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Fostering Sustainable Livelihoods in Indonesia: Economic Determinants of Productivity and Welfare in Capture Fisheries

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Abstract. *Indonesia's capture fisheries sector is crucial for economic development and food security, yet the welfare of small-scale fishers remains persistently low due to fluctuating income, limited infrastructure, and weak institutions. This study aims to analyze the economic determinants influencing the productivity and welfare of fisher households in Pinrang Regency, South Sulawesi. Employing a quantitative approach using Structural Equation Modeling–Partial Least Squares (SEM-PLS), this research investigates how institutional strengthening, empowerment, and infrastructure impact fisher productivity and economic welfare. Data were collected through structured questionnaires administered to 100 fishers and analyzed using SmartPLS 3.0. The results reveal that institutional strengthening significantly influences productivity ($\beta = 0.379, p < 0.01$) and welfare ($\beta = 0.533, p < 0.001$), while infrastructure also exerts a positive effect on both productivity ($\beta = 0.237, p < 0.05$) and welfare ($\beta = 0.217, p < 0.05$). Empowerment, however, shows no significant effect ($p > 0.5$). The model explains 63.2% of the variance in productivity ($R^2 = 0.632$) and 84.8% in welfare ($R^2 = 0.848$). Productivity serves as a mediating variable, with significant indirect effects between institutional strengthening and welfare ($\beta = 0.104, p < 0.05$). The findings highlight the importance of robust institutions and integrated infrastructure in fostering sustainable livelihoods. This study contributes to policy design by emphasizing localized, data-driven strategies that align with the needs of coastal communities. Its implications extend to improving economic welfare, promoting inclusive development, and supporting Sustainable Development Goals (SDGs), especially in vulnerable coastal zones*

Keywords: *Capture fisheries, fostering sustainable livelihoods, infrastructure, productivity, economic welfare*

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Introduction

The capture fisheries sector plays a strategic role in economic development and food security in Indonesia. As the largest archipelagic country in the world with a coastline of more than 95,000 km, according to (Djunarsjah and Putra 2021) Indonesia has enormous fisheries potential. This sector is not only the main provider of animal protein for the community, but also a source of livelihood for millions of fishermen and coastal economic actors. Data from the Ministry of Maritime Affairs and Fisheries (KKP) noted that more than 2.7 million households depend on capture fisheries activities to meet their living needs and as many as 95.6 percent of them are traditional fishermen operating around the coast. (Asiati 2016). However, the contribution of this sector to the welfare of fishermen and inclusive economic development is still far from optimal.

The majority of fishing households in Indonesia still live in vulnerable socio-economic conditions, characterized by fluctuating income levels, low productivity, limited access to markets and technology, and weak institutions. According to (Andari 2022), the poverty rate among fishermen is much higher than other community groups. This shows structural inequality in the distribution of economic benefits generated by the capture fisheries sector. One of the main causes of low welfare of fishermen is the low productivity they achieve.

According to (Heizer and Render 2011) Productivity is the ratio of output (goods and services) to input (labor, capital, energy, and so on). Increasing productivity means producing more output from the same or less input. Capture fisheries productivity is not only influenced by natural factors such as the availability of fish resources, but also by economic determinants such as ownership of fishing gear, level of education, skills, access to capital, and the functioning of local economic institutions. Several studies have shown that increased productivity has a significant positive correlation with the welfare of fishermen's households. (Panjaitan and Panjaitan 2020). Therefore, it is important to identify and understand the economic factors that determine this productivity more comprehensively so as to increase economic growth. (M. Murniati et al. 2021) Several welfare issues for fishermen in Pinrang Regency are influenced by socio-economic aspects such as seasonal income fluctuations, low levels of education and health vulnerabilities which further exacerbate the difficulties faced by fishermen. (Fadilah, 2025) and (Yusuf, 2021).Empowerment and infrastructure access have been proposed as solutions (Achmad 2024), yet their effectiveness remains questionable.

Fishermen's income tends to fluctuate due to dependence on fishing seasons, worsening their socio-economic conditions. Increasing productivity through empowerment and better infrastructure access can be a solution to increase income, which in turn can increase access to education and health (Achmad 2024) Furthermore, the sustainable development approach emphasizes the importance of building resilient and sustainable livelihoods, especially in areas that are ecologically and socially vulnerable. (Baiquni and Astuti 2018) In the context of capture fisheries, the concept of sustainable livelihoods includes economic (income, productivity), social (education, health, institutions), and environmental (marine biological resource sustainability) dimensions. (Wenzano 2024) According to (Allison and Ellis 2001) emphasized that policies that only focus on increasing production without considering aspects of social and ecological sustainability can actually worsen the conditions of fishermen in the long term.

In Indonesia, there are various government policies and programs that aim to improve the welfare of fishermen, However, many of these programs have not had a significant impact because they are not based on an in-depth analysis of local economic determinants that affect the productivity and welfare of fishermen. In addition, weaknesses in institutional design and program implementation often cause a mismatch between the needs of fishermen and the interventions provided. Therefore, this study is very relevant and important.(Sardjo, Darmajanti, and Boediono 2017)

This study aims to explore and analyze the economic determinants that influence the productivity and welfare of fishermen households in the capture fisheries sector. Specifically, this study wants to find out to what extent factors such as production capital, household assets, access to markets, institutions, and individual capacity affect the level of productivity and welfare of fishermen. By using a quantitative approach based on simultaneous equation models, this study is expected to provide a strong empirical contribution in developing an inclusive and sustainable fisheries development strategy. The focus of the research is directed at capture fisheries in coastal areas South Sulawesi

1. *Institutional Strengthening (X1)*
   Institutional strengthening includes the existence and effectiveness of fishermen's organizations, financial institutions, and government institutions. Strong institutions play a role in providing access to financing, training, and market information that support the productivity of fishermen in sustainable fisheries businesses. (Viola and Arif 2022);
2. *Fishermen Empowerment (X2)*
   Fishermen empowerment is measured through counseling, training, and mentoring. The purpose of this empowerment is to increase the capacity of human resources for fishermen in technical, managerial, and organizational aspects. (Abrori1;a.l. 2023) emphasizes that appropriate training and mentoring can increase production efficiency and open up opportunities for business diversification.
3. *Infrastructure (X3)*
   Infrastructure variables include the availability of traditional markets, fuel filling centers, and ice factories. Adequate infrastructure increases the operational efficiency of fishermen and expands market access.According to (Primyastanto 2014), fishing ports and cold storage can increase the selling value of catches, reduce product damage, and support efficient fisheries logistics.
4. *Fishermen's Productivity (Y1)*
   Fishermen's productivity is an intermediary variable that bridges the relationship between external factors and welfare. The indicators used include: fishing gear, business capital, and business management. Productivity is influenced by internal factors such as skills, technology, and access to capital (Trimiati 2018).
5. *Fishermen's Welfare (Y2)*
   Fishermen's welfare is measured through household income, living conditions, and family health.This indicator is adjusted from the parameters used by BPS and has been modified according to the coastal context. Studies by (Triyanti et.all 2016) show that welfare depends not only on income but also on access to basic services and living conditions.

This study integrates all these variables into a structural model that explains the direct and indirect relationships between variables. Findings in previous studies indicate that institutional strengthening and infrastructure availability have a significant effect on fishermen's productivity and welfare. Thus, relevant literature shows that the indicators used in this study are already based on a strong theoretical and empirical framework that reflects the complexity and dynamics of fishermen's livelihood systems and allows for a comprehensive analysis of the relationship between economic factors and their productivity and welfare.

Research Methodology

Research Design

This study used a quantitative explanatory design to analyze causal relationships between institutional strengthening, fisher empowerment, infrastructure, productivity, and welfare in Pinrang Regency, South Sulawesi . (M. G. Murniati, Noor, and Ekawaty 2024). Structural Equation Modeling–Partial Least Squares (SEM-PLS) was applied to examine direct and indirect effects (Ajeng Mira Herdina, Riesta Devi Kumalasari 2021). The explanatory design allows testing complex variable interactions with mediating effects, such as productivity (Lowry and Gaskin 2014)

Scope and Objects of the Study

The study focused on fishermen households in the coastal areas of Pinrang Regency, who are engaged in small-scale marine capture fisheries. The unit of analysis is the household head (who is actively involved in fishing operations, while the observation units include institutional environments, infrastructure, and family welfare indicators.

Materials and Equipment

The primary material used was a structured questionnaire developed from indicators adapted from (Badan Pusat Statistik 2015), relevant academic studies. Equipment included data collection

Study Site

The research was located in the coastal zone of Pinrang Regency, South Sulawesi Province, Indonesia. This region was selected due to its significant contribution to marine fisheries production and the high concentration of fishingcommunities whose livelihoods are directly dependent on capture fisheries (Badan Pusat Statistik Kabupaten Pinrang 2023).

Data Collection Technique

This study used a quantitative explanatory design with SEM-PLS, focusing on 100 purposively selected fishermen in Pinrang Regency. Criteria included at least five years' fishing experience, being household heads actively engaged in fishing, owning or operating fishing gear/boats, and fishing for at least eight months annually. Data were collected through structured questionnaires and analyzed using SmartPLS 3.0. The study employed five main constructs as the variables and operational definitions of the research.

Table 1
Research Variables, Indicators

Variable	Indicators	References
Institutional Strengthening (X1)	Fishermen organizations; Financial institutions; Government institutions	(Lasut, Rotinsulu, and Engka 2019);(Aryawati et al. 2023)
Empowerment (X2)	Counseling; Training; Education	(Diatmika and Rahayu 2022); (Lasut, Rotinsulu, and Engka et al. 2019)
Infrastructure (X3)	Markets; Fuel stations; Ice factories	(Sutiono 2018); (Magfirah 2022); (Deswati and Muhadjir 2015)
Productivity (Y1)	Fishing gear; Business capital; Management	(Trimiati 2018); (Ridha 2017)
Welfare (Y2)	Income; Housing condition; Health	(Cholik 2020); (Triyanti and Firdaus 2016)

Source: Author 2025

The Data Analysis Techniques

The data analysis technique in this study uses several hypothesis tests using Partial Least Square (PLS) using SmartPLS 3.2.9 software where PLS has the ability to connect a group of independent variables with several dependent variables(Xhafaj et al. 2021). Analyzing using PLS has three stages that need to be done, namely Outer model analysis, Inner model analysis, and continued with hypothesis testing (Herianti 2020). The following are the steps in using the PLS method.

1. Outer Model Analysis

Outer model testing in Partial Least Squares (PLS) Analysis establishes the relationship between latent variables and their indicators. In other words, the outer model defines how each indicator relates to its latent variables (Sarstedt and Ringle 2021).

$x = \lambda x \xi + \delta x$............................(1)

$y = \lambda y \eta + \varepsilon y$............................(2)

where x and y are indicators for the independent and dependent latent variables (ξ and η).

a. Convergent Validity, is conducted to assess the validity of the relationship between indicators and the latent variables being measured. The convergent validity value can be seen from the standardized loading factor. The acceptable convergent validity value is the loading factor value > 0.5 (Herianti 2020)

b. Discriminant Validity, validity is assessed through cross-loading and comparing AVE with the squared correlation between constructs. A construct achieves validity if its indicators correlate higher with it than with others. AVE > 0.5 indicates good discriminant validity, ensuring constructs predict their indicators effectively (Irwan and Adam 2015).

$$r_{xy} = \frac{n\sum_{i=1}^{n} X_i Y_i - \left(\sum_{i=1}^{n} X_i\right)\left(\sum_{i=1}^{n} Y_i\right)}{\sqrt{\left\{n\sum_{i=1}^{n} X_i^2 - \left(\sum_{i=1}^{n} X_i\right)^2\right\}\left\{n\sum_{i=1}^{n} Y_i^2 - \left(\sum_{i=1}^{n} Y_i\right)^2\right\}}}$$ ....(3)

c. Average Variance Extracted (AVE) is the average value that shows how much the latent variable can explain the variance of its indicators (Herianti 2020). The indicator can be accepted if the AVE value is > 0.5 measure the targeted latent construct.

$$AVE = \frac{\sum_{i=1}^{m} \lambda_i^2}{\sum_{i=1}^{m} \lambda_i^2 + \sum_{i=1}^{m} \mathrm{var}(\varepsilon_i)}$$ .... (4)

d. Composite Reliability, Construct reliability testing can be measured using the composite reliability criteria. The purpose of this test is to ensure that a tool is reliable, consistent, and accurate. (Herianti 2020).

$$pc = \frac{\left(\sum_{i=1}^{m} \lambda\right)^2}{\left(\sum_{i=1}^{m} \sum \lambda_i\right)^2 + \sum_{i=1}^{m} \mathrm{var}(\varepsilon_i)}$$ .... (5)

e. Cronbach's Alpha, Reliability testing can be done by testing the consistency of each answer by looking at the results of the Cronbach's alpha value. Cronbach's alpha can be said to be good if it has a value > 0.7 for all constructs, thus the results of the reliability test can be ensured to have a high level of accuracy (Herianti 2020).

2. Inner Model Analysis

Inner model analysis is connecting latent variables that are in accordance with the specified model, so that it can provide a clearer picture of the relationship between these latent variables. The inner model in PLS is evaluated using R-square and Q-square.

$$\eta = \beta\eta + \gamma\xi + \zeta$$ ....(6)

where represents the vector of dependent latent variables, is the vector of exogenous latent variables, and is the vector of residual variables.

a. R-Square, The R-square test aims to help determine how big the role of the independent variable (exogenous) is in explaining the variation of the dependent variable (endogenous). if greater than 0.75 indicates that the model is strong. If it has a value of 0.50, it indicates that the model is moderate. (Ghozali and Latan 2020).

$$R^2 = 1 - \frac{\sum(\eta_i - \hat{\eta}_i)^2}{\sum(\eta_i - \hat{\eta}_i)^2} \quad \text{.........(7)}$$

b. Q-Square (Stone-Geisser's), it is used to assess the extent to which the model can produce accurate observation values and the extent to which the parameter estimates are appropriate. A Q-Square value> 0 indicates that the model has predictive relevance, and vice versa if the Q-Square value <0 indicates that the model has less predictive relevance (Ghozali and Latan 2020).

Q2 = 1 – (1–R12) (1–R22)…(1–Rn2) .. (8)

3. Hypothesis Testing

According to (Herianti 2020), hypothesis testing can be done by looking at the results of the t-statistic value and the probability value. In hypothesis testing using statistical values, with an alpha of 5%, To reject or accept a hypothesis using probability, Ha is accepted if the p value < 0.05.

$$t_{hitung} = \frac{\hat{\gamma}_{jb}}{S_e(\hat{\gamma}_{jb})}; b = 1,2,...,k \quad \text{........(9)}$$

H0 refused if $t > t\alpha/2$ ....(10

Results and Discussion

Outer Model Evaluation

Based on the results of the analysis, all indicators showed good convergent validity with outer loading values above 0.7, except for several items that were eliminated because they did not meet the convergence requirements.

Outer Model Evaluation Results

1. Discriminant Validity

The model has sufficient discriminant validity if the root of AVE (Average Variance Extracted) for each construct is greater than the correlation between the construct and other constructs.)

Table 2.
AVE dan Composite Reliability

Variabel	AVE (Average Variance Extracted)
Institutional Strengthening (X_1)	0,642
Empowerment (X_2)	0,579
Infrastructure (X_3)	0,765
Productivity (Y_1)	0,510
Welfare (Y_2)	0,719

Source: Processed data results, 2024

The values of Average Variance Extracted (AVE) for each construct used in this study, which measure the convergent validity of the latent variables. According to Hair et al. (2021), an AVE value greater than 0.50 indicates that the construct explains more than half of the variance of its indicators, thus meeting the threshold for acceptable convergent validity. As shown, all constructs demonstrate satisfactory AVE values: Institutional Strengthening (X_1) = 0.642, Empowerment (X_2) = 0.579, Infrastructure (X_3) = 0.765, Productivity (Y_1) = 0.510, and Welfare (Y_2) = 0.719. These results confirm that each construct has adequate convergent validity and that the indicators used effectively represent their respective latent variables. Assessing the validity of a construct by looking at the AVE value, a good model is required if the AVE value of each construct is greater than 0.5. The AVE value of each latent variable is greater than 0.5 so it can be said that each latent variable meets discriminant validity.

2. Composite Reliability

Composite reliability is a construct reliability test conducted to ensure the accuracy, consistency, and precision of the instrument in measuring the construct. A latent variable/construct is said to be reliable when the composite reliability value is greater than 0.7.

Table 3

Composite Reliability Output

Variables	**Composite Reliability**
Institutional Strengthening (X_1)	0,843
Empowerment (X_2)	0,742
Infrastructure (X_3)	0,884
Productivity (Y_1)	0,764
Welfare (Y_2)	0,891

Source: Processed Data Results, 2024

The Composite Reliability (rho_c) value of each latent variable is greater than 0.7 so it can be said that each latent variable meets composite reliability.

Inner Model Evaluation Results

1. Collinearity Statistics (VIF) Test

The collinearity statistics test is a test of collinearity problems between constructs/ latent variables by looking at the VIF value of each latent variable/construct and its indicators. If the VIF value is less than 5, there is no collinearity problem, while if the VIF value is greater than 5, there is a collinearity problem. The SmartPLS Output

The VIF value of each latent variable and its indicator is less than 5, so it can be said that there is no collinearity problem.

2 R Square

The R Square value shows how much variation the independent variable can explain to its dependent variable. The greater the R Square value, the better an independent variable is in explaining its dependent variable.

Table 4

VIF Value

Variables	Fishermen Productivity (Y_1)	Fishermen Welfare (Y_2)
Institutional Strengthening (X_1)	2.268	2.483
Empowerment(X_2)	2.999	3.011
Infrastructure(X_3)	1.506	1.590
Productivity (Y_1)		1.497

Source: Processed Data Results, 2024

Table 5
R-Square Value

Variable	R-Square
Productivity(Y_1)	0.632
Welfare (Y_2)	0.848

Source: Processed Data Results, 2024

The R Square value of variable Y1 is 0.632 so that variables X1, X2 and X3 can explain the variation of Y1 by 63.2% while the remaining 36.8% is explained by other factors outside the model used. The R Square value of variable Y2 is 0.848 so that variable Y1 can explain the variation of Y2 by 84.8% while the remaining 15.2% is explained by other factors outside the model used. This section consists of the results of validity and reliability the limitation of the study.

Path Coefficients (Pengujian Hipotesis)
limitations of using survey methods

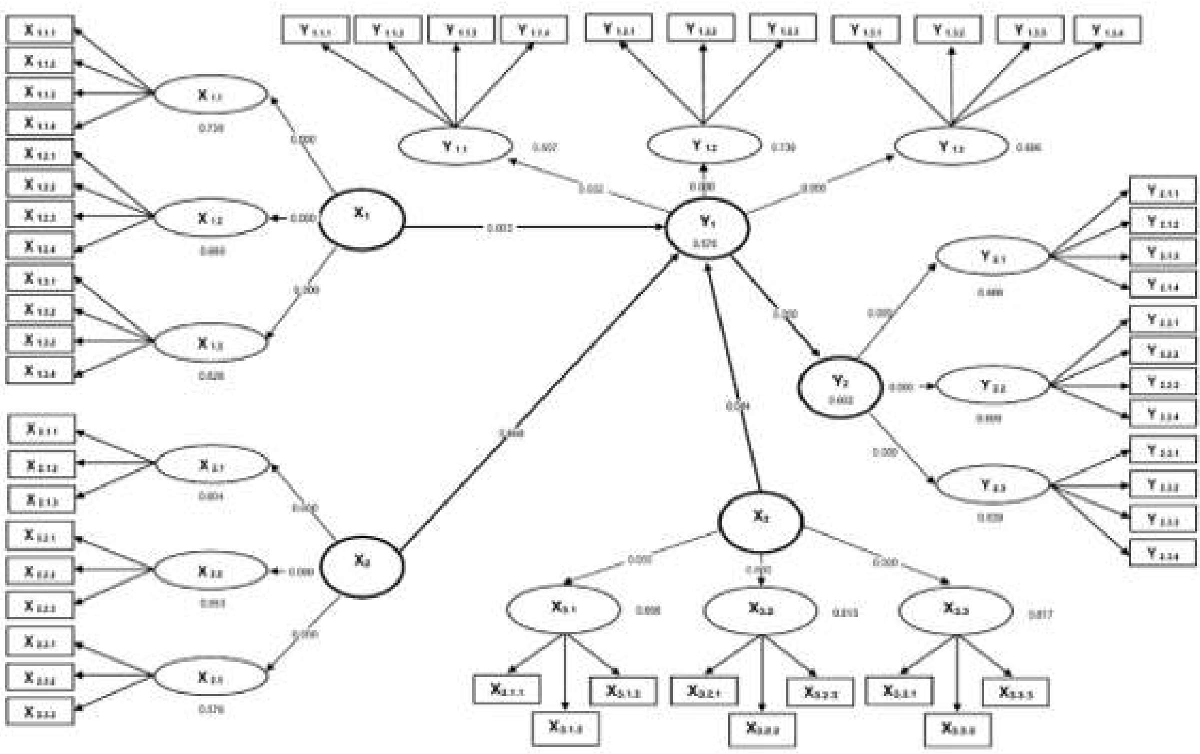

Figure 1
Output SmartPLS
Source: SmartPLS Output Data Results

Table 6
Output SmartPLS

Variabel	Original sample (O)	Sample mean (M)	Standar deviation (STDEV)	T statistics ([O/STDEV])	P values
X1 -> X1.1.	0.850	0.851	0.037	23.075	0.000
X1 -> X1.2.	0.845	0.848	0.031	27.533	0.000
X1 -> X1.3.	0.708	0.715	0.060	11.722	0.000
X1 -> Y1	0.379	0.371	0.128	2.965	0.003
X1 -> Y2	0.533	0.527	0.118	4.522	0.000
X2 -> X2.1.	0.767	0.767	0.070	10.992	0.000
X2 -> X2.2.	0.733	0.737	0.078	9.457	0.000
X2 -> X2.3.	0.774	0.784	0.048	16.089	0.000
X2 -> Y1	0.090	0.114	0.161	0.562	0.574
X2 -> Y2	0.017	0.005	0.128	0.134	0.893
X3 -> X3.1.	0.814	0.817	0.039	20.625	0.000
X3 -> X3.2.	0.905	0.907	0.017	52.587	0.000
X3 -> X3.3.	0.899	0.900	0.019	46.632	0.000
X3 -> Y1	0.237	0.222	0.122	2.934	0.043
X3 -> Y2	0.217	0.211	0.089	2.431	0.015
Y1 -> Y1.1.	0.109	0.107	0.057	2.015	0.033
Y1 -> Y1.2.	0.860	0.861	0.038	22.722	0.000
Y1 -> Y1.3.	0.833	0.827	0.057	14.698	0.000
Y1 -> Y2	0.276	0.270	0.082	3.359	0.001
Y2 -> Y2.1.	0.820	0.826	0.030	27.231	0.000
Y2 -> Y2.2.	0.949	0.949	0.009	109.522	0.000
Y2 -> Y2.3.	0.809	0.814	0.037	22.097	0.000

Source: SmartPLS Output Data Results

Table 7
SmartPLS Indirect Effects Output Results

Variabel	Original sample (O)	Sample mean (M)	Standar Deviation (STDEV)	T Statistics ([O/STDEV])	P Values
X1 -> Y1 -> Y2 -> Y2.1.	0.086	0.085	0.044	1.938	0.053
X1 -> Y1 -> Y2 -> Y2.2.	0.099	0.097	0.049	2.007	0.045
X3 -> Y1 -> Y2 -> Y2.2.	0.062	0.058	0.038	1.613	0.107
X3 -> Y1 -> Y2 -> Y2.1.	0.054	0.051	0.034	1.581	0.114
X3 -> Y1 -> Y2 -> Y2.3.	0.053	0.050	0.033	1.620	0.105

Table 7. (Continued)

Variabel	Original sample (O)	Sample mean (M)	Standar Deviation (STDEV)	T Statistics ([O/STDEV])	P Values
X2 -> Y1 -> Y2 -> Y2.1.	0.020	0.024	0.036	0.562	0.574
X2 -> Y1 -> Y2 -> Y2.2.	0.024	0.027	0.042	0.565	0.572
X2 -> Y1 -> Y2 -> Y2.3.	0.020	0.024	0.036	0.564	0.573
X1 -> Y1 -> Y2 -> Y2.3.	0.085	0.083	0.042	1.999	0.046
X1 -> Y1 -> Y1.1	0.123	0.141	0.078	1.585	0.113
X1 -> Y2 -> Y2.1	0.437	0.435	0.098	4.466	0.000
X1 -> Y1 -> Y1.2	0.326	0.319	0.110	2.950	0.003
X1 -> Y2 -> Y2.2	0.506	0.500	0.111	4.537	0.000
X1 -> Y1 -> Y1.3	0.316	0.307	0.110	2.858	0.004
X1 -> Y2 -> Y2.3	0.432	0.430	0.102	4.217	0.000
X1 -> Y1 -> Y2	0.104	0.102	0.052	2.010	0.044
X2 -> Y1 -> Y1.1	0.029	0.037	0.065	0.450	0.653
X2 -> Y2 -> Y2.1	0.014	0.004	0.106	0.133	0.894
X2 -> Y1 -> Y1.2	0.078	0.100	0.140	0.557	0.578
X2 -> Y2 -> Y2.2	0.016	0.004	0.122	0.134	0.893
X2 -> Y1 -> Y1.3	0.075	0.093	0.132	0.571	0.568
X2 -> Y2 -> Y2.3	0.014	0.004	0.104	0.134	0.894
X2 -> Y1 -> Y2	0.025	0.029	0.044	0.566	0.572
X3 -> Y1 -> Y1.1	0.077	0.089	0.064	1.193	0.233
X3 -> Y2 -> Y2.1	0.178	0.175	0.074	2.401	0.016
X3 -> Y1 -> Y1.2	0.204	0.191	0.105	1.948	0.051
X3 -> Y2 -> Y2.2	0.206	0.201	0.085	2.435	0.015
X3 -> Y1 -> Y1.3	0.197	0.184	0.102	1.926	0.054
X3 -> Y2 -> Y2.3	0.176	0.122	0.072	2.449	0.014
X3 -> Y1 -> Y2	0.093	0.091	0.050	2.001	0.049
Y1 -> Y2 -> Y2.1	0.226	0.223	0.070	3.238	0.001
Y1 -> Y2 -> Y2.2	0.262	0.256	0.078	3.355	0.001
Y1 -> Y2 -> Y2.3	0.223	0.219	0.066	3.376	0.001

Source: SmartPLS Output Data Results

The SEM-PLS analysis demonstrates that institutional strengthening significantly influences productivity ($\beta = 0.379$, $p < 0.01$) and welfare ($\beta = 0.533$, $p < 0.001$). Infrastructure also exerts significant effects on both productivity ($\beta = 0.237$, $p < 0.05$) and welfare ($\beta = 0.217$, $p < 0.05$). Productivity mediates the relationship between institutions and welfare ($\beta = 0.104$, $p < 0.05$). In contrast, empowerment was not statistically significant ($p > 0.5$). This result aligns with field data, where 62% of respondents reported that training was too generic, short-term, or misaligned with their fishing practices.

These findings suggest that empowerment initiatives often fail due to limited contextual adaptation and weak monitoring. In contrast, institutional strengthening through cooperatives and microfinance, and infrastructure support such as cold storage and markets, directly enhance both productivity and welfare. The unique contribution of this study lies in confirming the mediating role of productivity, which accounts for indirect welfare improvements when institutions and infrastructure are strengthened.

1. *Institutional Strengthening and Its Impact*
   This study reinforces North's institutional theory, emphasizing that formal and informal institutions shape economic interactions. In fishermen's context, institutions such as KUB, cooperatives, and microfinance play a vital role in boosting competitiveness. Local support through capital, market access, and legal protection enhances incentives and productivity. Moreover, institutional effectiveness improves welfare by expanding access to education, health, and housing. Consistent with Robles-Zavala (2014), , institutions are crucial pillars for building sustainable livelihoods in coastal communities.
2. *Infrastructure as a Catalyst for Productivity and Welfare*
   Infrastructure has a direct and significant influence on fishermen's productivity, as well as being an indirect determinant of their welfare. Access to fish landing ports, cold storage, fish markets, and adequate fuel availability contribute to increasing operational efficiency of fishing (Susilo and Indrayani, Erlinda Fathah 2023). Adequate infrastructure allows fishermen to store their catch longer, access wider markets, and sell products at higher value, thus having a direct impact on increasing income. This study strengthens the argument of Lloret et al. (2018) that improving fisheries infrastructure in coastal areas not only increases production value but also expands economic access for fishing communities. (McClanahan, Allison, and Cinner 2015) Therefore, the development of infrastructure integrated with logistics systems and digital marketing technology is one of the important follow-up recommendations.
3. *Mediating Role of Fisher Productivity*
   One of the important contributions of this study is the proof of the mediating role of productivity in the relationship between external factors (institutions and infrastructure) and welfare. This finding supports the livelihood framework theory by Chowdhury (2021) and Morse and Mc Namara (2013), which places productivity as an important capital asset in building sustainable livelihoods. The higher the productivity of fishermen, the more likely they are to earn income that can meet basic needs such as education, health, and decent housing.
4. *Non-significant Impact of Empowerment Programs*
   Although empowerment is theoretically considered important, the results of this study indicate that this variable does not have a significant effect on the productivity or welfare of fishermen. This indicates a gap between the design of empowerment programs and their implementation in the field. Many training or extension programs are formalities and have not been able to reach the real needs of fishermen in increasing technical and managerial capacity (Priharanto et al. 2023) This failure of empowerment can also be linked to the minimal involvement of women and the younger generation of fishermen in

training programs. The study by (Nasuka, Zubair, and Semaun 2023) emphasized the importance of an inclusive and gender-based approach in the design of coastal community empowerment programs. Therefore, there needs to be a redesign of empowerment policies that are based on local needs (local wisdom), involve the active participation of fishermen, and are supported by ongoing evaluation.

5. *Specific and Unique Findings*

This study has unique findings in the local context of Pinrang Regency, namely that the high productivity of fishermen is not solely determined by the number of fishing gear or capital, but also the efficiency of business management and the availability of supporting facilities such as fish storage and transportation facilities for catches. In addition, informal institutions such as religious groups and traditional leaders have a strong role in strengthening social cohesion, which indirectly affects the sustainability of fishing businesses.

Conclusion

This study concludes that institutional strengthening and infrastructure are critical drivers of productivity and welfare among capture fishers in Pinrang Regency, whereas empowerment initiatives remain ineffective. The novelty lies in identifying productivity as a mediating factor between economic determinants and welfare outcomes. For policymakers, the findings recommend redesigning empowerment programs to be participatory, gender-inclusive, and locally adapted. Infrastructure investment should not only focus on physical facilities but also integrate digital tools for market access and cold-chain logistics. These interventions can foster sustainable livelihoods, improve resilience, and contribute to achieving the Sustainable Development Goals (SDGs) in coastal communities.

This study was limited to fishermen in Pinrang Regency, thus its findings may not represent broader coastal regions in Indonesia. Data were collected cross-sectionally, potentially overlooking seasonal variations in fishermen's productivity. Moreover, socioeconomic and environmental variables outside the model may influence welfare outcomes but were not examined in depth. Recommendations for Future Research, Future studies should adopt longitudinal or mixed-method approaches to capture dynamic changes in fishermen's welfare and productivity across different seasons. Expanding the research area to include other coastal provinces and integrating environmental, policy, and technological innovation factors will enhance model generalization and policy relevance. Furthermore Future studies should explore gender-inclusive empowerment strategies and incorporate environmental variables to develop more comprehensive frameworks for improving resilience and economic welfare in coastal communities.

Open Data
This Data Can Be Accessed On https://Data.Mendeley.Com/Datasets/Fh9hmkmwbv/1

Author Contribution
Conceptualization, M.M.; methodology, P.A.P., and M.M.; validation, M.M.; formal analysis, N.H., and M.M.; investigation, N.H., and M.M.; writing—original draft preparation, S.H., and M.M.; writing—review and editing, S.H., and M.M.; supervision, M.M.; funding acquisition, M.M. All authors have read and agreed to the published version of the manuscript.

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