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The Framework Analysis of Small and Medium Fishery Industries in West Papua Province, Indonesia

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

West Papua's fishery resources are in fishery management areas 715 and 717 with a potential of 1,242,526 tonnes/ha and 1,054,695 tonnes/ha respectively. On average, most fishery products are marketed fresh and only 1.20% are in the form of further processing. Therefore, the analysis of small and medium fisheries industries' (SMFI) development framework is needed to encourage small and medium fisheries enterprises to grow and be sustainable. The analytical framework is realized by considering the initial data consisting of household capacity of fishermen, product superiority, and maximum sustainable yield; data management and processing; support from legal policy; community-based institutions; and co-management arrangements.

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1. INTRODUCTION

More than 80% of Indonesia's marine potential has not been explored and managed properly. The potential for marine fisheries in Indonesia is spread throughout almost all of Indonesia's sea territory. Indonesia's sea area is estimated at 5.8 million km^2. There are accounted several fishery development potentials, including (1) capture fisheries in general waters covering an area of 54 million hectares with a production potential of up to 0.9 million tonnes/year, (2) Marine aquaculture consisting of fish cultivation (among others snapper, grouper, and gobia), cultivation of mollusks (batik, pearls, and sea cucumbers) and cultivation of seaweed, (3) Brackish water cultivation (ponds) has the potential to develop a land area of around 913,000 ha, (4) Freshwater cultivation consists of public waters (lakes, reservoirs, rivers, and swamps), freshwater ponds, and fish farming on the sidelines of rice in rice fields area; (5) Marine biotechnology for the development of the marine biotechnology industry such as the food, natural feed, fish and shrimp and food ingredients industries [1-3].

Nationally, the utilization of the fishing industry is around 36.1 percent for the medium and large scale, while for the SMFI scale it reaches 62 percent. This condition is due, among other things, to the limited supply of fish raw materials, fishing facilities, and infrastructure, as well as fish cooling warehouses. Therefore, the government and the business world must work together to overcome this obstacle, so that the fishing industry can develop rapidly [4-6].

The Fisheries Management Area in West Papua Province is included in zones 715 and 717. Zone 715 is in the fishing grounds in Tomini Bay, Maluku Sea, Halmahera Sea, Seram Sea, and Berau Bay with a total allowable catch of 80% of the total potential (996,021 tons/year) . Likewise for zone 717 is in the fishing areas in the Pacific Ocean, Cendrawasih, and Gulf with a total allowable catch of 80% of the total potential (873.755 tonnes/ha). The types of fishing potential consist of small pelagic, big pelagic, demersal fish, reef fish, penaeid shrimp, lobster, blue swimming crab, 3-spot swimming crab, and squid [7-9].

The situation mentioned above should place the fisheries sector as one of the sectors with great potential in Indonesia, especially in West Papua Province. The SMFI development policy in West Papua is directed at empowering local communities, business actors, industrialists, and traders of indigenous Papuans. This policy was carried out in order to support the acceleration of the spread and equity of SMFI throughout the West Papua Region [10].

Analysis of the SMFI development framework in West Papua Province needs to be carried out by increasing integrated partnerships between upstream and downstream and ensuring the utilization of resources for superior commodities using the maximum sustainable yield approach. Thus, a supply of raw materials is created according to the capacity of the environment and a business climate that is conducive to the development of the capacity of local fishermen's households [11,12].

2. METHODS

2.1 Study Area

This study was carried out in 13 regencies/cities in West Papua Province with coordinate locations located between $0^0 – 4^0$ S and between $124^0 – 132^0$ E with altitudes ranging from 0 - 1.094 m (Fig 1). The average annual air temperature ranges from 26.4 - 27.7 ^oC. Annual average humidity is included in the high category reaching 82-86%. Annual rainfall ranges from 2.134 - 4.692 mm. Average wind speeds range from light breezes (2-4 m/s) to high winds during tropical storms (11 m/s) [13].

Based on its geographical position, West Papua Province has boundaries: North – Pacific Ocean; South – Banda Sea, Maluku Province; West – Seram Sea, Maluku Province; East – Papua Province. West Papua Province is divided into 12 regencies and 1 city with a total land area of 102,946,15 km^2. While the centre of government is in Manokwari Regency with access to other regencies, generally using aeroplane, sea and some are already accessible by lands such as South Manokwari, Bintuni Bay, Sorong and Arfak Mountains with distances ranging from 4 - 12 hours.

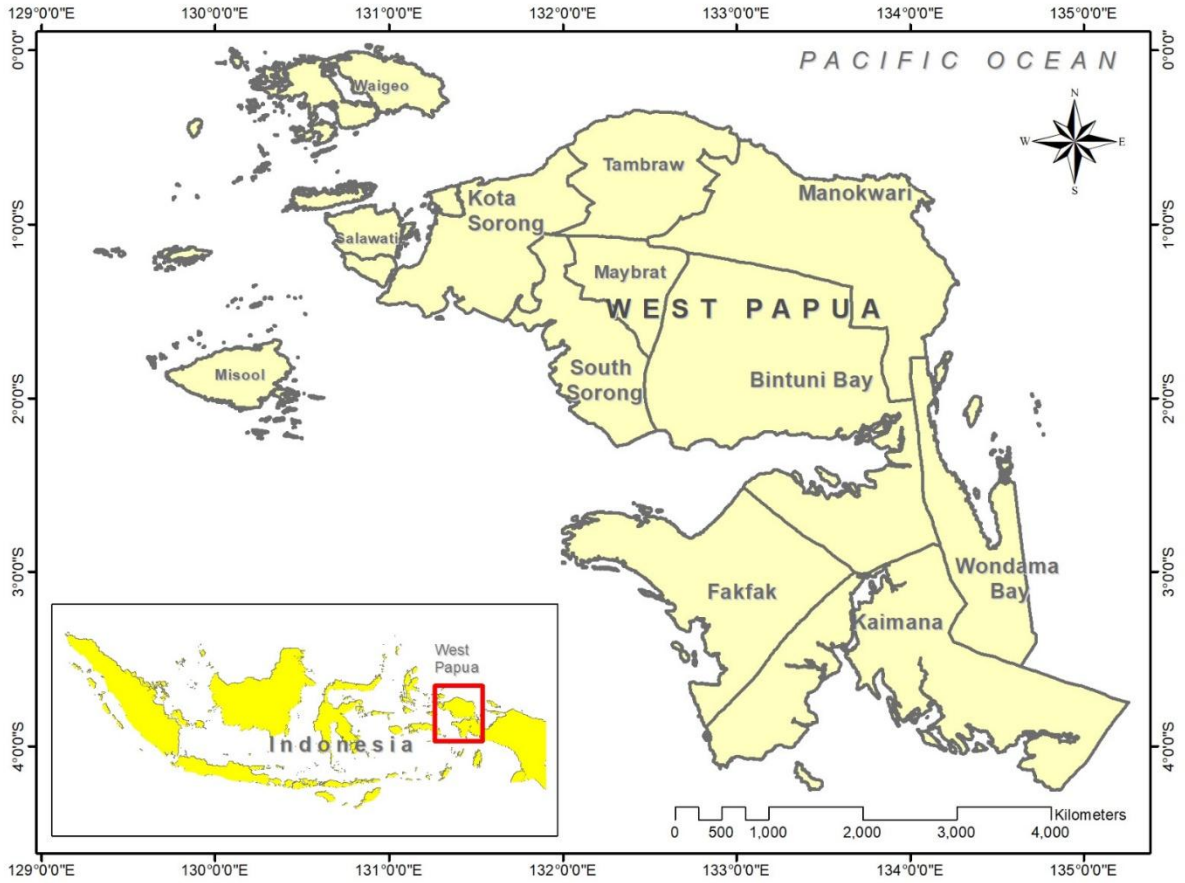

Fig. 1. Study site of SMFI in West Papua, Indonesia.

2.2 Method of Data Analysis

Analysis of Small and Medium Fisheries Industries (SMFI) Development Framework was introduced as an initial tool, basic information, best practices, and a lesson learned on how Small Medium Fishery Enterprises (SMFE) to build [14]; evaluation of new fishery performance indicators (FPIs); management tool for triple bottom line outcomes; and optimization of small fisheries enterprise with fishery performance indicators through the triple bottom line. In this paper, an analysis of the SMFE development framework is built using a local community empowerment approach (social-economic aspects) and maximum sustainable yield (ecological aspects [15-17]. The time trend analysis based on least squares method, as follows:

$$\hat{Y}_i = a + bt_i \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad 1$$

$$a = \overline{Y_i} - b\overline{t_i} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad 2$$

$$b = \frac{\sum(t_i - \overline{t_i})(Y_i - \overline{Y_i})}{\sum(t_i - \overline{t_i})^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad 3$$

where, $\hat{Y}_i$ is dependent variable to be predicted and $\overline{Y_i}$ is averages of dependent variable. While notation, t_i is time trend and $\bar{t}_i$ is average times. Meanwhile, a shows constant and b denote coefficient.

3. RESULTS AND DISCUSSION

3.1 The Role and Contribution of the Fisheries Sector

West Papua Province is one of the provinces in Indonesia which has high marine fishery potential. Fishery resources in the sea of West Papua include small pelagic fish, large pelagic fish, penaeid shrimp, and reef fish, as well as various other types of fish. The results of a study conducted by West Papua Research and Innovation Agency and the University of Papua - Bank of Indonesia in the form of capture fishery products are one of the superior products in West Papua Province. Data of Year 2017 showed that the contribution of the capture

fisheries sector in West Papua Province was 5.97 percent of the total national capture fisheries. This contribution is the largest contribution in the Sulampua region (Sulawesi, Maluku, and Papua). Based on the area in West Papua, Kota Sorong is the area with the largest contribution to West Papua Province capture fisheries [18,19].

Another measure that can be used to see the role of the fisheries sector in the economy is the sector's contribution to the Gross Regional Domestic Product (GRDP). In 2020, the sector's contribution to GRDP shows that the fisheries sub-sector is able to contribute 5.70 percent. The fisheries sub-sector is the largest contributing sub-sector in the agriculture, forestry, and fisheries sector group). Furthermore, capture fisheries production increased for three years (Fig. 2). This increase was triggered by local government policies in allocating aid for fishing gear for local communities [20].

Fisherman households in West Papua Province tend to experience an increase from year to year. The average growth in the last four years was 0.99 percent (Fig. 3). Kota Sorong is the area with the largest number of fishing households in West Papua Province. In general, the style of fishing households in West Papua Province is small-scale fisheries. This is indicated by several indicators: 1) the fishing technology used by most fishermen is hand-line which is a traditional technology, 2) the fishing boats used are traditional boats (boats without motors), 3) the resulting product is sold directly. This condition causes the added value of capture fisheries not to be felt optimally by fisherman households in West Papua Province and in the end, their level of welfare does not increase. This shows that the wealth of marine resources owned by West Papua Province has not been able to prosper the community, especially fishermen. West Papua Province is the second province in Indonesia which has the highest percentage of poor people after Papua Province [21].

On the other hand, West Papua Province is one of the conservation provinces in the world and the only one in Indonesia. As a conservation province, development in West Papua Province should adhere to a sustainable development paradigm. In the fisheries sector, especially marine fisheries, various efforts have been made by the local provincial government, one of which is to designate several areas as conservation areas. In addition, the government also limits overfishing based on Decree of the Minister of Maritime Affairs and Fisheries No 50/KEPMEN-KP/2017. However, several marine fisheries catches have been in a condition of overfishing in the territorial waters of West Papua [22].

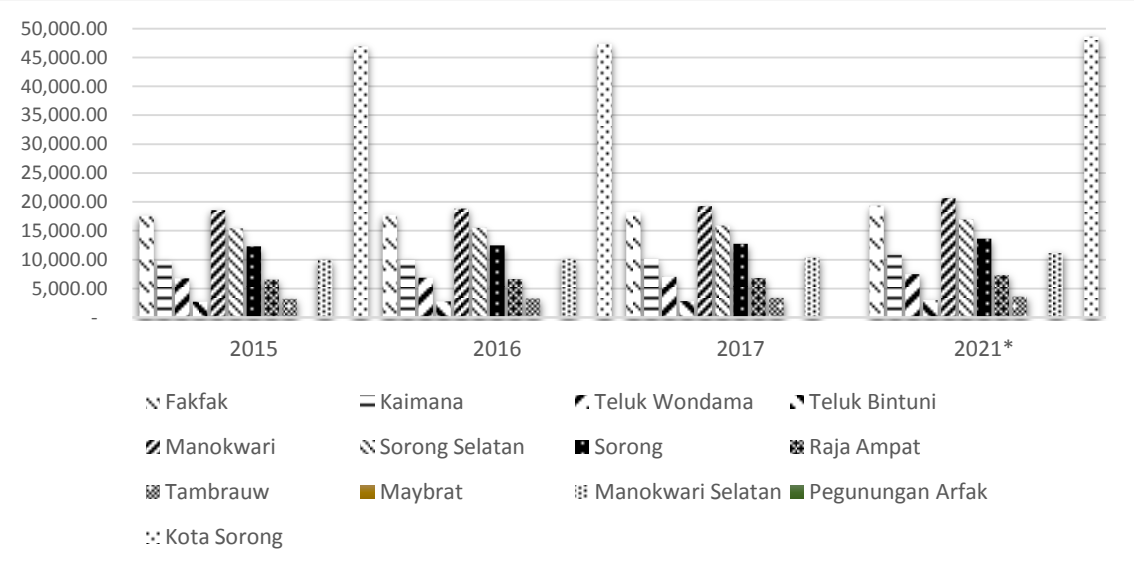

Fig. 2. Marine fisheries production by district/city in West Papua Province, 2015 – 2017 (tonnes)

*Note: *linear trend prediction*

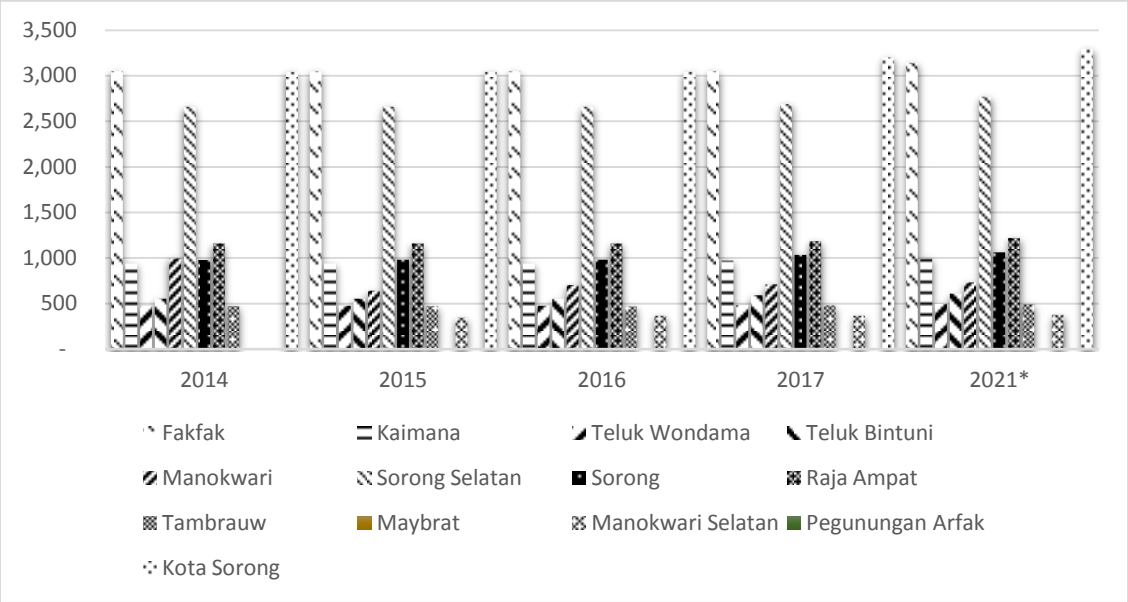

Fig. 3. Number of Fisherman Households by Regency/City in Papua Barat Province, 2014 – 2017

*Note: *linear prediction*

3.2 Capacity Building for Fisherman Households

The short-term impact of sustainable development policies on the marine fisheries sector carried out by the West Papua Provincial government is a decrease in people's income, especially fishing households. One effort that can be done is to increase the added value of fishermen's catches. Increasing this added value can be done by downstream the industrializing marine fishery products. The intended industrialization is sustainable industrialization which is a critique of conventional industrialization. Conventional industrialization failed for several reasons, namely: (1) a misunderstanding that fish resources can be recovered (renewable resource), so that they are exploited on a large scale, causing the problem of "tragedy of the open access" in natural resource management. fisheries in several places; (2) maximizing the production of fish catches to achieve maximum profit; and (3) a misunderstanding that the capture fisheries business is something separate (not a unit) between fishermen, fish and their ecosystem [23].

The sustainable fishing industry development model is one of the answers to fisheries problems in West Papua Province. Another site, the industrialization of fisheries will increase the added value of fishermen's fishery products so that it will increase their income. On the other hand, sustainable industrialization will be able to preserve marine ecosystems. This model can then be used as a model for sustainable fisheries management in conservation areas spread across West Papua Province.

The added value of the fisheries sector in West Papua Province can be said to be still low. This can be seen from the processing method carried out by the majority of the community, where the catch is sold directly and only a small amount is then processed into processed products. Most fishery products are marketed fresh, namely 55.26 percent of the total catch. While. the average catch that received further processing (drying/salting, smoking and canning) was 1.20 percent. This condition indicates that the management of capture fisheries in the province level has not been carried out optimally to increase product-added value [24].

Capture fishery products whose processing methods are marketed fresh provide the lowest added value from the value chain. The impact of this low added value is twofold: first, fishing households will gain little profit from the catch they get so they cannot increase their production capacity making it difficult to develop. Second, the contribution of capture fisheries to West Papua GRDP can be categorized in the growing dimension with pressure on the Klassen Typology classification [25].

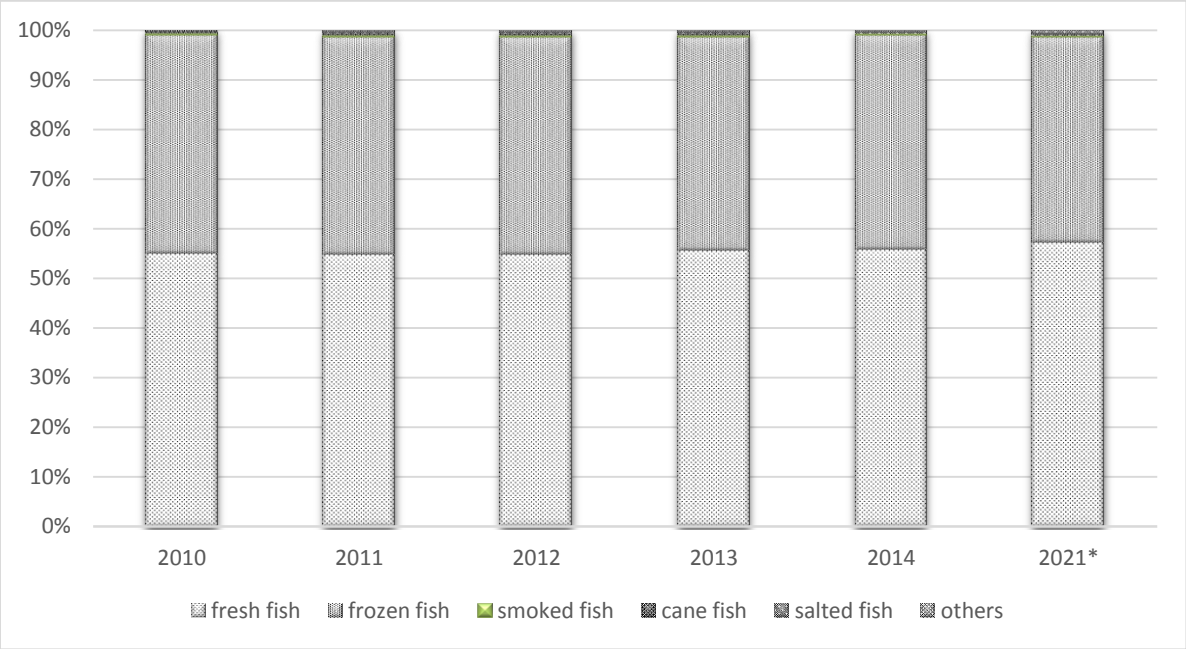

Fig. 4. Contribution of methods of processing capture fisheries products in West Papua Province, 2010 – 2014

*Note: *linear prediction*

One solution that can be done to increase the added value of the capture fisheries sector is industrialization. Thus, it is necessary to have a good mapping of what type of fishing industry is suitable for each region in West Papua Province to increase the added value of the fisheries sector which in turn can improve the welfare of fishermen. However, on the other hand, social and environmental aspects need to be considered in formulating policies related to the fishing industry. On the social side, it is necessary to pay attention to local institutions that currently exist in the community. Meanwhile, from the environmental side, attention must be paid to the carrying capacity of the environment and its sustainability. The results of research conducted by the Regional Research and Development Agency of West Papua show that each region in the province level has superior commodities and different utilization levels.

3.3 Maximum Sustainable Yield Approach in SMFI

The global trend of society in the current era of globalization is the desire to pay for goods that are of good quality and environmentally friendly (eco-label). This condition becomes important in ensuring the existence of SMFI when faced with fishery resources (stock availability) and economic aspects related to demand. This means that the decision to buy fishery products is almost unrelated to price, but rather to the quality of products produced by SMFI. Modern society is more sensitive to the quality, constituent composition and form of fishery products, in addition to the characteristics of natural fishery resources. This condition is changing and difficult to predict from the aspect of market demand and raw materials from nature.

Building a thriving fishing industry with the principle of sustainability of existing fishing models is important in West Papua Province. The facts show that the environmental impacts of global seafood production are well known [26] and there is a tendency for global fishery resource depletion due to over-exploitation of many species [27,28], the effect of fishing on the entire ecosystem is illustrated by diversity, change and resilience of ecosystems [29], and reduction of marine biodiversity [30]. These conditions are just some of the main environmental problems associated with the intensive exploitation of the sea that has been happening so far. This concern for marine preservation does not only have an impact on fishing but also spreads across all fishing industries related to the processing and distribution of fishery products.

Current environmental problems have shifted from an assumption or paradigm to become a major problem for product competitiveness in many fisheries sectors engaged in SMFI. In this context, the fishing industry must start from the production process by looking at the availability of fishery resources as a central part of an industrial approach that is oriented towards exploiting sustainable fisheries potential (Maximun Sustainable Yield, MSY). The number of catches is adjusted to the amount that can be utilized without exceeding the natural carrying capacity of fishery resources in nature. Activities to utilize resources that are the target of fishing can still guarantee natural processes or recruitment of natural stocks. Thus the fishing industry plays an important role in reducing industrial waste [31], and consequently has an economic impact on traditional food producers [32], or Fisheries Households (FHs) which can take advantage of the economic finance created by the SMFI. This means that there are FHs as fish fishermen and there are FHs processing fishery products and there are FHs engaged in the marketing and distribution of fishery products.

The synergistic effect of the economic opportunities that are created spatially from the SMFI is the analysis of the development framework of this study. The clusters that are formed as a result of the SMFI style become a concept in its development. This condition is achieved by optimizing the fishing business (FHs) based on the economic variables of SMFI and MSY integrated into an analysis of the SMFI development framework in West Papua Province. Another specific characteristic is the spatial distribution of SMFI according to the characteristics of fishery resources. This context provides a win-win solution between the SMFI business economy and fishery resources contributing to each other in creating the sustainability of SMFI West Papua Province in the future.

In detail, an analysis of the SMFI development framework is carried out in the following stages:

1. The survey will be conducted on micro and small-scale fishery business actors (or fishermen), policymakers, researchers, or stakeholders. Stakeholders are those who have an understanding of the fishing industry in West Papua Province. Primary data for micro and small-scale industries include. Catching activities include: fishing gear, supporting facilities, catchment areas, catches, marketing areas, marketing of results, operational costs etc.
2. Conduct an investment feasibility analysis for each industry selected as a potential fishing industry to be developed.
3. Conduct a simulation to obtain a model for developing a sustainable fishing industry. This stage will obtain a fishing industry that provides optimal profits with a sustainable environmental carrying capacity where the MSY value is taken into account.
4. Performing various simulations on the financial feasibility and maximum sustainable yield (MSY) data that has been obtained. This condition will show the optimal condition of SMFI's business (Fig. 5). Optimization is carried out to obtain a financially feasible fishing industry with maximum sustainable yield (MSY) constraints. MSY used, MSY multi-species or MSY species, depending on the type of raw material for the fishing industry (fish species). Monte Carlo Simulation (MCS) is used to find the optimal SMFI development from scenario analysis that calculates the magnitude of change in a dependent variable when several independent variables change simultaneously. MCS calculates a very large number of scenarios to estimate the spread of possible outcomes in a given situation. The possible scenarios that occur are simulated in a more complex manner
5. Conduct a sensitivity analysis to determine the intensity of sensitive interests that affect sustainability. Each dimension requires an anomaly analysis that shows the sensitivity of each interest. Monte Carlo analysis is used to determine the effect of calculation errors and misjudgments on the interests of respondents. If the difference between the Monte Carlo sustainability index and the sustainability index is less than 1, the effect of error in the analysis is small. Therefore, the smaller the difference between the sustainability index and the Monte Carlo simulation, the more accurate the results [20,33]. According to Idris and Kavanagh [21,34] Goodness of Fit is indicated by the magnitude of the stress value [20,33], while the validity of the model is indicated by the magnitude of the stress value. The results of the analysis that can present the model well are shown by the strees value below 0.25 and R2 which is close to 1 or 100%.

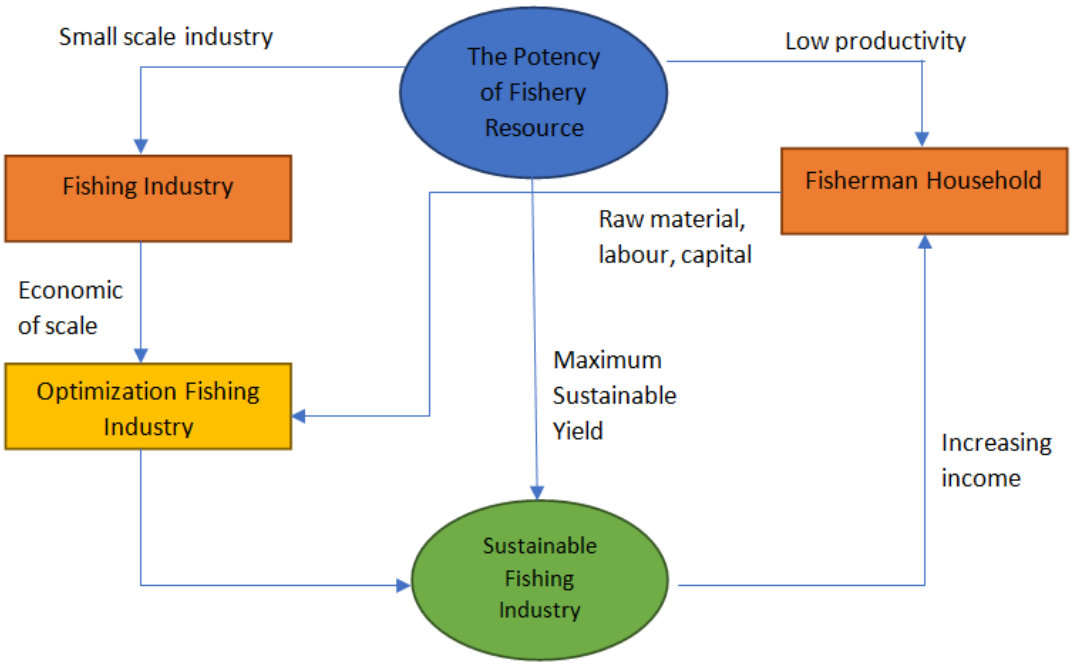

Fig. 5. Analysis of SMFI development framework

4. CONCLUSION

The assessment of the analysis of SMFI development framework can be used as a concept in the development of FHs in West Papua Province. This concept considers the sustainability of fishery resources with the MSY approach and the capacity of fishing households. This approach allows for an integrated approach between environmental values and the economic and social benefits of fishing households. It is necessary to have policies and strategies that encourage a sustainable blue economy sector so that social status can be fulfilled in the context of developing the three pillars of sustainable development goals in the Land of West Papua. Besides that, working capital, market, and technology incentives are urgently needed in an effort to increase the economic sector as support for the SMFI in order to increase West Papua Gros Domestic Products from the fishery sector.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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