



# Influence of the environmental challenges on the resilience of purse seine fisherman in Kutaraja oceanic fishing port, Banda Aceh

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## ABSTRACT

Purse seine fishermen in Kutaraja Oceanic Fishing Port, Banda Aceh, face various socio-economic and environmental challenges that affect the sustainability of their fishing activities. This study aims to identify and analyze the factors influencing the resilience of these fishermen in facing such challenges. A quantitative approach was employed through a survey method, and data were collected from 100 purse seine fishermen using structured questionnaires. The data were analyzed using descriptive and inferential statistics with multiple linear regression models. The findings show that income and social support significantly affect fishermen's resilience, with p-values of 0.002 and 0.015 ( $p < 0.05$ ), respectively. Meanwhile, education and environmental conditions have less influence, indicated by p-values of 0.089 and 0.122 ( $p > 0.05$ ). The coefficient of determination ( $R^2$ ) is 0.68, suggesting that 68% of the variance in fishermen's resilience can be explained by these four variables. The practical implications of this research highlight the importance of empowering fishermen through enhanced access to education, skills training, and social infrastructure development to strengthen their resilience in dealing with environmental and economic changes in the fisheries sector. The study concludes that economic and social support systems are key drivers in improving fishermen's adaptive capacity.

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## Introduction

The fisheries sector plays a critical role in the coastal communities' economy, contributing significantly to food security, employment, and regional development in Indonesia (Kementerian Kelautan Dan Perikanan Indonesia, 2023). In 2023, the fisheries sector contributed around 2.7% to the national Gross Domestic Product (GDP), with the capture fisheries sub-sector being the primary contributor (FAO, 2022; Kementerian Kelautan Dan Perikanan Indonesia, 2023). One of the dominant fishing groups operating in Banda Aceh is the purse seine fishermen, who primarily operate from Kutaraja Oceanic Fishing Port (Sugiharto *et al.*, 2023).

Despite their contribution, purse seine fishermen face various socio-economic and environmental challenges. Socially, their relatively low education level limits their access to technology and fisheries information (Akhmad *et al.*, 2021; Rahmawati &

Wijayani, 2013). Economically, they encounter unstable fish prices, high operational costs, and dependency on middlemen, which affects their income stability (Setiawan & Kurniawan, 2022). Environmentally, climate change, extreme weather, and overfishing significantly affect fish stock availability and increase fishing risks (Muchlisin *et al.*, 2010; Sugiharto *et al.*, 2023).

The concept of resilience has gained attention as a framework to understand the capacity of small-scale fishers to adapt and survive in the face of such adversities (Adger, 2000; Hehanusa *et al.*, 2017; Hikmatullah, 2022; Rahmawati & Wijayani, 2013). Several factors are believed to influence fishermen's resilience, such as education, income, social support, and environmental conditions (Akhmad *et al.*, 2021).

Previous studies have shown that income stability and strong social support networks are crucial in enhancing fishermen's adaptive capacity (Aswani,

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2019; Bachtiar & Bachtiar, 2019). However, empirical research examining these factors among purse seine fishermen in Banda Aceh remains limited. Therefore, identifying and analyzing these factors becomes essential to develop effective strategies that enhance their resilience and ensure the sustainability of their livelihoods (Kurniawan et al., 2020).

The objective of this study is to identify and analyze the factors influencing the resilience of purse seine fishermen in Kutaraja Oceanic Fishing Port, Banda Aceh. This research provides valuable insights for policymakers and stakeholders in formulating strategic policies to empower fishermen and increase their adaptive capacity to socio-economic and environmental challenges.

## Materials and Methods

### Location and time of research

This research was conducted at the Kutaraja Oceanic Fishing Port, Banda Aceh, which serves as one of the primary fishing hubs in Aceh Province. The study was carried out over a period of three months, from January to March 2024. The site selection was based on the high concentration of purse seine fishing activities in this area, making it a representative location for studying fishermen's resilience.

This research was conducted at the Kutaraja Oceanic Fishing Port, located in Banda Aceh, Indonesia (Figure 1). The port serves as one of the largest and most strategic fishing centers in Aceh Province, with a high concentration of purse seine fishing activities. This location was selected based on its role as a central hub for the small-scale fisheries sector and its vulnerability to various socio-economic and environmental challenges faced by local fishermen.

The area experiences tropical monsoon climate patterns, which significantly influence the fishing seasons and productivity of purse seine fishermen (Rahmawati et al., 2021). Based on these criteria, a total of 100 respondents were selected. The sample size was determined using the Slovin formula (Sevillia et al., 2007) with an error tolerance of 5% and an estimated population of 200 fishermen.

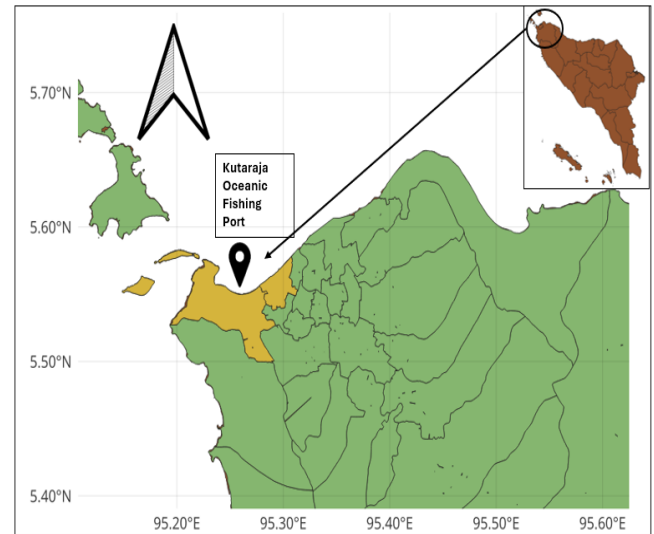
### Data Collection Procedures

The primary data were collected using structured questionnaires consisting of two sections:

**Section 1:** Demographic characteristics of respondents, including age, education level, fishing experience, and number of dependents.

**Section 2:** Items measuring resilience factors using a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree). The factors analyzed were education, income, social support, and environmental

conditions. In addition to questionnaires, semi-structured interviews were conducted with selected fishermen to gain deeper insights into their daily challenges and adaptive strategies.



**Figure 1.** Map of Kutaraja Oceanic Fishing Port Data Analysis

### Descriptive Analysis

Descriptive statistics were used to describe the demographic profile of respondents and their responses related to the resilience factors. The data were presented in frequency distribution tables and charts.

### Inferential Analysis

Multiple linear regression analysis was applied to examine the influence of independent variables education ( $X_1$ ), income ( $X_2$ ), social support ( $X_3$ ), and environmental conditions ( $X_4$ ) on fishermen's resilience ( $Y$ ). The regression model used was as follows:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + e$$

Where:

$Y$  = Resilience of fishermen

$X_1$  = Education

$X_2$  = Income

$X_3$  = Social support

$X_4$  = Environmental conditions

$\beta_0$  = Constant

$\beta_1 \dots \beta_4$  = Regression coefficients

$e$  = Error term

### Correlation Coefficient ( $r$ ), Coefficient of Determination ( $R^2$ ) and Hypothesis Testing

The correlation coefficient ( $r$ ) measured the strength of the relationship between the independent and dependent variables. The coefficient of determination ( $R^2$ ) indicated the proportion of variance in fishermen's resilience explained by the four variables (Adger, 2000). T-test was conducted to examine the partial effect of each independent

variable on resilience. F-test was used to test the simultaneous effect of all independent variables on resilience. The hypotheses were tested at a significance level of 5%. If  $t_{count} > t_{table}$  or  $F_{count} > F_{table}$ , the null hypothesis ( $H_0$ ) was rejected (Sugiyono, 2018).

### Analytical Tools

All statistical analyses were performed using SPSS version 26 software to ensure the accuracy of regression, correlation, and hypothesis testing results.

### Results

#### Characteristics of Respondents

This study involved 100 purse seine fishermen operating at Kutaraja Oceanic Fishing Port, Banda Aceh. The descriptive analysis of respondents' characteristics is presented in Table 1. The majority of respondents were in the 35–50 years old age group (62%), with more than 10 years of fishing experience (57%). Most fishermen had completed elementary school (SD) (45%), followed by junior high school (SMP) (35%) and senior high school (SMA) (20%). From an economic perspective, the average monthly income of the fishermen ranged from IDR 3,000,000 to IDR 5,000,000 (55%), while 28% of them earned less than IDR 3,000,000, and 17% earned more than IDR 5,000,000.

#### Multiple Linear Regression Analysis, Correlation Coefficient (r) and Coefficient of Determination ( $R^2$ )

Multiple linear regression analysis was conducted to determine the influence of education ( $X_1$ ), income ( $X_2$ ), social support ( $X_3$ ), and environmental conditions ( $X_4$ ) on the resilience of purse seine fishermen ( $Y$ ). The regression results are shown in Table 2. The analysis shows that income ( $X_2$ ) and social support ( $X_3$ ) have a significant effect on fishermen's resilience at  $p < 0.05$ , while education ( $X_1$ ) and environmental conditions ( $X_4$ ) are not statistically significant ( $p > 0.05$ ). The correlation coefficient ( $r$ ) between the independent variables and the dependent variable is 0.82, indicating a strong relationship. The coefficient of determination ( $R^2$ ) is 0.68, meaning that 68% of the variability in fishermen's resilience can be explained by the four factors studied.

#### Hypothesis Testing

The F-count value obtained was 15.72, while the F-table value at  $\alpha = 0.05$  and degrees of freedom (df) of 4; 95 is 2.70. Since  $F_{count} > F_{table}$ , the null hypothesis ( $H_0$ ) is rejected. This indicates that education, income, social support, and environmental conditions simultaneously influence the resilience of purse seine fishermen. Partial testing using the **t-test** showed that Income ( $X_2$ ) and Social Support ( $X_3$ ) significantly influence resilience ( $p < 0.05$ ). Education ( $X_1$ ) and Environmental Conditions ( $X_4$ ) do not have a significant partial effect ( $p > 0.05$ ).

**Table 1.** Characteristics of Purse Seine Fishermen Respondents at Kutaraja Oceanic Fishing Port

| Variable           | Category                 | Frequency (n) | Percentage (%) |
|--------------------|--------------------------|---------------|----------------|
| Age (years)        | 18–34                    | 20            | 20%            |
|                    | 35–50                    | 62            | 62%            |
|                    | >50                      | 18            | 18%            |
| Education Level    | Elementary School (SD)   | 45            | 45%            |
|                    | Junior High School (SMP) | 35            | 35%            |
|                    | Senior High School (SMA) | 20            | 20%            |
| Fishing Experience | <5 years                 | 25            | 25%            |
|                    | 5–10 years               | 18            | 18%            |
|                    | >10 years                | 57            | 57%            |
| Monthly Income     | <IDR 3,000,000           | 28            | 28%            |
|                    | IDR 3,000,000–5,000,000  | 55            | 55%            |
|                    | >IDR 5,000,000           | 17            | 17%            |

**Table 2.** Multiple Linear Regression Results of Factors Affecting Fishermen's Resilience

| Independent Variable               | Regression Coefficient ( $\beta$ ) | t-count | Sig. (p-value) |
|------------------------------------|------------------------------------|---------|----------------|
| Education ( $X_1$ )                | 0.087                              | 1.71    | 0.089          |
| Income ( $X_2$ )                   | 0.215                              | 3.19    | 0.002*         |
| Social Support ( $X_3$ )           | 0.175                              | 2.45    | 0.015*         |
| Environmental Conditions ( $X_4$ ) | 0.092                              | 1.55    | 0.122          |
| Constant ( $\beta_0$ )             | 2.314                              | -       | -              |

\*Significant at  $\alpha = 0.05$

## Discussion

The results of this study indicate that income and social support have significant effects on the resilience of purse seine fishermen in Kutaraja Oceanic Fishing Port, Banda Aceh. Meanwhile, education and environmental conditions did not significantly affect resilience. These findings reflect the complex interplay of socio-economic and environmental factors influencing small-scale fisheries' adaptive capacity, which aligns with previous studies on fishermen's resilience in similar contexts (Adger, 2000; Akhmad *et al.*, 2021; Sugiharto *et al.*, 2023).

The significant influence of income suggests that stable and sufficient financial resources enhance fishermen's ability to adapt to socio-economic and environmental changes. This result supports the findings of Aswani (2019), who emphasized that higher household incomes improve access to technology, fishing gear, and alternative livelihoods, thereby increasing resilience. Similarly, (Bachtiar & Bachtiar, 2019) found that financial security enables fishermen to invest in education, health, and productive assets, reducing vulnerability to external shocks.

Social support also plays a critical role in fostering resilience among fishermen. This study demonstrates that fishermen with strong social networks such as family ties, peer groups, and community organizations are more capable of coping with adversities. Social support facilitates information sharing, collective action, and access to government programs or financial assistance (Setiawan & Kurniawan, 2022). Lu *et al.* (2018) also highlighted that cooperative organizations among fishermen can enhance their bargaining power and market access, contributing to economic stability and resilience.

Contrary to expectations, education did not significantly influence resilience. This finding may be attributed to the fact that most fishermen rely more on practical experience and traditional knowledge rather than formal education to adapt to environmental and market changes (Rahmawati *et al.*, 2021). Moreover, the limited access to continuing education and vocational training programs in coastal areas reduces the potential impact of education on resilience capacity (Rahmawati & Wijayani, 2013).

The non-significant effect of environmental conditions on resilience indicates that fishermen perceive these factors as external and beyond their control. Although climate change, extreme weather, and declining fish stocks pose significant threats, fishermen tend to develop adaptive strategies such as

changing fishing grounds, adjusting fishing seasons, and modifying fishing gear (Sugiharto *et al.*, 2023). However, the lack of institutional support for climate adaptation may limit the effectiveness of these strategies (Ma'mun *et al.*, 2018).

One of the key limitations of this study is its focus on quantitative analysis, which may overlook the nuanced, qualitative aspects of fishermen's resilience strategies. Future research should incorporate ethnographic or participatory approaches to explore the cultural and social dimensions of resilience in greater depth (Akhmad *et al.*, 2021; Aswani, 2019).

This study contributes to the growing body of literature on fisheries resilience by providing empirical evidence from the Banda Aceh region. The findings underscore the importance of strengthening economic empowerment and social capital to enhance the resilience of small-scale fishermen. Government policies should prioritize programs that stabilize fish prices, provide microfinance, and encourage the formation of fishermen cooperatives (Bachtiar & Bachtiar, 2019; Kementerian Kelautan Dan Perikanan Indonesia, 2023).

Moreover, tailored capacity-building programs that combine traditional knowledge with modern fisheries management practices could enhance adaptive capacities and sustainability (Lu *et al.*, 2018; Rahmawati *et al.*, 2021). Finally, integrating climate adaptation strategies into coastal development planning is essential to mitigate the long-term impacts of environmental change on small-scale fisheries (Hehanusa *et al.*, 2017; Sugiharto *et al.*, 2023).

## Conclusion

The findings emphasize the importance of economic empowerment programs and the strengthening of social capital to enhance the resilience of small-scale fishermen. Policymakers are encouraged to implement strategies that stabilize fishermen's income, provide access to affordable financial resources, and facilitate the formation of cooperative groups to improve social support mechanisms.

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