality of human resources. Whereas at a macro level, the contribution of human capital can be analyzed from the aggregated micro contributions to be part of national economic development. The development has an impact on the increase in welfare, which is indicated by an increase in the level of gross regional domestic product per capita. The Strategy of financial capital is to increase the business management that can be realized in training for managing a business and household finances. According to Fauzi et al. [14], financial resources have no effect on financial performance and competitive strategies, but competitive strategies have an effect on financial performance. Therefore, sufficient financial resource capacity has not been able to contribute to financial performance, and competitive strategies have an effect on financial performance. The concept of social capital arises from the thought that community members individually may not be able to encounter various problems [15]. The strategy of social capital focuses on institutional strengthening through creating a fishermen group and fishermen cooperatives as the economic power in coastal society. Finally, the strategy for physical capital is to improve main road access and other public facilities. The activity can be done by improving market
access, opening markets for processed products, providing and improving public transportation, and providing clean water facilities for coastal communities.

5. Conclusion
Coastal communities in the Serewe Village is still highly dependent on the utilization of marine and coastal resources, mainly for mariculture. Meanwhile, the utilization of marine and fisheries resources for tourism has not yet become as an alternative for seaweed farmers and fishermen to earn alternative income. Socio-economic characteristics of fisheries households in Serewe Village have characterized by seaweed farming with the longline system, floating raft, and fixed bottom stakes.

Based on iKERT analysis, the policies and related programs, composites on the natural capital index, social capital index, physical capital index, are quite in-line with the sustainability of marine and fisheries' household economy. The three indexes are already close enough to the average value of the index spread (50%) is the ideal condition for the sustainability of the household economy. The policy and programs related to the human capital index have not yet optimal in the sustainability of the marine and fisheries economy. The age variable that states the age class when becoming the economic actors in fisheries is quite late (over 30 years). As a result, the business innovation sector is not very developed in the marine and fisheries sector.

Therefore, there are several strategic policies that can be taken to give positive impacts on the economic sustainability of marine and fisheries households:
1. Local governments collaborated with the central government and private sector to improve fishermen's skills through training and mentoring. It could be implicated the increased skills of fishermen/seaweed farmers and increases the added value of the products.
2. Local governments and the central government provide training to fishermen on how to handle the catch. It could obtain higher revenue outcomes for fishermen by applying the principle of "less catch more value".
3. Local governments and local universities collaborate to give training to fishermen and seaweed farmers in financial management. This is expected to have implications on increasing the skills of the fishermen/farmers to manage the finances for consumption, social, and investment purposes.
4. Programs and strategies related to the creative economy in the marine and fisheries sectors need to be developed so that the creativity of business can be developed and followed by marine and fisheries businessmen.

Acknowledgment
The authors would like to express his deepest thanks to all parties who support during the field survey, discussion, given advice and sharing information. All respondents who share important information during field survey. Authors also convey special thanks to the Research Center for Marine and Fisheries Socio-Economics (RCMFSE) and all researchers who contributed to iKERT research activities.

References
[1] Satria A 2015 Pengantar sosiologi masyarakat pesisir (Yayasan Pustaka Obor Indonesia)
[2] Kusnadi 2000 Nelayan: strategi adaptasi dan jaringan sosial (Humaniora Utama Press)
[3] Arikunto S 2014 Metode penelitian kuantitatif, kualitatif, dan kombinasi (mixed methods) Bandung Alf.
[4] Umar H 2005 Studi Kelayakan Bisnis Edisi Ketiga PT. Gramedia Pustaka Utama, Jakarta
[5] Sheets D S L G 1999 Department for International Development: London
[6] Saragih S, Lassa J and Ramli A 2007 Kerangka Penghidupan Berkelanjutan Sustainable Livelihood Framework Hivos–Circle Indonesia.
[7] Rahman B R A 2016 Determining the flagship sector of PDRB in Regencies in Lombok Island using the Location Quotient (LQ) method, Dynamic Location Quotient (DLQ) and Multivariate Analysis Of Variance (MANOVA)
[8] Nizar M 2015 The sustainability analysis of seaweed cultivation business at the recipient of the
direct assistance palette of communities in Muna District (Brill)

[9] Widodo S 2009 Strategi nafkah rumah tangga nelayan dalam menghadapi kemiskinan J. Kelaut. Indones. J. Mar. Sci. Technol. 2 150–7

[10] Sulistiyanto T I 2013 Identifikasi kerentanan petani di daerah rawan genangan banjir melalui pendekatan Penghidupan Berkelanjutan (studi kasus: Desa Bulung cangkring, Kecamatan Jekulo, Kabupaten Kudus).

[11] Ngadi N 2016 Mata Pencaharian Dan Pendapatan Rumah Tangga Di Kawasan Pesisir Kabupaten Wakatobi J. Sos. Ekon. Kelaut. dan Perikan. 11 209–23

[12] Farah A and Puspita Sari E 2014 Human Capital and Productivity J. Econ. Policy 7 22–8

[13] Anwar A 2017 The Role of Human Capital Toward Regional Economic Growth in Java J. Econ. 13 79–94

[14] Fauzi A, Suharjo B and Syamsun M 2017 Pengaruh sumber daya finansial, aset tidak berwujud dan keunggulan bersaing yang berimplikasi terhadap kinerja usaha mikro, kecil dan menengah di Lombok NTB Manaj. IKM J. Manaj. Pengemb. Ind. Kecil Menengah 11 151–8

[15] Syahra R 2003 Social Capital Concepts and Applications J. Masy. dan Budaya 5 1–21