

Vulnerability Assessment of Small-Scale Tuna Handline Fisheries in Morotai Island District

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ABSTRACT: Small-scale fisheries often face threats from various factors that have the potential to cause vulnerability and stagnation. This study aims to analyze the level of vulnerability of small-scale fisheries in Morotai Island Regency, focusing on aspects of natural resources, human, technology, social, economic and institutional. Data collection was conducted through a participatory approach, including questionnaires, interviews, and observations, and analyzed using the Likert scale method. The analysis was conducted using a Likert scale analysis approach to assess vulnerability in the six predetermined aspects. The results showed that the vulnerability assessment of the natural resources aspect is the most vulnerable aspect, while the human resources (HR), technology, social, economic and institutional aspects are aspects that are considered quite resilient for small-scale tuna fisheries in Morotai Island Regency. The eastern fishermen group has the lowest vulnerability due to limited technology and human resources, while southern fishermen, collectors, and institutions are more resilient, although they require improvements in technology, institutions, and policies to support small-scale fisheries in Morotai Island Regency.

KEYWORDS: Fisheries business, Morotai Island, resilience, small-scale, vulnerability.

I. INTRODUCTION

One of the areas in North Maluku Province that has potential fishery resources is Morotai Island Regency. Morotai Island Regency is a new expansion area since 2008 which is located between 20°-24°LU and 128°15'-128°48'BT. Morotai Island District borders the Pacific Ocean to the north, the Halmahera Sea to the east, the Morotai Strait to the south and the Sulawesi Sea to the west. Morotai Island Regency is included in three fisheries management areas, namely WPPNRI 715, 716, and 717. This geographical position is favorable for Morotai Island Regency, especially in tuna fisheries. BPS Morotai Island Regency [1] reported that tuna production in Morotai Island Regency in 2021 was 2,612 tons. This condition makes tuna fish a superior commodity in Morotai waters [2]. Tuna fishing by fishermen in Morotai Island Regency is generally a small-scale business, which is carried out using longlines and tonda with a one-day trip duration (one day fishing) [3] - [5]. However, this sector is also faced with various challenges and threats that can reduce the productivity, welfare, and sustainability of its business [6], so it is often categorized as a vulnerable sector [7].

Small-scale tuna handline fisheries in Morotai Island Regency are faced with threats from various factors such as limited fish resources or declining tuna stocks due to overfishing, uncertainty of catch and weather, and increasingly distant fishing grounds. These factors indicate

that the business is vulnerable to threats, and this can result in losses and stagnation that threaten the sustainability of small-scale tuna handline fisheries in Morotai Island District. Although the local government of Morotai Island Regency has the responsibility to develop the fisheries sector, there is currently no appropriate strategy to implement. In developing a strategy, supporting information is needed, including the level of vulnerability of small-scale tuna handline fisheries in Morotai Island District. Vulnerability information is very important in order to develop a more appropriate and sustainable fisheries management policy strategy.

Information on the level of vulnerability of small-scale tuna handline fisheries can be obtained by identifying six aspects that can affect the sustainability of small-scale tuna handline fisheries, namely natural resources, human resources, technology, social, economic and institutional aspects. Evaluation of these areas is conducted through participatory methods, such as interviews and observations, using a Likert-scale questionnaire. An in-depth understanding of these vulnerabilities is important for formulating effective fisheries development strategies. The information generated from this research can be used as a basis for policy formulation to improve the condition of small-scale fisheries businesses and assist in reducing or overcoming business vulnerabilities.

II. MATERIALS AND METHODS

A. Time and Place

Data collection was conducted in June and July 2024 in Morotai Island District, North Maluku Province. The

research location was carried out in 2 (two) sub-districts that have high tuna fishery activities in Morotai Island District, namely East Morotai District and South Morotai District. (figure1).

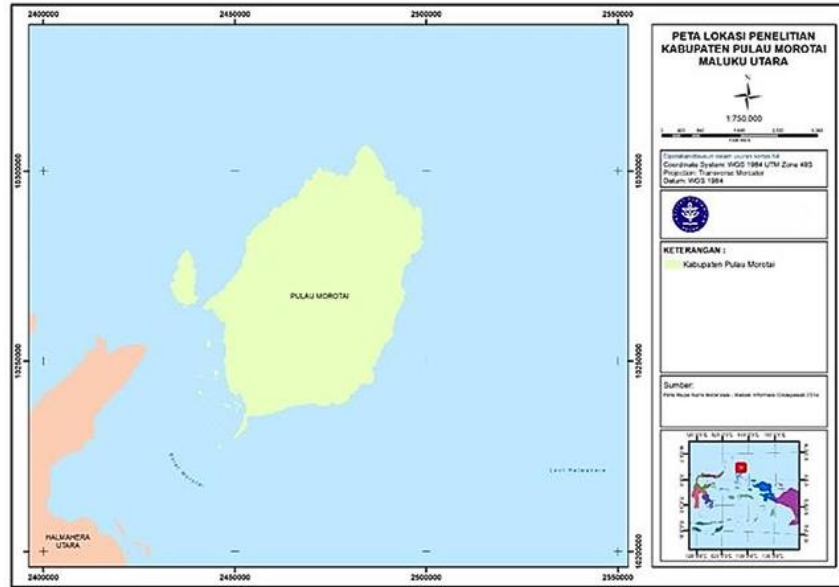


Figure 1. Map of the Research Location.

B. Tools

The tools used in the research and their uses are presented in Table 1.

No	Tool	Usefulness
1	Respondent	Interview questionnaire
2	Microsoft Excel	Data processing of research results

C. Method of collecting data

The types of data used in this research are primary data and secondary data. Primary data were collected through participatory methods, including interviews and observations, using a questionnaire with a Likert scale. The vulnerability assessment of small-scale fisheries businesses was conducted in six aspects: natural resources, human resources, technology, social, economic and institutional (Table 2), following the pattern of the “fisheries livelihoods resilience communities check (FLIRES check)” instrument [8]. During the field interviews, each respondent was asked to rate the attributes in the questionnaire. Each response was scored on a range from 1 to 4, with 1 being highly

vulnerable, 2 vulnerable, 3 moderately resilient and 4 resilient. Secondary data was obtained from literature relevant to the research topic.

Sample determination was carried out using purposive sampling method. The purposive sampling method was used to collect data from fishermen respondents, collectors, DKP Morotai Island Regency, Pacific tuna cooperative, SKPT (Integrated Fisheries Marine Center). The number of respondents was 47 people consisting of 40 fishermen from 20 people from East Morotai District and 20 people from South Morotai District, 4 collectors, 1 person from DKP Morotai Island, 1 person from SKPT and 1 person from Pacific tuna cooperative.

Table 2 Data types for measuring fishery vulnerability

Field	Attribute	Field	Attribute
SDA	1 Condition SDA	Social	1 Mutual cooperation nature
	2 Climate change		2 Community/social network
	3 Catch results		3 Family participation
	4 Catch size		4 Status and frequency of conflicts
	5 Fishing grounds		5 Environmental knowledge
	1 Fishermen skills		1 Business capital

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SDM	2 Young generation	Economic	2 Capital institutions
	3 Expected education (for children)		3 Ability to save
	4 Education of fishermen		4 Side business
	5 Understanding of SDI		
	1 Level of sophistication of new technology		1 Counseling
	2 Effective and efficient fishing aids		2 Social institutions
	3 Environmentally friendly technology		3 Long-term program/assistance (group)
Technology	4 Productive technology	Institutional	4 Long-term program/assistance (individual)
	5 Easy technology		5 Useful training
	6 Low-cost technology		

D. Data analysis

This study used descriptive analysis and vulnerability analysis using the Likert scale method to evaluate the level of vulnerability of small-scale fisheries businesses in Morotai Island Regency. Factors affecting vulnerability were identified and assessed based on respondents' perceptions, which were collected through a questionnaire. Data was then tabulated and averaged to obtain a total and average score, which was used to categorize the level of vulnerability. If the score falls within the interval of 1.00 to 1.75, it is categorized as highly vulnerable, 1.76-2.50 as vulnerable, 2.51-3.25 as moderately resilient, and 3.26-4.00 as resilient.

III. RESULTS AND DISCUSSION

Vulnerability Level of Small-scale Fisheries Businesses in Morotai Island Regency

The vulnerability level of small-scale tuna handline fisheries in Morotai Island Regency was determined through a vulnerability analysis based on interviews with a questionnaire guide. The questionnaire consists of 30 questions structured in 6 aspects, namely natural resources, human resources, technology, economic, social, and institutional aspects. Each answer is given a score from 1 to

4, these values indicate the level of vulnerability of small-scale tuna handline fisheries in the area. The results of these interviews will provide an overview of business vulnerability based on the perceptions of small-scale fisheries business actors in Morotai Island District.

Vulnerability level to natural resource aspects (SDA)

The vulnerability assessment of small-scale fisheries from the aspect of natural resources was assessed with five attributes (Figure 2). Based on respondents' perceptions, it is known that catch size is the most vulnerable attribute to the sustainability of fisheries with a value of 1.85. This is because their understanding of the size of the fish catch is very important for the sustainability of small-scale tuna handline fisheries on Morotai Island. All business groups showed vulnerability in catch size. Based on the study Tanaka *et al.* [9], changes in catch size in small-scale tuna fisheries are often affected by marine environmental degradation and uncontrolled fishing, which can reduce the adult tuna population. Meanwhile, the attribute with the highest value score in natural resource conditions with a score of 2.60 indicates a 'moderately resilient' category for the sustainability of tuna handline fisheries in Morotai Island Regency.

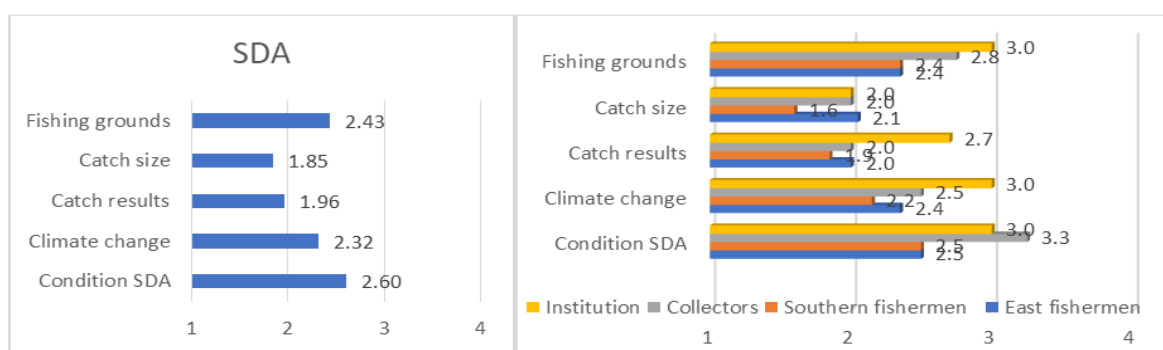


Figure 2. Vulnerability score of all attributes and respondents of natural resources aspect

The respondent groups of southern fishermen and eastern fishermen are perceived as 'quite vulnerable' in all attributes of the natural resources aspect. While the respondent groups of institutions and collectors give different perceptions, namely almost all attributes in the aspect of natural resources (SDA) are considered 'quite resilient' and resilient. However, at the attribute of the size of the catch, the four respondent groups give the perception of a value score below 2.50, which indicates that small-scale tuna handline fisheries on these attributes are 'quite vulnerable'.

1. Level of vulnerability to human resources aspects (SDM)

Evaluation of the vulnerability of small-scale tuna handline fisheries in Morotai Island Regency in the aspect of human resources (HR) was assessed through five attributes (Figure 3). The attribute of the younger generation of respondents perceived vulnerable to tuna fisheries with a score of 2.04 'quite vulnerable'. In contrast, the attribute of education for children perceived by respondents with the highest average value score, namely a value score of 3.89, shows the 'resilient' category against tuna handline fisheries in the aspect of human resources.

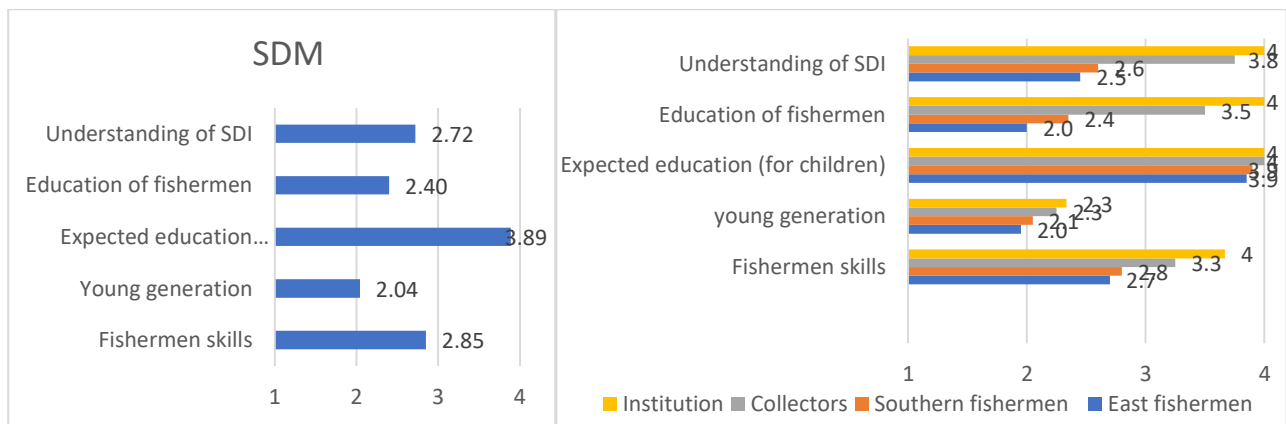


Figure 3. Vulnerability scores of all HR attributes and respondents

In general, the perceptions of the four business groups or respondents gave the lowest score to the young generation attribute, with a score below 2.50, indicating a 'moderately vulnerable' category for the human resources aspect. This is in line with Yusuf and Hasan's research [10], which shows that the younger generation tends to avoid the fisheries sector due to low income and the high risks associated with achieving catches. Whereas in the other four attributes, the respondent groups of institutions and collectors gave a fairly high perception by giving an average value score above 2.56 to 4, with the categories 'moderately resilient' and 'resilient' on the vulnerability of small-scale tuna handline fisheries in Morotai Island District. According to Putri and Abdullah [11], the education of fisher children plays an important role in

reducing the dependence of the next generation on a fisheries sector that is vulnerable to climate change and economic cycles.

2. Level of vulnerability to technological aspects

Measuring the vulnerability of small-scale tuna handline fisheries in Morotai Island Regency in technological aspects is measured by six attributes (Figure 4). The lowest mean value of the six attributes is in the cheap technology attribute with a value score of 1.89 'moderately vulnerable'. On the other hand, the attribute with the highest mean score perceived by respondents is the productive technology attribute with a score of 3.32, indicating a 'resilient' category for tuna handline fisheries in the technological aspect in Morotai Island District.

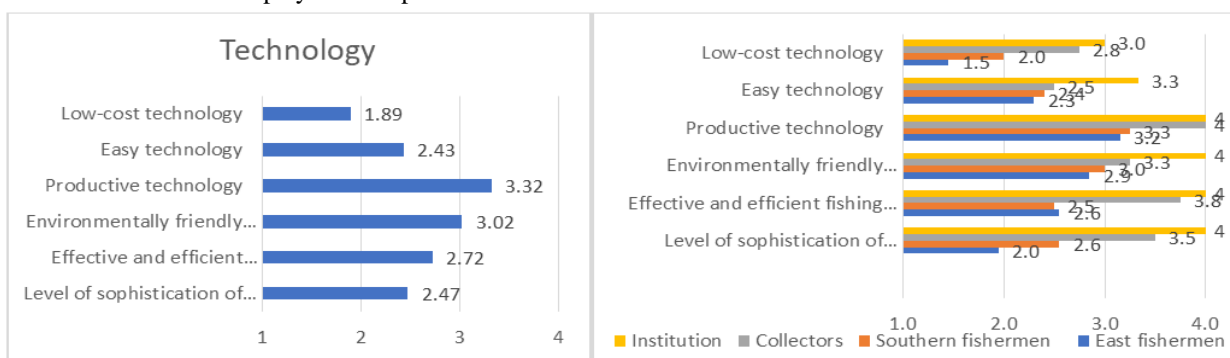


Figure 4. Vulnerability scores of all attributes and respondents of the Technology aspect

In general, six attributes are perceived from the respondent groups of southern fishermen and eastern fishermen, giving the lowest value score on the easy technology attribute, the cheap technology attribute and the new technology sophistication level attribute, namely with a score of 2.50, which shows the category 'quite vulnerable' in the technology aspect. Cheap and simple technology is very important for small-scale fishers with limited capital [12], because it can increase productivity without requiring complex training [13]. In addition, advanced technology also plays a role in helping them deal with climate change and fish population dynamics [14]. Different groups of collector and institutional respondents gave the highest mean scores on all technology attributes, with scores above

2.56 to 4, indicating a moderately resilient to resilient category to the vulnerability of small-scale tuna handline fisheries in Morotai Island District.

4. Level of vulnerability to social aspects

The social aspect of the vulnerability of small-scale tuna handline fisheries is assessed through five attributes (Figure 5). Based on the results of interviews with respondents, the community/social network attribute has the lowest average score of 1.94 (moderately vulnerable), while the family participation attribute recorded the highest score of 3.62 (resilient), reflecting the important role of family participation in supporting small-scale tuna handline fisheries in Morotai Island District.

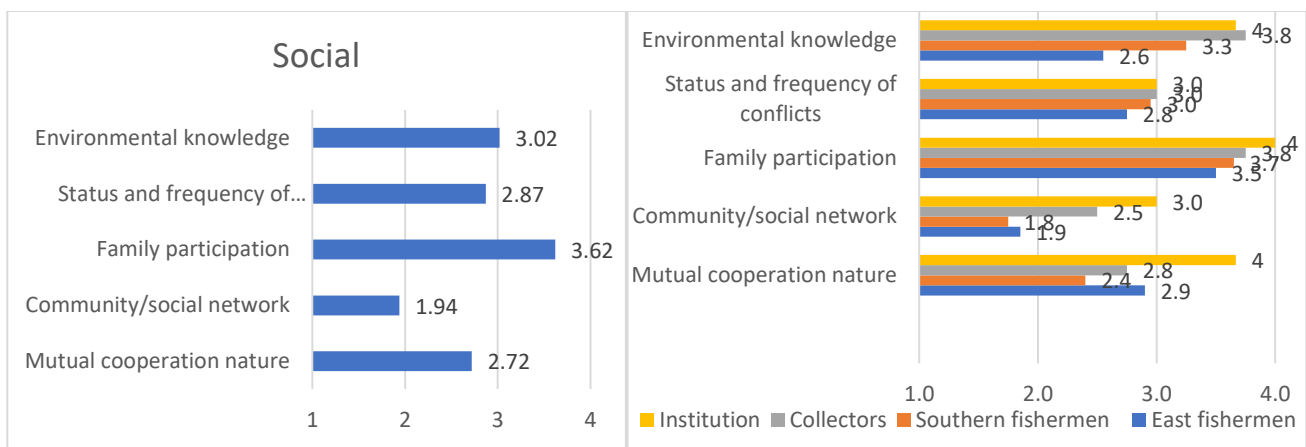


Figure 5. Vulnerability score of all attributes and respondents of Social aspect

The interview results from the four groups of respondents gave a perception, a low average value on the community/social network attribute with a score of 2.50 which is categorized as 'quite vulnerable' to social aspects. Research by Mulyadi *et al.* [15] confirmed that strong social networks provide additional security for fishermen in facing economic and environmental risks. In contrast to the other four attributes, the respondent group gave the perception of the highest average score value above 2.56 to 4, with a value range of 'moderately resilient to 'resilient to the vulnerability of small-scale tuna fisheries in Morotai Island Regency to social aspects.

5. Level of vulnerability to economic aspects

Measurement of the vulnerability of small-scale tuna fishing businesses in the economic aspect is measured by four attributes as shown in (Figure 6). The lowest average value of the four attributes is found in the side business attribute with an average value of 2.19 which explains the value category 'quite vulnerable'. The highest value is found in the capital institution attribute, with an average score of 3.15 indicating the value of the 'moderately resilient' category of small-scale tuna fisheries vulnerability in Morotai Island Regency.

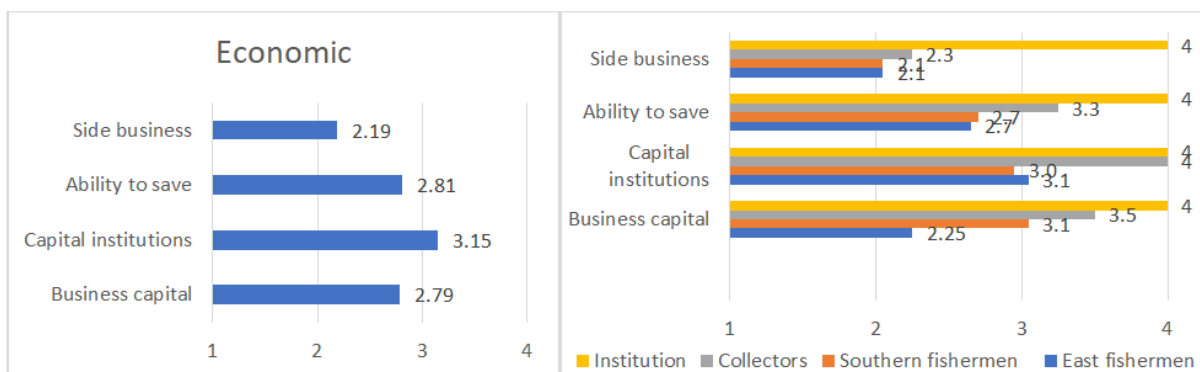


Figure 6. Vulnerability score of all attributes and respondents of Economic aspect

Based on respondents' perceptions on the economic aspect, eastern fishers, southern fishers, and collectors gave the lowest score below 2.50 for the side business attribute (moderately vulnerable). Side businesses help small-scale fishers overcome the economic damage caused by low catches, by providing additional income that supports economic resilience, especially during the lean season [16]. Meanwhile, institutions gave a maximum score of 4 on all attributes, indicating a resilient category to the vulnerability of small-scale tuna handline fisheries in Morotai Island District. Institutional respondents had a more optimistic view of the role of economic aspects in the sustainability of small-scale fisheries, likely due to a better

understanding of income diversification, access to capital, and financial ability to deal with threats.

6. Level of vulnerability to institutional aspects

Assessing the vulnerability of small-scale tuna fisheries to institutional aspects was assessed from five attributes (Figure 7). According to respondents, the lowest average value of the six attributes is the attribute of long-term (personal) programs/assistance with a score of 2.21, the value category is 'moderately vulnerable'. While the highest value is found in the social institutional attribute with a score of 2.68 which indicates 'quite resilient' to the vulnerability of small-scale tuna fishing businesses in the institutional aspect.

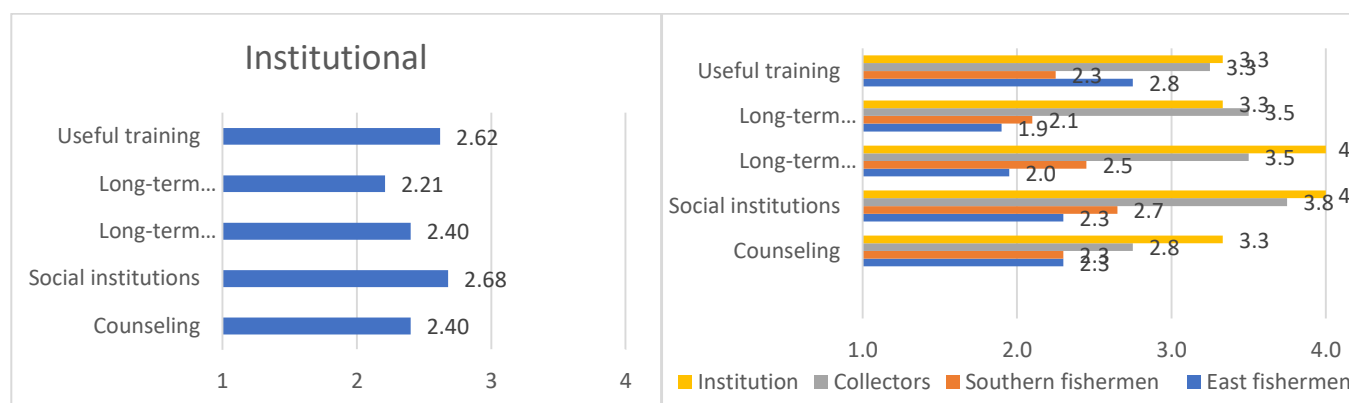


Figure 7. Vulnerability score of all attributes and respondents of Institutional aspect

Based on the assessment of the four business groups or respondents on the institutional aspect, the respondent groups of eastern fishermen and southern fishermen gave the lowest perceived value in five attributes with an average score value below 2.50 which is categorized as a 'moderately vulnerable' value for small-scale tuna fisheries, especially in the long-term program/assistance attribute and the extension attribute. Long-term assistance can strengthen fishers' resilience to economic damage, while group assistance strengthens social networks and adaptability, and structured extension helps them adapt to regulations and support sustainable fisheries [17] - [19]. While the collector and institutional respondent groups gave the highest scores of all attributes, namely with score values above 2.56 to 4, which indicates the 'moderately resilient' and 'resilient' categories of vulnerability of small-scale tuna handline fisheries in Morotai Island District. Collectors and institutions have a more positive view of all institutional attributes, which may be due to their understanding of the importance of institutional support in maintaining small-scale fisheries.

7. Overall Level of Vulnerability

In general, the natural resources aspect is the most vulnerable aspect with a vulnerability score of 2.38 in the context of the sustainability of small-scale tuna handline fisheries in Morotai Island District. On the other hand,

human resources (HR), technology, social, economic and institutional aspects are aspects that are considered quite resilient for small-scale tuna fisheries in Morotai Island Regency, with vulnerability values of 2.87 to 3.09. Resilient in this case means that these aspects are able to withstand and recover from various challenges or changes that threaten the sustainability of the business.

When viewed by business group or respondent, eastern fishers are the group with the lowest level of vulnerability with a score of 2.44. This vulnerability may be due to limited access to technology and human resources, where small-scale fishers often face challenges in mastering capture technology and fishing skills [20]. Meanwhile, southern fishermen, collectors and institutions are perceived as quite resilient business groups or respondents in Morotai Island District, scoring 2.55, 3.15 and 3.48, respectively. This proves that southern fishers show moderate vulnerability with social and economic resilience, but need to increase access to technology and human resources. Collectors experience moderate vulnerability due to technological and institutional limitations, while institutions need to strengthen their role and policy support for the small-scale fisheries sector in Morotai Island District.

SDA	2,38	East fishermen	2,44
SDM	3,07	Southern fishermen	2,55
Technology	3,00	Collectors	3,15
Social	3,03	Institution	3,48
Economic	3,09		
Institutional	2,87		

Figure 8. Overall vulnerability level

CONCLUSIONS

Based on the results of the analysis of the level of vulnerability of small-scale fisheries businesses in Morotai Island District, it can be concluded that the most vulnerable aspect is natural resources with a value of 2.38. This results in most of the attributes in the natural resources aspect having a vulnerable status. Meanwhile, human resources (HR), technology, social, economic and institutional aspects are aspects that are considered quite resilient for small-scale tuna fisheries in Morotai Island Regency, with a vulnerability value of 2.87 to 3.09. In the context of business or respondents, the southern fishermen group, collectors and institutions are perceived as the most resilient groups with scores of 2.55, 3.15 and 3.48. Meanwhile, the eastern fishermen group with a score of 2.44 showed a tendency to be more vulnerable to small-scale tuna fisheries.

ACKNOWLEDGEMENTS

1. To ensure the sustainability of small-scale fisheries in Morotai Island Regency, there should be improvements in the aspect of natural resources (SDA) in the future. The Morotai Island District Government needs to regulate tuna management with a policy on the size of tuna that can be caught.
2. It is necessary to conduct further research on small-scale fisheries in all fishing gear and all sub-districts in Morotai Island Regency to present the overall level of fisheries vulnerability.research.

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