Al-Kharaj: Journal of Islamic Economic and Business
Volume 8 (3), 2026: xxx - xxx
P-ISSN: 2686-262X; E-ISSN: 2685-9300

Analysis of the Impact of Pearl Cultivation on the Welfare of Coastal Communities Involved in Pearl Cultivation Activities in Batu Putih Village, Sekotong District, West Lombok Regency

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Keywords:
Pearl Cultivation; The Welfare Of Coastal Communities; Sustainable Livelihood Framework; PLS-SEM; Sekotong

Abstract

The fisheries and marine sector is one of the main pillars of livelihood for coastal communities, but the gap between the potential of the marine economy and the actual welfare of cultivators is still a problem in various coastal areas of Indonesia, including in Batu Putih Village, Sekotong District, West Lombok Regency, which is known as one of the South Sea Pearl pearl cultivation centers. This study aims to analyze the influence of pearl cultivation activities on the welfare of coastal communities involved in these activities, with the Sustainable Livelihood Framework as a conceptual foundation. The study used an explanatory quantitative approach with purposive sampling technique on 100 respondents, analyzed using Partial Least Squares-Structural Equation Modeling (PLS-SEM) through SmartPLS 4. Hypothesis testing through bootstrapping proves that pearl cultivation activities have a positive and significant effect on the welfare of coastal communities, so the research hypothesis is accepted. These findings confirm that pearl farming plays a role as an effective livelihood strategy for the coastal communities of Batu Putih Village, as well as providing empirical evidence for the application of the Sustainable Livelihood Framework in the context of aquaculture with high economic value in Indonesia.

INTRODUCTION

Global food security, international trade flows, and the livelihoods of millions of coastal residents are closely dependent on the sustainability of the fisheries and marine sectors. Food and Agriculture Organization (2023) reports that nearly 59 million people in the world depend on fisheries and aquaculture for their livelihoods, with the value of global trade in marine products exceeding US$164 billion throughout 2022. This large economic value does not necessarily guarantee the welfare of the perpetrators, fishers in many developing countries remain economically vulnerable due to low productivity, lack of access to technology, as well as the pressures of climate change and the destruction of the marine environment (Johnston et al. 2020: Simard et al. 2022). The shock of the COVID-19 pandemic exacerbated this vulnerability, Suresh (2023) documented the decline in fishermen's income in Kerala, India, due to restrictions on activities during the pandemic. This series of pressures shows the urgency of diversifying coastal livelihood sources, which according to FAO (2024) It can be answered through the development of sustainable aquaculture as a way to boost income, create jobs, and strengthen the economic resilience of communities that depend on the sea.

Indonesia is not spared from similar problems. Armed with a coastline of 108,000 km and a water area of more than 6.4 million km², this archipelago country holds an extraordinary marine economic potential. Central Statistics Agency (2024) noted that the contribution of the fisheries sector to the national Gross Domestic Product is around 2.7%, with the absorption of labor reaching 2.6 million fishing households. In fact, the average income of fishermen is only around Rp2.5 million per month, far behind the national average income (Ministry of Maritime Affairs and Fisheries, 2023; Central Statistics Agency, (2024). The gap between the large marine potential and the low actual welfare of coastal communities indicates that the utilization of marine resources has not been optimal, thus opening up space for the marine aquaculture sector to appear as a strategic alternative in expanding employment and income outside of conventional capture fisheries routes.

Among the various subsectors of marine aquaculture, pearl cultivation *(Pearl Aquaculture)*, especially types *South Sea Pearl* oyster product Pinctada maxima, stands out as a promising economic contributor. Ministry of Maritime Affairs and Fisheries (2023) recorded that Indonesia's pearl exports reached US$33.6 million, growing 15% compared to US$29.2 million in the previous year, signaling that international market demand for the quality and color of Indonesian pearls continues to increase. Because it involves coastal communities from the seed preparation stage to harvest, this activity has the opportunity to grow into a livelihood strategy *(livelihood strategy)* community-based initiative that helps to alleviate poverty in coastal areas. Empirical evidence from other regions reinforces this picture: in Fiji and Tonga, Mikhailovich et al. (2022) found that *Half-pearl aquaculture* boosted fishermen's household incomes while expanding women's role in the local economy, while Johnston et al. (2020) It shows that community-based pearl farming systems also support the conservation of marine ecosystems through the Blue Economy approach. Simard et al. (2022) He added that the pearl industry remains the backbone of the coastal economy even though export prices often fluctuate. In the Indonesian context, Kasamatsu et al. (2020) and Ramdani (2023) revealed that the success of pearl cultivation is highly dependent on the technical capacity of the community, access to capital and technology, and the agility to diversify sources of livelihood, findings similar to those of Picaulima and Erbabley (2023) and Assagaf et al. (2024), which both prove that aquaculture has high economic value boosting the income and welfare of coastal households. However, economic factors are not the only determinants of success. Reisser et al. (2020) reminded the importance of ecological and genetic management for the sustainability of the pearl industry, while Sodikin and Ardiansyah (2024) shows that environmental degradation due to abrasion and sedimentation can erode cultivation productivity as well as the economic conditions of the community that sustain their lives in this sector.

Stringing together the findings above, it appears that two study streams that have been developing are relatively running independently. The first wave highlighted the economic and social impacts of pearl cultivation, such as increased income, job creation, and diversification of livelihoods (Johnston et al. 2020; Mikhailovich et al. 2022; Simard et al. 2022; Southgate et al. 2023; Gandhiwati & Rahmanita, 2023; Osman & Nor, 2024; Hoque et al. 2021; Assagaf et al. 2024). The second stream concentrates more on the technical aspects, environmental quality, and sustainability of the management of aquaculture resources (Kasamatsu et al. 2020; Reisser et al. 2020; Sodikin & Ardiansyah, 2024; Costanza et al. 2021). The two are rarely brought together in a single analytical framework that places the welfare of coastal communities as a core variable that is empirically tested for pearl cultivation activities, especially by relying on a theoretical foundation that is able to comprehensively explain how the livelihood mechanism of the community works. Without bringing these two points of view together, the understanding of the contribution of pearl cultivation to welfare risks being uneven, either because it ignores the theoretical basis that explains the process of transforming assets into welfare, or because it misses direct empirical evidence from the perspective of the people who undergo these activities.

Sustainable Livelihood Framework (SLF) is seen as appropriate to bridge that void. Chambers and Conway (1992) first introduced the concept of livelihood as a unity of abilities *(Laughs)*, assets *(assets)*, and activities *(activities)* which individuals or households use to sustain their lives, with livelihoods said to be sustainable if they are able to survive pressure and shocks without reducing the opportunities of the next generation. Scoones (1998) then develop it into an analytical framework that makes livelihood assets the foothold of livelihood strategies, while DFID (1999) refining it through a series of relationships between vulnerability contexts *(vulnerability context)*, livelihood assets *(livelihood assets)*, which includes human capital, natural capital, social capital, physical capital, and financial capital, transforming structures and processes, livelihood strategies *(livelihood strategies)*, to the external livelihood *(livelihood outcomes)*. Referring to this framework, this study positions pearl cultivation activities as *Livelihood Strategy* which is reflected in four dimensions, namely the involvement of cultivation activities, the implementation of cultivation activities, cultivation operational support, and the application of technology, which respectively represent the utilization of human capital, physical capital, social capital, and financial capital as conceptualized by SLF (Chambers & Conway, 1992; DFID, (1999). As a livelihood outcomes, the welfare of coastal communities is reflected in four dimensions, namely income levels, economic stability, income diversification, and family socio-economic conditions, in line with Sen's views (1999) that welfare is multidimensional and is not only measured by the amount of income, nor

Ellis (2000) dan Costanza et al. (2021) which interprets coastal welfare as the result of the interaction between economic productivity and socio-ecological resilience.

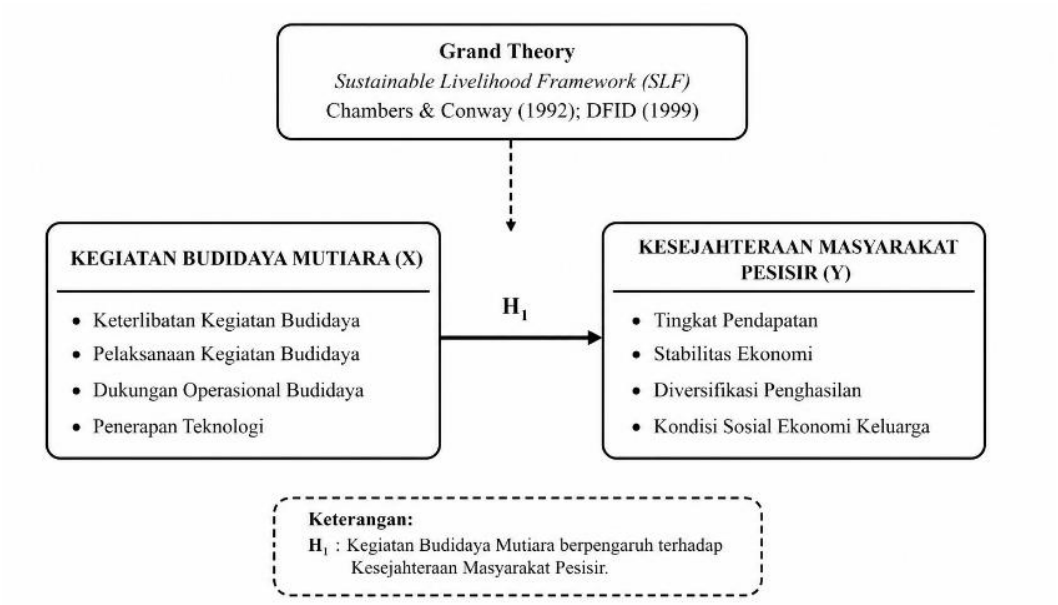
Sekotong District, West Lombok Regency, is one of the coastal areas in West Nusa Tenggara Province that has grown into a cultivation center *South Sea Pearl* thanks to friendly oceanographic conditions, namely the quality of the waters, salinity, temperature, and ocean currents that are suitable for the growth of pearl oysters (Fathurrahman & Aunurohim, 2015). This natural condition places Sekotong as a strategic area for the development of export-oriented cultivation as well as a driving force for the coastal economy (Oktaviani et al. 2018), with the community involved in various stages of production ranging from hatchery to harvest (NTB Provincial Marine and Fisheries Service, 2024). This development is also supported by government support through coaching programs, strengthening the capacity of human resources, providing aquaculture facilities, and technical assistance (Directorate General of Aquaculture Fisheries KKP, 2021; The Marine Fisheries Department, 2024), which in turn encourages the increasing number of people of Batu Putih Village who are involved in pearl cultivation activities (Lombok Marine Aquaculture Fisheries Center, 2024). Marine and Fisheries Service of West Lombok Regency (2024) He also noted that the fisheries and marine sector is still one of the main pillars of the economic activities of coastal communities in this district. The data is sourced from official local government documents and is used here solely as an overview of the regional context, not as the main empirical evidence of the research, thus strengthening the relevance of Batu Putih Village as a representative location to examine the relationship between pearl cultivation and the welfare of coastal communities.

Although the literature on the economic impact and technical aspects of pearl cultivation continues to grow, studies that specifically examine the influence of pearl farming activities on the welfare of coastal communities directly involved in it are still relatively rare, especially those that integrate *the Sustainable Livelihood Framework* as a theoretical basis with Partial Least Squares Structural Equation Modeling (PLS-SEM) as an analysis approach based on public perception, especially in the context of Batu Putih Village, Sekotong District. Moving on from these gaps, this study was compiled to answer the question: whether pearl farming activities have a significant impact on the welfare of the coastal communities involved in them, and how much of this influence can be explained through the Sustainable Livelihood Framework framework.

Based on this description, this study aims to analyze the influence of pearl cultivation activities on the welfare of coastal communities involved in pearl cultivation activities in Batu Putih Village, Sekotong District, West Lombok Regency, with the PLS-SEM approach and *Sustainable Livelihood*

Framework as a conceptual foundation. The contribution of this research to the study of coastal economics lies in two aspects. First, this study integrates SLF as a theoretical basis to explain the relationship between pearl farming activities and the well-being of coastal communities, a different perspective from the majority of previous studies that have focused more on technical, productivity, or environmental conservation aspects (Johnston et al. 2020; Kasamatsu et al. 2020; Reisser et al. 2020; Sodikin & Ardiansyah, 2024). Second, this study applies PLS-SEM to analyze these influences based on the perception of the community directly involved in cultivation activities, so that the novelty lies in the application of the combined theoretical foundation and analysis methods in the local context that has not been widely studied, the contribution of this research does not lie in the discovery of a completely new theory. Thus, this study is expected to provide empirical evidence regarding the role of pearl cultivation as a livelihood strategy *(livelihood strategy)* in improving the welfare of coastal communities, as well as being a reference for similar research in other coastal locations with similar characteristics.

Departing from *Sustainable Livelihood Framework* and the results of previous research showing that community involvement in pearl farming and aquaculture activities contributes to increasing income, economic stability, income diversification, and socio-economic quality of coastal communities (Southgate et al. 2023; Mikhailovich et al. 2022; Hoque et al. 2021; Osman & Nor, 2024), this study assumes that the more optimal the implementation of pearl cultivation activities, the higher the level of welfare of coastal communities produced. The relationship between these variables is presented in the following conceptual framework.



Sumber: Diadaptasi dari Chambers & Conway (1992), DFID (1999), Sen (1999), Ellis (2000), Costanza *et al.* (2021), Mikhailovich *et al.* (2022), kemudian dikembangkan oleh peneliti (2026).

Figure 1. Research Conceptual Framework

Referring to this conceptual framework, this study proposes the following hypothesis.

H1: Pearl cultivation activities have a positive and significant effect on the welfare of coastal communities in Batu Putih Village, Sekotong District, West Lombok Regency.

METHOD

Types of Research

This study carries a quantitative approach with explanatory design *(Explanatory Research)* to test the influence of pearl cultivation activities on the welfare of coastal communities in Batu Putih Village, Sekotong District, West Lombok Regency. This approach was chosen because the study aimed to test the causal relationship between variables through structured measurements with questionnaire instruments, relying on *Sustainable Livelihood Framework* as a theoretical foundation that explains the relationship between pearl cultivation activities as a livelihood strategy *(livelihood strategy)* and the welfare of coastal communities as an external livelihood *(livelihood outcomes)*. Data analysis was carried out through Partial Least Squares–Structural Equation Modeling (PLS-SEM) with the help of SmartPLS 4, this method was chosen because it is suitable for testing causal relationships between latent constructs and is able to produce relatively stable estimates even though the data does not fully meet the assumption of multivariate normality. (Hair et al. 2022; Ghozali & Latan, (2020). It should be noted that the design *Cross-sectional* With the scope of one location of this study having consequences for the limited generalization of findings, the results of the study are more accurately read as a portrait of the condition of Batu Putih Village in the data collection period, and will be discussed further as the limitations of the research in the Conclusion section.

Location, Time, and Data Source

The research took place in Batu Putih Village, Sekotong District, West Lombok Regency, a location that was chosen purposively because the community is actively involved in pearl cultivation activities, both as workers and parties who receive direct economic benefits from these activities. Primary data collection took place in the June-July 2026 period through the distribution of questionnaires, while secondary data was collected from publications by the Central Statistics Agency, the Directorate General of Aquaculture Fisheries of the Ministry of Marine Affairs, the Lombok Marine Aquaculture Fisheries Center, as well as scientific articles and other supporting documents relevant to pearl farming and the socio-economic conditions of coastal communities, in order to strengthen the theoretical foundation and enrich the analysis.

Population and Sample

The research population includes all coastal communities of Batu Putih Village who are involved in pearl cultivation activities, both those who participate directly in cultivation activities and those who depend on their livelihoods from these activities. The sample was determined using the purposive sampling technique, which is sampling based on certain criteria that are in line with the research objectives (Scott, 2023), considering that not all coastal communities have involvement in pearl cultivation activities. The criteria for respondents that were determined include: (1) domiciled in Batu Putih Village; (2) be at least 18 years old; (3) involved in pearl cultivation activities, both as workers, business actors, and other parties who are directly related; and (4) willing to be a research respondent. Referring to these criteria, the number of samples was set as 100 respondents, a number that was considered adequate for PLS-SEM analysis because it met the minimum sample size recommendations in simple structural models and was able to produce stable parameter estimates (Hair et al. 2022; Ghozali & Latan, 2020)

Data Collection Instruments and Techniques

The research instrument is in the form of a questionnaire that is compiled according to the indicators of each variable, developed from *Sustainable Livelihood Framework* and enriched with the findings of previous research. Each item of a statement is measured using a four-point Likert Scale (1 = Strongly Disagree, 2 = Disagree, 3 = Agree, 4 = Strongly Agree). The selection of a four-point scale is intended to eliminate the choice of neutral answers so that respondents are encouraged to give a more assertive assessment, while avoiding the tendency to choose answers in the middle (central tendency bias) (Joshi et al., 2015).

The variables of pearl cultivation activities (X) are lowered into four dimensions, namely the involvement of cultivation activities, the implementation of cultivation activities, cultivation operational support, and the application of technology, which are represented by 9 indicators as a whole. The Coastal Community Welfare variable (Y) is lowered into four other dimensions, namely income level, economic stability, income diversification, and family socio-economic conditions, which are represented by 11 indicators, as summarized in Table 1.

Table 1. Operational Research Variables

Variable	Dimensions	Number of Indicators	References
Pearl Cultivation Activities (X)	Involvement in cultivation activities;	9	Chambers & Conway (1992); DFID (1999);

Variable	Dimensions	Number of Indicators	References
	implementation of cultivation activities; operational support of cultivation; Application of technology		Scoones (1998); Kasamatsu et al. (2020)
Coastal Community Welfare (Y)	Income level; economic stability; income diversification; family socioeconomic conditions	11	Sen (1999); Ellis (2000); Costanza et al. (2021); Mikhailovich et al. (2022)

Source: Processed by researchers based on Chambers and Conway (1992), DFID (1999), Scoones (1998), Sen (1999), Ellis (2000), Kasamatsu et al. (2020), Costanza et al. (2021), and Mikhailovich et al. (2022).

Before being used in the main data collection, the instrument is first tested *(pilot test)* to 30 respondents with characteristics similar to the study population, using the PLS-SEM approach through SmartPLS 4. These trials are intended to ensure that each indicator is actually able to measure the research construct validly and consistently, before the instrument is disseminated to the main sample (Hair et al., 2022; Ghozali & Latan, (2020). The validity of the convergence was checked through the outer loading value (≥ 0.70) and the Average Variance Extracted/AVE (≥ 0.50); discriminant validity was examined through the Heterotrait-Monotrait Ratio/HTMT (< 0.90); while construct reliability was checked through Composite Reliability and Cronbach's Alpha, both of which were required to be valued at least 0.70 (Hair et al., 2022; Ghozali & Latan, (2020). The same criteria are also applied to the evaluation of the measurement model (outer model) for the main data of the research later.

The results of the pilot test show that a number of indicators have not met the validity criteria, so indicators with an outer loading value below the minimum threshold must be eliminated. The number of indicators in the pearl cultivation activities variable also shrank from 12 to 9, while in the Coastal Community Welfare variable shrank from 12 to 11. After the elimination process, the two constructs managed to meet all the required criteria: the variable of Pearl Cultivation Activity recorded AVE 0.698, Composite Reliability 0.954, and Cronbach's Alpha 0.945; the Coastal Community Welfare variable recorded AVE 0.733, Composite Reliability 0.968, and Cronbach's Alpha 0.963; while the HTMT value between constructs was recorded at 0.657, comfortably below the maximum limit of 0.90. A summary of the results *of this pilot test* is presented in Table 2.

Table 2. Summary of Instrument Test Results (Pilot Test, n=30)

Variable	Initial Items	Eliminated	Final Item	AVE	Composite Reliability	Cronbach's Alpha	HTMT	Remarks
Pearl Cultivation Activities	12	3	9	0,698	0,954	0,945	0,657	Valid and reliable
Coastal Community Welfare	12	1	11	0,733	0,968	0,963	0,657	Valid and reliable

Source: The results of data processing by researchers using SmartPLS 4 (2026). The HTMT value between constructs was 0.657 (< 0.90), indicating good discriminant validity.

The instrument that has been declared valid and reliable through the pilot test is then used in the main data collection through a Google Form-based questionnaire, which is distributed to 100 respondents according to purposive sampling criteria. During the filling process, the researcher accompanies the respondents directly to ensure understanding of the intent of each statement without directing or influencing the answers given, so that the data collected still reflects the respondents' perceptions and experiences objectively.

Data Analysis Techniques

Data from 100 respondents in the main data collection will be analyzed using the PLS-SEM approach through four sequential stages. The first stage is descriptive statistical analysis, which describes the characteristics of the respondents, including gender, age, level of education, occupation, and length of involvement in cultivation activities, as well as mapping the tendency of respondents' responses to each indicator through the distribution of frequency, percentage, and average scores. The second stage is the evaluation of the measurement model *(outer model),* which ensures the validity and reliability of all indicators on the main data with the same criteria as *the pilot test* (*outer loading*, AVE, HTMT, *Composite Reliability*, and *Cronbach's Alpha*). The third stage is the evaluation of the structural *model (inner model*), which measures the model's ability to explain the relationship between latent variables through three indicators: determination coefficient (R^2) to see the magnitude of the ability of independent variables to explain dependent variables, *effect size* (f^2) to measure the magnitude of the influence of exogenous variables on endogenous variables, and *predictive relevance* (Q^2) to assess the predictive ability of the model, with a value of $Q^2 > 0$ indicating adequate predictive ability. The fourth stage is hypothesis testing through the bootstrapping procedure on SmartPLS 4, with the decision to accept or reject the hypothesis determined by *the path coefficient*, *t-statistic*, and *p-value* values, while the hypothesis is declared accepted if *the t-statistic* exceeds 1.96 and *the p-value* is below 0.05 at the significance level of 5%. The *path coefficient value* will also be used to show the direction and strength of the relationship between Pearl Cultivation Activities and the Welfare of Coastal Communities.

RESULTS AND DISCUSSION

This section presents the results of data analysis collected from 100 respondents from coastal communities in Batu Putih Village, Sekotong District, West Lombok Regency, who are involved in pearl cultivation activities. The analysis was carried out using *the Partial Least Squares-Structural Equation Modeling* (PLS-SEM) approach through SmartPLS 4, including analysis of respondent characteristics, descriptive analysis of research variables, evaluation of measurement models (outer model), evaluation of structural models (inner model), and hypothesis testing through bootstrapping procedures.

Respondent Characteristics

The characteristics of the 100 study respondents were reviewed from gender, age, level of education, length of involvement, and form of involvement in pearl cultivation activities presented in Table 3.

Table 3. Respondent Characteristics (n = 100)

Characteristics	Categories	Quantity (n)	Percentage (%)
Gender	Male	69	69,0
	Women	31	31,0
Age	19-25 years old	20	20,0
	26-30 years	21	21,0
	31-35 years old	26	26,0
	36-40 years old	26	26,0
	41-48 years old	7	7,0
Final Education	High School/Vocational School	72	72,0
	Junior High School	20	20,0
	SD	7	7,0
	No School	1	1,0
Long Involved in Cultivation	< 1 year	4	4,0
	1-3 years	44	44,0
	4-6 years	43	43,0
	> 6 years old	9	9,0
Form of Engagement	Workers of cultivation companies	81	81,0
	Helping family members	13	13,0
	Independent cultivator	6	6,0

Source: Primary data processing results (2026).

The majority of respondents were male (69.0%), with a fairly even age distribution in the productive age group of 19-40 years (93.0%). In terms of education, the majority of respondents were educated in high school/vocational school (72.0%). Most of the respondents had been involved in pearl cultivation activities for 1-6 years (87.0%). As in the previous findings, the composition of the form of involvement remained dominated by the status of "cultivated company

workers" (81.0%) compared to independent cultivators (6.0%), a pattern that will be related again in the Discussion section in the context of the principle of livelihood diversification in the *Sustainable Livelihood Framework*.

Descriptive Analysis of Research Variables

Descriptive analysis was conducted to describe the tendency of respondents' answers on each dimension of the study variable, using a Likert scale class interval of 1-4 (1.00-1.74 = Poor; 1.75-2.49 = Sufficient; 2.50-3.24 = Good; 3.25-4.00 = Excellent). The results of the descriptive analysis are presented in Table 3 and Figure 2.

Table 4. Descriptive Analysis of Research Variables

Variable	Dimensions	Average	Std. Deviation	Categories
Pearl Cultivation Activities (X)	Involvement of Cultivation Activities	2,86	0,76	Good
	Implementation of Cultivation Activities	3,17	0,50	Good
	Cultivation Operational Support	3,17	0,56	Good
	Application of Technology	3,18	0,53	Good
	Total X	3,10	0,61	Good
Coastal Community Welfare (Y)	Income Levels	3,29	0,58	Excellent
	Economic Stability	3,05	0,62	Good
	Income Diversification	3,19	0,53	Good
	Family Socio-Economic Conditions	3,23	0,55	Good
	Total Y	3,20	0,57	Good

Source: Primary data processing results using SmartPLS 4 (2026). Interpretation category: 1.00-1.74 Less; 1.75-2.49 Enough; 2.50-3.24 Good; 3.25-4.00 is excellent.

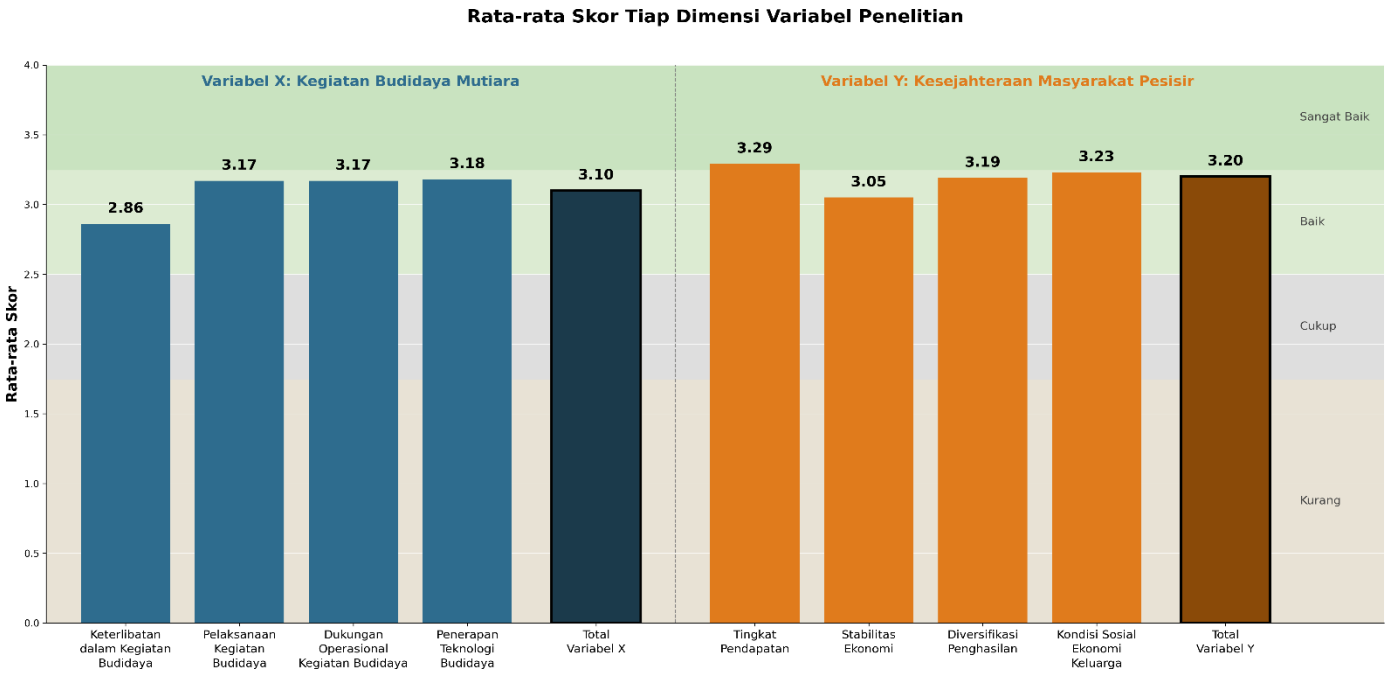


Figure 2. Average Score of Each Dimension of the Research Variable

The variable of Pearl Cultivation Activities obtained a total average of 3.10 (Good category), with the Technology Application dimension recording the highest score (3.18) and the Cultivation Activity Involvement dimension recording the lowest score (2.86). The Coastal Community Welfare variable obtained a total average of 3.20 (Good category), with the Income Level dimension as the highest score (3.29). This pattern shows that the economic benefits of pearl cultivation activities are felt quite clearly by respondents, while the level of active involvement at the production stage is relatively the dimension that needs to be strengthened.

Evaluation of Measurement Models (Outer Model)

External model evaluation was carried out to test the validity and reliability of indicators on the main data (n = 100), including convergent validity (outer loading and *Average Variance* Extracted/AVE), construct reliability *(Cronbach's Alpha and Composite Reliability)*, and discriminant validity (*Heterotrait-Monotrait Ratio*/HTMT). Threshold values *(cut-off value)* Each criterion refers to (Hair et al., 2022).

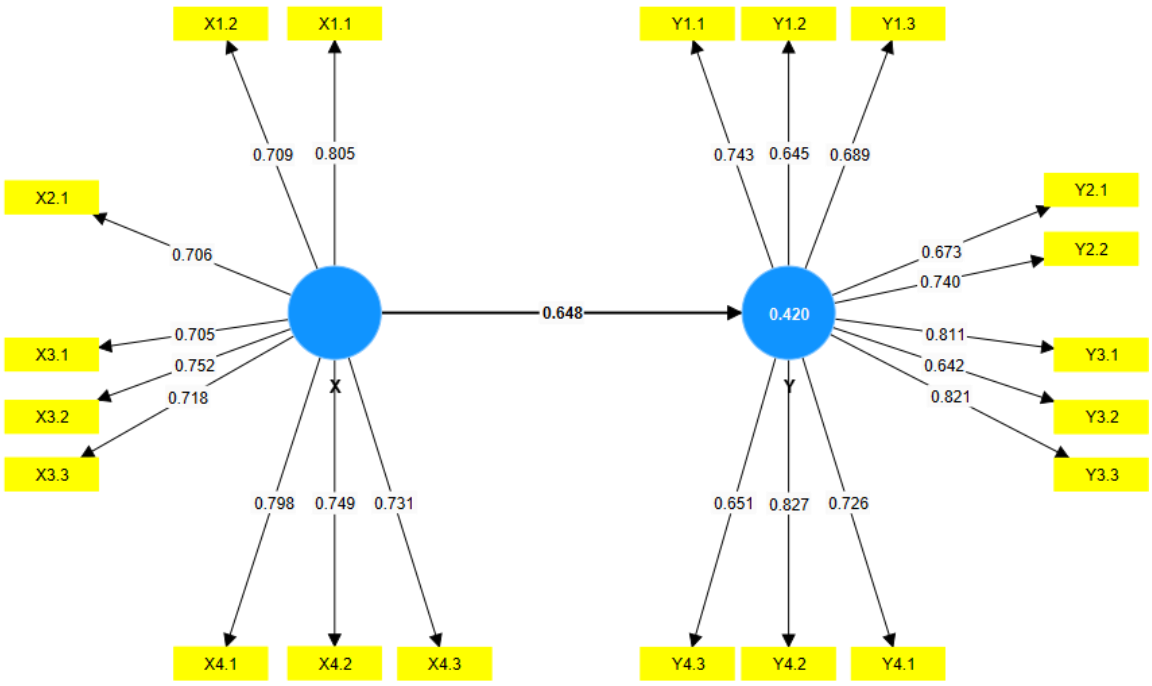


Figure 3. Measurement Results (Outer Model) of PLS Algorithm

The five indicators (Y1.2, Y1.3, Y2.1, Y3.2, and Y4.3) have an outer loading value in the range of 0.50 to 0.70. Referring to Hair et al. (2022), indicators in this range should not necessarily be removed from the model, as long as *the Average Variance Extracted* (AVE) value of the construct in question still meets the threshold of ≥ 0.50 in table 5. Therefore, all five indicators are retained in the model. The main consideration is to maintain content *validity* in the dimensions of Income Level, Economic Stability, Income Diversification, and Family Socio-Economic Conditions, because if these indicators are removed, the scope of concepts measured in these dimensions risks becoming incomplete.

Table 5. Reliability and Validity of Convergent Constructs

Construct	Cronbach'sAlpha	Threshold Values	CompositeReliability (rho_c)	Threshold Values	AVE	HTMT	Threshold Values	Remarks
Pearl Cultivation Activities (X)	0,899	≥ 0.70	0,917	≥ 0.70	0,551	0,664	≥ 0.50	Valid & Reliable
Coastal Community Welfare (Y)	0,911	≥ 0.70	0,925	≥ 0.70	0,529	0,664	≥ 0.50	Valid & Reliable

Source: Data processing results using SmartPLS 4 (2026). The standard refers to Hair et al. (2022).

All nine variable indicators of Pearl Cultivation Activities have an outer loading above 0.70. In the Coastal Community Welfare variable, six of the eleven indicators were above 0.70, while five indicators (Y1.2, Y1.3, Y2.1, Y3.2, and Y4.3) were in the range of 0.50-0.70. As stated in Table 5, these five indicators are still maintained because the AVE of the Y construct still meets the threshold of 0.50 (AVE = 0.529), so their removal is not necessary and instead risks reducing the content *validity of the* measured dimension. *Cronbach's Alpha* and *Composite Reliability values* of both constructs were well above 0.70, indicating excellent internal consistency. The validity of the discriminant was tested through HTMT, resulting in a value of 0.664 between constructs X and Y, below the maximum threshold of 0.90, so that both constructs were proven to measure different concepts empirically.

Evaluation of Structural Models (Inner Model)

The internal evaluation of the model was carried out to assess the model's ability to explain the relationship between pearl cultivation activities and the welfare of coastal communities, through the coefficient of determination (R^2) and *effect size* (f^2).

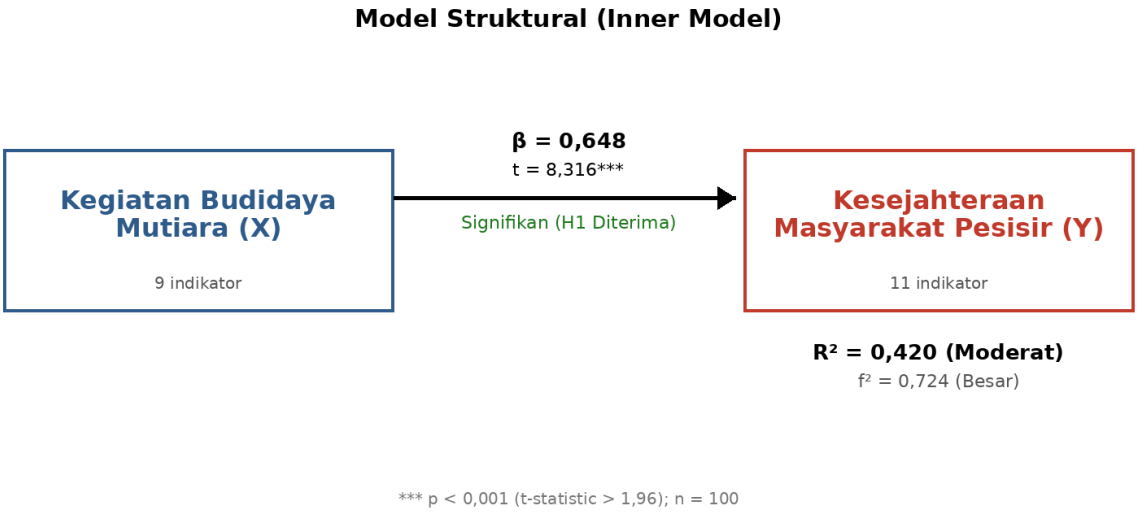


Figure 4. Structural Model (Inner Model) Research

The R^2 value of 0.420 indicates that Pearl Cultivation Activities are able to explain 42.0% of the variation that occurs in the Welfare of Coastal Communities. Referring to Chin's categorization (1998), this value is moderate. The remainder, at 58.0%, was explained by other factors outside the model of this study, such as pearl market conditions, local government policies, or other socioeconomic factors that were not included in the model.

An f^2 value of 0.724 indicates how much Pearl Cultivation Activities contribute to the Welfare of Coastal Communities if this variable is excluded from the model. Referring to Cohen's categorization (1988), the value is classified as *effect size* large *(large effect)*. These findings are important to underline because they show that even though the R^2 model is moderate, the contribution of pearl cultivation activities to the welfare of coastal communities remains statistically substantial. In other words, the variable of Pearl Cultivation Activities has a strong and non-negligible role in explaining the welfare of coastal communities, although there is still room for other factors to contribute.

Table 6. Structural Model Evaluation Results

Criteria	Value	Threshold Values	Categories
SRMR	0,097	< 0.10*(acceptable)* / < 0.08 *(good)*	*Acceptable Fit*
R-square (R^2)	0,420	0.75 Strong; 0.50 moderate; 0.25 Weak	Moderate
R-square Adjusted	0,414	-	-
f-square (f^2) X→Y	0,724	0.02 Small; 0.15 Intermediate; 0.35 Large	Large

Source: Data processing results using SmartPLS 4 (2026). Category R^2 refers to Chin (1998); category f^2 refers to Cohen (1988).

An R^2 value of 0.420 indicates that 42.0% variation in the welfare of Coastal Communities can be explained by Pearl Cultivation Activities, which according to Chin's categorization (1998) classified as moderate. The remainder, at 58.0%, is explained by other factors outside this research model. The f^2 value of 0.724 indicates that the Pearl Cultivation Activity provides *effect size* The big ones *(large effect)* on the Welfare of Coastal Communities according to Cohen's categorization (1988), confirms that the contribution of independent variables to dependent variables is statistically substantial, even if the R^2 model is moderate. Model fit evaluation (*Fit model*) resulting in an SRMR value of 0.097. Referring to the criteria Hair et al. (2021) than Henseler et al. (2016), an SRMR value below 0.10 indicates that the research model is at an acceptable level of fit (*acceptable fit*). This shows that the error estimation of the correlation matrix is within a safe tolerance range, so that the structural model structure is safe and feasible to proceed to the hypothesis testing stage.

Blindfolding Test Results (Predictive Relevance)

Blindfolding test is performed to evaluate *predictive relevance* (predictive relevance) structural model using the *Cross-validated redundancy*. A Q^2 value greater than 0 (zero) indicates that the model has a predictive relevance to the endogenous construct being studied, while a Q^2 value equal to or less than 0 indicates that the model has no predictive relevance. The assessment criteria for the value of Q^2 according to Hair et al. (2019)are as follows: 0.02 (small), 0.15 (medium), and 0.35 (large).

Construct Cross-Validated Redundancy (Q^2 Predict)

Table 7 presents the results of the Q^2 predict value at the construct level obtained through a structural model-based blindfolding procedure (construct cross-validated redundancy).

Table 7. Construct Cross-Validated Redundancy

Construct	SSO	SSE	Q^2 (= 1 − SSE/SSO)
X	900,000	900,000	0,000
Y	1.100,000	875,812	0,204

The X construct is an exogenous construct (not predicted by other constructs in the structural model), so the Q^2 value of 0.000 is normal and not an indication of a problem in the model. Meanwhile, the Y construct as an endogenous construct obtained a Q^2 value of 0.204. The value is above 0 (zero) and is in the range of 0.15–0.35, so it can be concluded that the model has a predictive relevance to the medium category to the Y construct.

Hypothesis Testing

Hypothesis testing was carried out through a bootstrapping procedure with 5,000 subsamples on SmartPLS 4. The hypothesis is stated to be accepted if *the t-statistical* value > 1.96 and *the p-value* < 0.05 at a significance level of 5%.

Table 8. Hypothesis Testing Results

Hypothesis	Pathway	Path Coefficient(β)	*T-statistic*	Threshold Values	*P-value*	Threshold Values	Verdict
H1	Pearl Cultivation Activities → Coastal Community Welfare	0,648	8,316	> 1.96	0,000	< 0.05	Accepted

Source: Data processing results using SmartPLS 4, bootstrapping procedure for 5,000 subsamples (2026).

The test results showed a *t-statistic* value of 8.316 (far exceeding the threshold of 1.96) with *a p-value* < 0.001, so H1 was accepted. Pearl cultivation activities have been proven to have a positive and significant effect on the welfare of coastal communities involved in pearl cultivation activities in Batu Putih Village, Sekotong District, West Lombok Regency, with a path coefficient of 0.648. This value indicates that any increase in the implementation of pearl cultivation activities is associated with a considerable increase in the welfare of coastal communities, with a 95% confidence interval in the range of 0.525 to 0.825 which does not pass the zero value, thus further strengthening the significance of the relationship.

DISCUSSION

The acceptance of H1 with a high level of significance ($t = 8.316$; $p < 0.001$) confirms that pearl cultivation activities empirically play a role as a livelihood strategy *(livelihood strategy)* which is effective for the coastal community of Batu Putih Village. Refer *Sustainable Livelihood Framework* (Chambers & Conway, 1992; DFID, 1999), these findings show that the utilization of human, physical, social, and financial assets through involvement, implementation, operational support, and application of pearl cultivation technology can be transformed in real life into livelihood outputs *(livelihood outcomes)* in the form of increasing income, economic stability, income diversification, and improving family socio-economic conditions. The magnitude of the path coefficient ($\beta = 0.648$) which is relatively strong and *effect size* large ($f^2 = 0.724$ according to Cohen, 1988), confirming that this relationship is not only statistically significant, but also substantial practically for the lives of the people involved.

These findings are in line with Mikhailovich et al. (2022) in Fiji and Tonga found that *Half-pearl aquaculture* increase fishermen's household income, while Johnston et al. (2020) It shows that community-based pearl farming systems support coastal economic resilience through the Blue Economy approach. Simard et al. (2022) also confirmed the role of the pearl industry as a driver of the coastal economy. In a context closer to the indicators of this study, Kasamatsu et al. (2020) and Ramdani (2023) emphasizing that operational support and technology application play an important role in the success of pearl cultivation, a pattern that is also reflected in the descriptive results of this study, where the dimensions of Technology Application and Cultivation Operational Support both obtained high scores (3.18 and 3.17). This consistency reinforces the external validity of the research findings, while also showing that the pattern of relationship between pearl farming activities and well-being tends to be consistent across different geographical contexts, from the Pacific (Fiji, Tonga) to the West Lombok coast.

However, these findings need to be interpreted with caution when associated with research that highlights aspects of environmental sustainability. Reisser et al. (2020) emphasized the importance

of ecological and genetic management for the long-term sustainability of the pearl industry, while Sodikin and Ardiansyah (2024) found that environmental degradation due to abrasion and sedimentation can suppress cultivation productivity. This study does not explicitly include environmental quality variables in the model, so that the positive results obtained reflect the welfare conditions of the community at the time the research was conducted, without being able to ensure its sustainability if the environmental pressure on the cultivation area in Sekotong continues to increase. In other words, the findings of this study and the findings of Reisser et al. (2020) as well as Sodikin and Ardiansyah (2024) Not contradictory, but rather complementary, pearl cultivation has been shown to promote well-being in current environmental conditions, but its sustainability depends on ecological factors that are beyond the scope of this research model.

The R^2 value is 0.420 (moderate category according to Chin, (1998) along with the value *Predictive Relevance* (Q^2) of 0.204 also provides an important note for the interpretation of the results. The value of $Q^2 > 0$ confirms that the structural model of this study has predictive capabilities with a moderate level of category accuracy (*medium predictive relevance*) (Hair et al. 2021). This proves that the variables of pearl cultivation activities are not only significant in relationships, but also have valid predictive power for the level of community welfare in the future. On the other hand, the R^2 value indicates that 58.0% of the variation in the welfare of coastal communities is explained by factors outside of pearl cultivation activities. Overall, the model fit evaluation (*Fit model*) results in an SRMR value of 0.097, which is within acceptable tolerance limits (*acceptable fit*, < 0.10) for prediction-based PLS-SEM analysis (Hair et al. 2021; Henseler et al. 2016), thus confirming that the model specifications have been adequate. This condition is consistent with the findings of Southgate et al. (2023) dan Hoque et al. (2021) which emphasizes that the welfare of coastal communities is multidimensional and is influenced by many factors other than cultivation activities alone, such as access to markets, local institutions, and social capital which are not explicitly measured in this study. In addition, the dominance of the respondents' status as workers of cultivation companies (81.0%) compared to independent cultivators (6.0%), as found in the characteristics of the respondents, provides an important nuance to the meaning of this result: the improvement in welfare that occurs is more derived from the employment relationship with the cultivation company than from the diversification of independent businesses as emphasized in the concept *livelihood diversification* on SLF (Ellis, 2000; Scoones, 1998). This pattern is different from the findings of Assagaf et al. (2024) and Picaulima and Erbabley (2023) What highlights aquaculture with high economic value is actually the most impactful when the community plays the role of business actors, not just workers.

Theoretically, this study contributes in the form of empirical validation of the application *of the Sustainable Livelihood Framework* in the context of pearl cultivation in Indonesia, a combination that, according to the synthesis in the Introduction, is still relatively rarely studied quantitatively through the PLS-SEM approach based on direct public perception. Practically, these findings support the sustainability of the coaching program that has been carried out by the Lombok Marine Aquaculture Fisheries Center and the Directorate General of Aquaculture Fisheries of the Ministry of Marine Affairs and Fisheries in Batu Putih Village, because it has been proven to be associated with real welfare improvements. However, considering that the score of the Cultivation Activity Involvement dimension was recorded as the lowest (2.86) and the dominance of the status of workers compared to independent cultivators, local governments and cultivation companies are advised to consider programs that encourage the transition of some of the workforce to small-scale cultivation business ownership or more equal partnerships, in line with the principle of livelihood diversification which is at the core of the Sustainable Livelihood Framework. in order to strengthen the economic resilience of coastal communities in the long term.

Research Limitations and Advanced Research Suggestions

The results of this study have several limitations that need to be considered in interpreting the results. First, the research design is cross-sectional and includes only one research location (Batu Putih Village), so generalization of findings in other coastal contexts needs to be done carefully. Second, data is collected through questionnaires *self-report* Likert scale, which has the potential to contain social desire bias *(social desirability bias)* Although the researcher has provided direct assistance during charging. Third, the value of *Standardized Root Mean Square Residual* (SRMR) of 0.097 is slightly above the threshold of 0.08 commonly used as a rule of thumb. However, according to Hair et al. (2021) and Henseler et al. (2016), SRMR values of up to 0.10 are still considered within acceptable tolerance limits (*acceptable fit*) on PLS-SEM-based analysis. In addition, because the PLS-SEM approach focuses on predictability (*Predictive Power*), these limitations do not interfere with the validity of the main findings of the study considering that all the conditions of validity, reliability, and predictability of the model have been adequately met (Henseler et al. 2015). Fourth, the five indicators of the Coastal Community Welfare variables (Y1.2, Y1.3, Y2.1, Y3.2, and Y4.3) have an outer loading in the range of 0.50-0.70, which although in aggregate does not lower the construct AVE below the threshold, shows that some instrument items in the dimensions of Income Level, Economic Stability, Income Diversification, and Family Socio-Economic Conditions can still be refined in future research. Fifth, the R^2 value of 0.420 indicates that there is still a considerable proportion of welfare variation (58.0%) that has not been

explained by the model, so other variables outside of pearl cultivation activities may also play a role.

Based on these limitations, further research is recommended to: (1) use longitudinal design to capture changes in the welfare of coastal communities over time, especially to test the sustainability of the influence of pearl cultivation in the long term; (2) to expand the scope of the research site to several other pearl cultivation centers in Indonesia to test the generalization of the model; (3) include the variables of environmental quality or ecological sustainability as additional moderator or exogenous variables, given the importance of this aspect according to Reisser et al. (2020) and Sodikin and Ardiansyah (2024); (4) adding other variables such as market access, local institutions, or social capital to magnify the model's clarity on the variation in the welfare of coastal communities; and (5) to improve the instrument items on the indicator with a load below 0.70, especially in the dimensions of Economic Stability and Income Diversification, in order to be able to capture the construct more sharply in the next measurement.

CONCLUSION

This study proves that pearl cultivation activities have a positive and significant effect on the welfare of coastal communities involved in pearl cultivation activities. The involvement, implementation, operational support, and application of technology in pearl cultivation activities empirically plays a role as an effective livelihood strategy in increasing income, economic stability, income diversification, and socio-economic conditions of coastal communities, in line with the principles of the Sustainable Livelihood Framework.

Theoretically, this study strengthens the relevance of the Sustainable Livelihood Framework as a basis for analysis in the context of high-economic aquaculture in Indonesia, while complementing the literature that previously focused more on the technical and environmental aspects of pearl farming. Practically, this finding recommends the sustainability of government development programs through the Lombok Marine Aquaculture Fisheries Center and the Directorate General of Aquaculture Fisheries of the Ministry of Marine Mammals, accompanied by efforts to encourage the transition of some aquaculture workers towards independent business ownership or more equal partnerships, the composition of respondents in this study is dominated by people who have the status of workers in pearl cultivation companies, which is 81.0%, Meanwhile, respondents who have the status of independent cultivators are only 6.0%. This condition shows that most of the people who are respondents obtain economic involvement in pearl cultivation activities through working relationships with companies. Given that this study uses a cross-sectional approach and is only conducted at one research site, further research with a wider area coverage and using a longitudinal approach is needed to test the consistency, sustainability, and generalization of research findings regarding the influence of pearl cultivation activities on the welfare of coastal communities.

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