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# STATUS OF SUSTAINABILITY TUNA FISHERIES MANAGEMENT IN THE BORDER AREAS OF INDONESIA AND TIMOR LESTE IN THE OMBAI STRAIT

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***Abstract***

*The potential of tuna fisheries resources in the border area of Indonesia and Timor Leste in the Ombai Strait has provided benefits for fishermen. In order to ensure the creation of a balance between the availability of tuna fish resources and their use by fishermen, it is necessary to have sustainable tuna fisheries management in the border areas of Indonesia and Timor Leste. This research aims to assess the status of management sustainability, determine management driving factors and analyze management priority scenarios. Data analysis was carried out using Multiaspect Sustainability Analysis (MSA) with EXsimpro software. The sustainability of tuna fisheries management in existing conditions is classified as sustainable. The driving factors for improving tuna fisheries management consist of CPUE trends, range collapse of fish resources, fishing capacity, application of fish handling technology, local wisdom, fishermen's cooperation, savings ratio, fishermen's assets, community participation and fisheries improvement programs. The status of highly sustainable tuna fisheries management can be achieved through moderate scenarios and optimistic scenarios. Efforts must be made to improve the leverage factors for improving tuna fisheries management to achieve a highly sustainable management status.*

***Key Word****: Fisheries management; Multiaspect sustainability; Tuna; Small-scale fisheries; Ombai Strait*

## Introduction

Indonesia is one of the largest tuna producers in the world [1-4] and together with the Philippines and Papua New Guinea has the potential for skipjack, yellowfin tuna and bigeye tuna [5] Furthermore, *D.E. Duggan and M. Kochen* [2] and *I. Sar et al.* [6] stated that small-scale tuna fisheries in Indonesia are essential to the Indonesian fisheries sector. However, Indonesian tuna fisheries face many challenges in their management.

*I. Sar et al.* [6], *I. Tauda* [7] and *I. Jaya et al.* [8] stated that the challenges of tuna fisheries management in Indonesia mainly concern juvenile bycatch, lack of effective fishing gear regulation, fishing fleet subsidies and unreported catches. This condition is compounded

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by the fact that supervision over the implementation of regulations still needs to be improved [1]. It is hoped that Indonesia can more effectively manage its fishing fleet and tuna stocks so that, in turn, it can improve regional tuna fisheries management [2, 3, 5].

The Ombai Strait is one of the entrance corridors for all types of marine biota originating from the Flores Sea and Banda Sea to the Sawu Sea and Indian Ocean or vice versa. *S. Gigentika* [9] and *T.W. Nurani et al.* [10] stated that the waters around Nusa Tenggara are the waters through which tuna fish migrate. The RI-RDTL border area is on the tuna fishing route in the Ombai Strait and Sawu Sea, which has the consequence that the waters in this region are rich in fish resources, especially tuna and the dominant tuna resources caught in the waters of the Ombai Strait are grouped into coastal fisheries and classified as small-scale fisheries.

Sustainability is essential in creating a balance between nature and humans [11, 12]. It was further explained that the fundamental essence of sustainability is continuously implementing strategies for a harmonious relationship between humans and nature. An important thing related to sustainability is how to measure and assess it. *I. Firmansyah* [13], *M.A. Gbededo et al.* [14] and *E.L. Yeyati & F. Sturzenegger* [15] state that sustainability analysis is an analysis carried out to look at various aspects that have their respective levels of importance to obtain a balance value between all aspects so that they are sustainable into the future.

Studies related to fisheries in the border areas of Indonesia and Timor Leste have been carried out by several previous researchers, including small-scale fisheries [16], tuna fish resources [17], cross-border fisheries [18], small pelagic fisheries [19], flying fish resources [20] and bioeconomics of small pelagic fish resources [21] Studies related to tuna fisheries in the border areas of Indonesia and Timor Leste have never been carried out. In order to ensure the creation of a balance between the availability of tuna fish resources and their use by fishermen, it is necessary to have sustainable tuna fisheries management in the border areas of Indonesia and Timor Leste. In this effort, several things need to be studied in depth, including: i) the sustainability status of tuna management; ii) factors driving sustainable tuna fisheries management and iii) priority scenarios towards sustainable tuna fisheries management. This research aims to: i) Assess the sustainability status of tuna fisheries management; ii) Determine the driving factors for sustainable tuna fisheries management and iii) Analyze priority scenarios for sustainable tuna fisheries management.

## Materials and Methods

### *Study area*

This research was carried out in the border area of Indonesia and Timor Leste in Belu Regency, East Nusa Tenggara Province, Indonesia. Data was collected at fishing centers in Jenilu Village, Dualaus Village, Kenebibi Village and Silawan Village (Fig. 1).

### *Data collection*

The data collected in this research includes primary data and secondary data. Primary data was collected through survey methods using interview techniques, FGD, observation and measurement. The data required covers five aspects: ecology, fishing technology, social, economic and institutional.

The indicator used in this research for assessing the sustainability status of tuna fisheries management is a modification of the assessment method using indicators for fisheries management with an ecosystem approach (EAFM) [22] Modifications to EAFM indicators are adjusted to tuna fisheries' characteristics and carried out through reference studies and expert judgment.

Analysis of sustainability status, factor sensitivity values, driving factors, priority scenarios and policy strategies will be carried out using Multiaspect Sustainability Analysis (MSA) with the help of Exsimpro software. Stages of sustainability analysis with MSA include: a) Preparing the MSA questionnaire; b) Expert judgment; c) Sustainability assessment by selected respondents; d) Assessment with Exsimpro software; e) Determination of driving factors; f) Scenario analysis and g) Implementation [14].

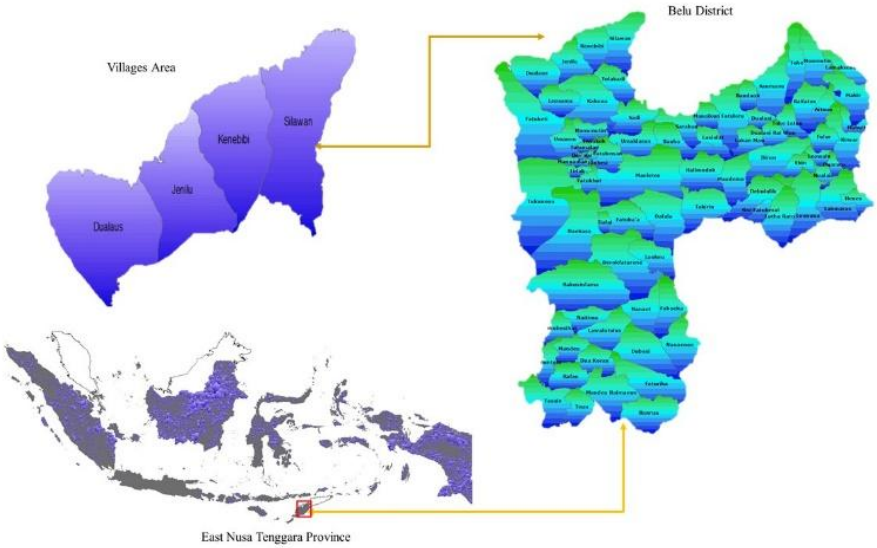


**Fig. 1.** Map of research locations in Belu Regency, East Nusa Tenggara, Indonesia

## Results and discussion

### *Respondent characteristics*

Focus Group Discussion (FGD) was used to cross-check information obtained during the interview survey and identify specific cross-border issues and problems. FGD participants invited were based on the primary duties of institutions/agencies related to fisheries management in the border areas of Indonesia and Timor Leste. In Belu Regency, FGD was carried out by inviting representatives of fishermen from 4 villages (Dualaus, Jenilu, Kenebibi and Silawan), fisheries entrepreneurs, academics, fisheries managers (East Nusa Tenggara Maritime and Fisheries Agency, Belu Fisheries Agency) and fisheries functional (supervisors, extension workers, quarantine). The characteristics of the FGD participants were analyzed based on gender, age, occupation and experience. FGD participants consisted of 76% men and 24% women. FGD participants were dominated by the age group >50 years, as much as 41%.

### *Characteristics of tuna fisheries*

Tuna fisheries in Belu Regency have developed since the early 1990s through fishing activities carried out by fishermen from the Bajo tribe who regularly visit the north coast of Belu Regency to catch tuna and market their catches. As time goes by and with the opening of fish marketing channels outside the region, especially Bali via Kupang, tuna fishing activities increase and the number of tuna fishing fishermen continues to increase with the arrival of tuna fishermen from South Sulawesi (Bajo tribe) and Southeast Sulawesi (Buton) who settle in Jenilu Village, Kakuluk Mesak District. Currently, three tuna fishing communities in the sub village of Fatuluka, Fatukaduak and Nualaran in Jenilu Village. Apart from that, some local

fishermen have the expertise to catch tuna and engage in fishing activities. Currently, two fisheries entrepreneurs in Jenilu Village purchase, store and market tuna fish.

The catches of tuna, skipjack and mackerel tuna that are landed and marketed in Belu Regency consist of yellowfin tuna *(Thunnus albacares)*, skipjack *(Katsuwonus pelamis)* and mackerel *(Euthynnus affinis)*. The main target for catching tuna fishermen in Belu Regency is yellowfin tuna and processing it into loins. Tuna loin is the main product of processed tuna marketed outside the region, especially in Bali. Tuna production recorded at the East Nusa Tenggara Maritime and Fisheries Agency of TTS, TTU, Belu and Malaka Branch Offices in Atambua during the 2020 – 2022 period is presented in figure 2.

Figure 2 shows the production trend, which fluctuates monthly and tends to experience the highest production in June and March and the lowest in January-February and August-September. These results also show that the tuna fishing season in Belu Regency lasts throughout the year. The peak fishing season occurs in May - June and the lean season occurs in January - February and August - September. A comparison of average monthly production for the 2020 – 2022 and the 2011 – 2016 periods is presented in figure 3.

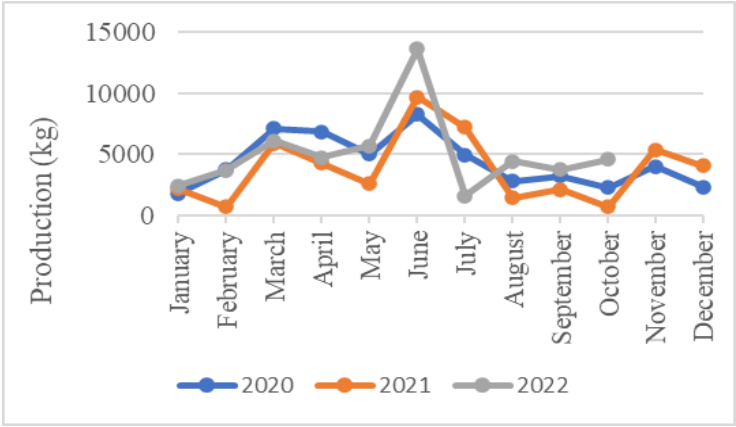


**Fig. 2**. Production trend (Kg) of tuna fisheries in 2020 – 2022 in Belu Regency

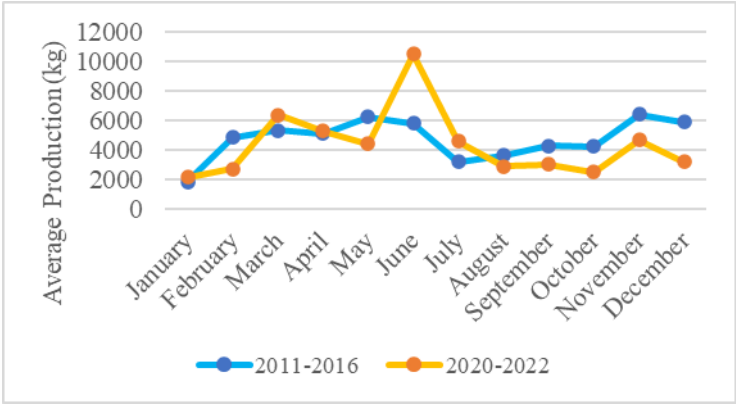


**Fig. 3.** Comparison of average monthly production for the period 2020 – 2022 and 2011 – 2016

The sampling results for recording catches of tuna fishing fleets from July to December 2022 are presented in Table 1. During the recording period, the success rate of fishing days (%)

shows an increasing trend from July – December 2022. The highest success rate was achieved in December and the lowest was in July. The success rate of fishing trips (%) shows the same trend from July to December 2022.

**Table 1**. Sampling results for recording tuna catches during the period July – December 2022

| Month | Number of days of fishing operations | Number of days of successful capture | Capture day success rate (%) | Number of fishing trips | Catch Trip Success Rate (%) |
|---|---|---|---|---|---|
| July 2022 | 31 | 12 | 38.71 | 341 | 4.10 |
| August 2022 | 31 | 21 | 67.74 | 341 | 13.5 |
| September 2022 | 30 | 23 | 76.67 | 330 | 12.73 |
| October 2022 | 31 | 22 | 70.97 | 341 | 14.96 |
| November 2022 | 30 | 26 | 86.67 | 330 | 23.03 |
| December 2022 | 6 | 6 | 100 | 66 | 39.39 |

Trends in tuna catches per trip from July to December 2022 are presented in Table 3. The analysis results show that the average number of catches per trip ranges from 0.05 – 0.55fish/trip, the highest in December and the lowest in July. The average catch weight per trip ranged from 2.08 – 20.28kg/trip, the highest on December trips and the lowest on July trips. The average weight of catch per fish ranged from 27.53 – 30.35kg/fish; the highest average weight was caught in July and November and the lowest in September.

**Table 2**. Trends in tuna catches per trip during the period July – December 2022

| Month | Average number of catches per trip (Tail/trip) | Average weight of catch per trip (Kg/trip) | Average catch weight per fish (Kg/fish) |
|---|---|---|---|
| July 2022 | 0.05 | 2.08 | 30.35 |
| August 2022 | 0.20 | 7.55 | 28,20 |
| September 2022 | 0.18 | 6.24 | 27.53 |
| October 2022 | 0.26 | 6.74 | 28.96 |
| November 2022 | 0.31 | 11.99 | 30.35 |
| December 2022 | 0.55 | 20.28 | 27.63 |

The tuna fishing fleet in Belu Regency uses motorboats made from fiber and wood/board materials and equipped with inboard and outboard engines with sizes ranging from 1 – 2 gross tons (GT). East Nusa Tenggara Maritime and Fisheries Agency data for 2021 shows that the number of motorboat fleets recorded in four coastal villages is 303 units, consisting of 62% motorboats measuring 1 GT, 34% measuring 2 GT and 3% measuring >2GT. There are 102 tuna fishing fleets with a capacity of 2 GT (34%) in Jenilu Village (Table 3).

**Table 3**. Distribution of fishing fleets by size and village in Belu Regency

| Village | Number of motorboats | Type of Boats | | |
|---|---|---|---|---|
| | | 1 GT | 2 GT | > 2GT |
| Fatuketi | - | - | - | - |
| Kenebibi | 34 | 34 | - | - |
| Dualaus | 126 | 125 | - | 1 |
| Jenilu | 132 | 20 | 102 | 10 |
| Silawan | 11 | 9 | - | 2 |
| Amount | 303 | 188 | 102 | 13 |

Source: Maritime and Fisheries Agency of East Nusa Tenggara Province (2021)

The distribution of fishing gear by type in Belu Regency is presented in Table 4. Maritime and Fisheries Agency data for East Nusa Tenggara Province for 2021 shows that fishermen use three types of fishing gear: trolling lines, handlines and gillnets. Tuna fishing is carried out by fishermen using trolling lines and handlines. Table 4 shows that 105 units (35%) of hand fishing gear are found in Jenilu Village.

**Table 4**. Distribution of fishing gear by type and village in Belu Regency

| Village | Number of fishing gear by type | | | Amount |
|---|---|---|---|---|
| | Trolling lines | Handlines | Gillnets | |
| Fatuketi | - | - | - | 0 |
| Kenebibi | - | 1 | 33 | 34 |
| Dualaus | - | 12 | 114 | 126 |
| Jenilu | 105 | 23 | 4 | 132 |
| Silawan | - | 1 | 10 | 11 |
| Amount | 105 | 37 | 161 | |

Source: Maritime and Fisheries Agency of East Nusa Tenggara Province (2021)

***Factors and indicators of sustainability in tuna fisheries management***

Tuna fisheries management in Belu Regency aims to preserve the tuna ecosystem and resources and improve the welfare of the community (fishermen) through effective tuna fisheries management. Based on these objectives, five aspects of sustainable tuna fisheries management in Belu Regency were formulated, including:

1. Ecological aspects: ecosystem health and fish resource status.
2. Fishing technology aspects: fishing gear selectivity and environmental friendliness, fishing capacity and product handling technology.
3. Social aspects: conflict and cooperation, local wisdom.
4. Economic aspects: fishermen's income, savings ratio, productive assets and market access.
5. Institutional aspects: community participation, compliance, fisheries management plans and synergy of institutions and policies.

The sustainability status of tuna fisheries management in Belu Regency is assessed based on five aspects and 19 factors. These factors result from a desk study of previous studies published in reputable national and international journals. Apart from that, to formulate factors appropriate to the conditions of tuna fisheries in the Belu Regency, a compilation of data collected in the field and expert validation was conducted.

The ecological aspect of sustainable tuna fisheries management in Belu Regency is based on two critical parameters, namely ecosystem health and fish resource status, which includes four indicators, namely the presence of charismatic species, ETP species - Endangered, Threatened, Protected (rare, threatened species endangered and protected) caught, trends in CPUE (Catch per Unit Effort) and range collapse of tuna fish resources. The fishing technology aspect includes three critical parameters: fishing gear selectivity and environmental friendliness, fishing capacity and product handling technology. It includes four indicators: fishing gear selectivity, destructive and illegal fishing, fishing capacity and implementation of fish handling technology. Furthermore, *T.V. Nguyen et al*. [23] said that using appropriate fishing technology can help increase productivity efficiency, technical efficiency and technological change in tuna fisheries in Vietnam. The social aspect consists of two critical parameters, namely conflict and cooperation and local wisdom, which includes three indicators: conflict between fishermen/fleets/fishing gear/fishing areas, fishermen cooperation (formal and informal) and utilization of wisdom local management of coastal and marine resources.

The economic aspect includes parameters of fishermen's income, savings ratio, production assets and market access, which includes indicators of fishermen's income, fishermen's savings ratio, fishermen's assets and market access. The fishermen's income indicator refers to all income received by fishermen originating from fishing activities. The fishermen's income indicator uses the Regional Minimum Wage (RMW). Belu Regency's RMW in 2022 is IDR 1,975,000. The fishermen's savings ratio indicator compares the difference between the income and expenses of fishermen's families and their income. A positive ratio indicates fishermen can save part of their income, whereas a negative ratio indicates their inability to save. The fishermen's assets indicator refers to asset ownership, which compares the number of productive assets owned by fishermen's households currently and the previous year [24]. The increase in fishermen's ownership of productive assets indicates good performance of productive asset indicators. Market access shows the ability of fishermen and/or fisheries product traders/entrepreneurs to reach specific markets. Market access includes local, regional/national and international market coverage.

Essential parameters for institutional aspects include community participation, compliance, fisheries management plans and synergy between institutions and policies. Indicators for assessing institutional aspects include community participation in capture fisheries management, compliance with regulations, the Fisheries Improvement Program (FIP) or tuna fisheries improvement program and the level of synergy of fisheries management policies & and institutions [3, 25, 26]. Community and other stakeholder participation in tuna fisheries management is demonstrated by the frequency of participation in fisheries management activities [3, 4, 26, 27]. Good performance of community participation indicators is determined based on participation and effectiveness [28-30]. Compliance with regulations is demonstrated by the number of violations of applicable fisheries management regulations [31]. The more you obey the rules, the smaller the number of violations. The tuna fisheries improvement program is an effort to develop sustainable tuna fisheries practices that have a long-term impact on fishermen's welfare, fish resources and governance. A program plan supports good tuna fisheries management and effectively implements it. The level of synergy between management policies and institutions is an essential indicator in supporting the success of sustainable fisheries management [32, 33]; practical management actions must cover various aspects, such as regulating fishing pressure, managing habitat, managing non-target species and managing fishing capacity. So, sustainable fisheries management requires good policy synergy and institutional management. There is good synergy between policies and management institutions if there is integrated action between institutions and policies in fisheries management so that there is no conflict.

*F. Tolentino-Zondervan and N.A. Zondervan* [34] conducted research related to sustainable fisheries production that contributes to economic, social and environmental goals and conducted a meta-analysis of the implementation status of various sustainable fisheries management strategies in the Philippines over the last 20 years. The research results show that overall, the sustainability management theme is more socio-economic. *Duggan et al.* [2] have researched to analyze the sustainability status of tuna fisheries from three dimensions. The research results show that the sustainability status seen from three dimensions, namely ecological, economic and social, shows that the level of sustainability of tuna fisheries from the economic and social dimensions is categorized as entirely sustainable. In the ecological dimension, it is categorized as less sustainable. In general, the level of sustainability of tuna fishing in Sendang Biru is entirely sustainable. There is a need for activities related to environmental conservation to increase ecological sustainability. Apart from that, it is necessary to provide outreach and training about aquatic ecosystems so that they utilize natural resources in the short term and long term. Furthermore, *D. Hermawan et al.* [35] have researched to

analyze the sustainability and feasibility of the skipjack fishery on Buhung Pitoe Island, Indonesia, from an economic aspect. The research results show that the level of sustainability of the skipjack fishery on Buhung Pitoe Island is entirely sustainable from an economic perspective, with a sustainability index value of 53.07%. Five attributes leverage the sustainability of the skipjack fishery business: level of economic accessibility, existence of economic institutions, business managerial ability, knowledge/skills in business and business feasibility.

In a socio-cultural context, an important issue related to managing transboundary fisheries in the border areas of Indonesia and Timor Leste is the cultural connection between the Belu Regency and Bobonaro District communities. It is shown by the local wisdom of the people in the two areas, which is similar, namely in the form of traditional rules/prohibitions carried out with the permission of traditional elders (traditional leaders), which are marked by tying prohibitory signs to trees or poles through traditional processions. This local wisdom practice has been implemented to regulate the use of natural resources in coastal areas in both areas. In Aidabaleten Village, Bobonaro District, the local wisdom of Tara Bandu has been implemented in establishing a custom-based marine protected area.

Apart from that, there are social relations between communities in the border areas of Indonesia and Timor Leste, but they have yet to be utilized to support fisheries management; socio-culturally, traditional communities in Belu Regency and Bobonaro District have strong family ties. It can be seen from the language used, traditions and customs in both communities. These socio-cultural relationships can become social capital in supporting efforts to manage coastal resources and cross-border fisheries in the border areas of Indonesia and Timor Leste in supporting a blue economy-based fisheries industry development strategy.

***Sustainability status***

Table 5 presents the results of the analysis of the sustainability of tuna fisheries management in Belu Regency. The status of tuna fisheries management in Belu Regency in existing conditions shows an aggregate value of 60,55 and is classified as sustainable. The governance and ecological aspects show low values and generally influence the aggregate value, while the economic aspects show the highest values compared to other aspects. It shows that the ecological and governance aspects have not performed well under existing conditions, while the economic aspects have the best performance.

**Table 5**. Results of sustainability analysis of tuna fisheries management in Belu Regency

| No | Aspects | Existing | Scenario 1 | Scenario 2 |
|---|---|---|---|---|
| 1 | Ecology | 58,25 | 66,75 | 91,75 |
| 2 | Fishing Technology | 62,50 | 71,00 | 91,75 |
| 3 | Governance | 50,00 | 62,50 | 87,50 |
| 4 | Social | 61,00 | 89,00 | 100 |
| 5 | Economy | 71,00 | 83,50 | 100 |
| | Total average | 60,55 | 74,55 | 94,20 |
| | | Sustainable | Sustainable | Very Sustainable |

***Leverage factors***

Lavarege factors describe the factors that most influence changes in the status of each aspect and aggregate status. The leverage factor value is taken from the highest value resulting from the sum of the maximum sensitivity value added to the actual sensitivity value [13]. The results of the analysis of driving factors for improving tuna fisheries management in Belu Regency are presented in Figure 4.


**Fig. 4**. Leverage factors for improving tuna fisheries management in Belu Regency

Figure 4 presents the maximum sensitive and sensitive value for all factors from ecology, fishing technology, social, economic and governance. The highest max sensitivity value is 0.5 and the highest sensitivity value is 1, so the highest total sensitivity value is 1.5. The sensitivity value shows the status of each factor in good or bad condition so that it needs improvement and is selected as a leverage factor. A factor with a sensitivity value of 0 indicates that the factor is in good condition and no improvement efforts are needed. On the other hand, a factor with a sensitivity value > 0 – 1 indicates that the factor is not in good condition and improvement efforts are still needed. Two driving factors from each aspect (5 aspects) are selected based on the sensitivity value, which has the highest sensitivity and combines the maximum sensitivity value factor plus the sensitivity value. The results of calculating the highest sensitivity value for each factor and determining the selected driving factors for each aspect are presented in Table 6.

**Table 6**. Leverage factors for improving tuna fisheries management in Belu Regency

| No | Aspect | Driving Factors (Leverage factors) | *Sensitivity Max* | *Sensitivity Value* |
|---|---|---|---|---|
| 1 | Ecology | 1) CPUE Trends | 0.33 | 0.67 |
| | | 2) *Range collapse*fish resources | 0.5 | 0.5 |
| 2 | Technology | 3) Fishing capacity | 0.33 | 0.67 |
| | | 4) Application of handling technology | 0.5 | 0.5 |
| 3 | Social | 5) Local wisdom | 0.33 | 0.67 |
| | | 6) Fishermen's cooperation | 0.5 | 0.5 |
| 4 | Economy | 7) Savings ratio | 0.5 | 0.5 |
| | | 8) Fishermen's assets | 0.33 | 0.33 |
| 5 | Governance | 9) Society participation | 0.5 | 0.5 |
| | | 10) Management improvement program | 0.5 | 1.0 |

Table 6 shows that the leverage factors for ecological aspects to improve tuna fisheries management in Belu Regency are CPUE trend factors and range collapse of fish resources [4, 36], explains that tuna fisheries in Indonesia have experienced a decline in production in recent years; the same thing also happens in general; the CPUE trend of tuna fisheries in Belu Regency shows a slight downward trend (< 25%) and the range of collapse of tuna fish resources is increasingly tricky and regional arrests are getting very far. The leverage factors for fishing technology to improve tuna fisheries management are fishing capacity and the application of fish handling technology [37, 38]. Tuna fishing capacity in Belu Regency has decreased by <50%. The implementation of tuna fish handling technology has been carried out but has yet to be effective in maintaining fish quality and increasing value. The leverage factor for the social aspect is using local wisdom in managing coastal and marine resources (CMR) and fishermen's cooperation. Indigenous communities in Belu Regency have local wisdom in managing natural resources but have yet to utilize it to manage coastal and marine resources. Fishermen's formal and informal cooperation has been carried out but has yet to be effective. The ratio of fishermen's savings and assets is a leverage factor in economic aspects for improving tuna fisheries management in Belu Regency. The fishermen's savings ratio is a comparison value of the difference between the income and expenses of the fishermen's family and their income, which shows a negative ratio value. Fishermen's ownership of productive assets tends to decrease compared to the previous year. Community participation and fisheries management improvement programs are the leverage factors for governance aspects to improve tuna fisheries management in the Belu Regency. Community participation in tuna fisheries management efforts in Belu Regency has been carried out but has yet to be effective. Documents on plans for programs to improve tuna fisheries management in Belu Regency have yet to be made available.

***Management scenarios***

Improving tuna fisheries management in Belu Regency is designed in two scenarios, namely moderate (1st scenario) and optimistic (2nd scenario). The moderate scenario is carried out by improving the driving factors in each aspect in order to increase the status of the assessment indicators to a better level. In contrast, the optimistic scenario is carried out by maintaining the indicator status and/or increasing the status of the assessment indicators by one level from the moderate scenario. The moderate scenario will increase each aspect's performance value and aggregate value to 74.55 and the sustainability status is classified as sustainable. The optimistic scenario increases the performance value of each aspect better than the moderate scenario and the aggregate value increases to 94.2 and is classified as very sustainable.

## Conclusions

The experimental data allows the drawing of the following conclusions:

1. The sustainability status of tuna fisheries management in Belu Regency in existing conditions is classified as sustainable.
2. The leverage factors for improving tuna fisheries management consist of CPUE trend factors, range collapse of fish resources, fishing capacity, application of fish handling technology, local wisdom, fishermen's cooperation, savings ratio, fishermen's assets, community participation and fisheries improvement programs.
3. Moderate and optimistic scenarios increase the sustainability status of tuna fisheries management, which is needed to achieve a very sustainable status.

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