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Sustainable Livelihood Approach for Supporting Aquaculture Households Amid Structural Shifts in Sidoarjo Regency

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ABSTRACT

This study examines the role of the Sustainable Livelihood Approach (SLA) in supporting aquaculture households in Sidoarjo Regency as they adapt to structural shifts driven by industrialization and urbanization. The research analyzes how sustainable livelihood strategies enhance the economic stability of pond-based households impacted by land-use change. Using a quantitative approach with descriptive analysis, the study employs Structural Equation Modeling Partial Least Squares (SEM-PLS) to evaluate the influence of key variables. Conducted in Kalisogo Pond Village, the study uses purposive sampling based on criteria such as economic reliance on aquaculture and sector experience. Data were gathered through questionnaires and analyzed for model validity and reliability. Findings indicate that the SLA significantly bolsters pond households' adaptive capacity to structural shifts. Income diversification through non-aquaculture activities enhances economic stability and reduces dependence on pond farming. Social capital further supports households by strengthening local community networks. The study underscores the importance of institutional backing and microcredit access for aquaculture households. Policymakers and financial institutions are encouraged to support sustainable adaptation measures. These findings offer valuable insights into the SLA's application amid structural changes in industrialized coastal regions.

Keywords: *Aquaculture Households; Income Diversification; Social Capital; Structural Shifts; Sustainable Livelihood Approach*

1. Introduction

The Sustainable Livelihood Approach (SLA) is increasingly relevant in addressing structural changes aquaculture households face, particularly in industrial areas such as the Sidoarjo Regency. Sidoarjo, a significant aquaculture-producing region in Indonesia, has experienced notable changes due to urbanization, climate change, and economic pressures that affect the stability and sustainability of the aquaculture sector (Wibisono et al., 2023). SLA offers a holistic perspective, utilizing natural, social, financial, and physical resources to strengthen resilience and reduce vulnerability among aquaculture households. Through SLA, coastal communities are expected to enhance their well-being without compromising the ecological sustainability essential for long-term livelihoods (Kumar et al., 2023). This study aims to deepen understanding of SLA's application within the specific context of aquaculture households in Tambak Kalisogo Village.

The growing interest in SLA in aquaculture indicates that this model identifies key assets and encourages adaptation to significant structural shifts. Research has shown that SLA enhances household resilience through income diversification and environmental adaptation (Ulukan et al., 2022). In aquaculture contexts, SLA can empower communities to reduce their reliance on aquaculture as the sole income source by developing additional income streams that strengthen household economic stability.

Aquaculture households in Sidoarjo Regency face significant challenges due to limited access to resources essential for sustaining economic and environmental viability. Constraints in financial capital, technical knowledge, and modern farming equipment hinder households' ability to adapt to structural changes (Wibisono et al., 2023). Addressing these challenges generally involves increasing access to microcredit technical training and strengthening social and local institutional capacities to support SLA implementation. These measures are necessary for aquaculture households to thrive amidst economic and environmental challenges.

Previous studies suggest that specific solutions, such as access to microcredit and technical training, can help aquaculture households improve the stability and sustainability of their livelihoods (Israr et al., 2017). Furthermore, the literature shows that income diversification through activities related to the fisheries sector, such as processing catches or pond-based tourism, can enhance the economic resilience of aquaculture households (Yoga & Pinasti, 2021). Such diversification provides additional income and reduces dependence on aquaculture, which often fluctuates due to climate change and other environmental factors.

Other studies indicate that locally adapted SLA can help address aquaculture households' structural constraints. However, little research has thoroughly examined SLA implementation within coastal aquaculture in areas like Sidoarjo. This study identifies a research gap in the specific implementation of SLA in Sidoarjo, particularly in adapting SLA to address local challenges.

This research aims to analyze the role of SLA in supporting the economic resilience of aquaculture households in Sidoarjo, focusing on Tambak Kalisogo Village. The novelty of this study lies in the adaptive SLA approach tailored to local structural challenges. Thus, the research scope includes analyzing the core SLA assets and relevant economic diversification strategies to provide a sustainable model applicable to aquaculture households in industrial areas.

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2. Literature Review

2.1. Theory of Economic Structural Shifts

As Todaro and Smith outlined, economic development is a progressive phase of an economy characterized by changes beyond mere productivity increases in goods and services. It includes broader economic transformations across various sectors over time (Todaro & Smith, 2013).

The theory of structural shifts focuses on the mechanisms driving economic structural transformations, particularly in underdeveloped regions (Rinaldi et al., 2022). This transformation often involves a shift from a traditional subsistence-based agricultural economy, which primarily meets basic needs, to a modern, urban-oriented economy with a strong manufacturing and service industry presence (Sasmita et al., 2023).

Economic structural shifts are long-term transformations within the economic structure of a region or country. These shifts typically involve changes in labor, investment, and resource use distribution across different economic sectors (Todaro & Smith, 2013). Classical theory (Todaro & Smith, 2013) states that structural shifts are integral to modernization and economic development. They involve transitions from agrarian sectors to industry and services in response to technological advances and dynamic market demands.

In the context of Sidoarjo Regency, structural shifts occur alongside rising industrialization and urbanization, leading to the conversion of aquaculture farmland into industrial and residential areas. This shift significantly impacts aquaculture households that rely on land as a primary livelihood source. Consequently, these households are compelled to adopt new livelihood strategies to sustain themselves amid the changing economic conditions in Tambak Kalisogo Village.

2.2. Sustainable Livelihood Approach Concept

The Sustainable Livelihood Approach (SLA) encompasses community activities involving capabilities, assets, and actions to secure livelihoods. A livelihood is sustainable if it enables individuals to cope with and recover from vulnerabilities and external shocks (Su et al., 2021). SLA seeks to identify the greatest obstacles communities face and the most promising opportunities available, regardless of their origins—whether from different sectors, regions, or levels, from local to international. This approach builds upon the community's understanding of these challenges and opportunities and, where possible, encourages collective discussion and awareness.

SLA is founded on the belief that individuals or groups require diverse assets that can be processed and leveraged to achieve desired livelihood outcomes. The strength of an individual or group depends on the diversity and balance of these assets. According to Diartho, assets and capabilities constitute resources individuals or groups can manage and use to pursue their livelihood goals (Diartho, 2018). These livelihood assets are classified into five categories, often visualized as a model known as the "Pentagon of Assets" (Fahad et al., 2023).

Human capital involves the knowledge, skills, and abilities that allow individuals to effectively manage and utilize their assets. Social capital represents individuals' ability to engage, participate, and collaborate in building mutually beneficial networks. This capital is founded on trust and supported by positive social norms and values, providing a strong foundation for achieving shared goals (Xiong et al., 2021). Such social capital is only meaningful within the trust shared by community members. Physical capital, or infrastructure, encompasses the equipment and facilities (including roads, healthcare centers, etc.) accessible to households to support activities that foster sustainable livelihoods (Luo et al., 2022). As

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described by Meraj et al., natural capital includes renewable and non-renewable natural resources that can be utilized to meet human needs (Meraj et al., 2021). However, these resources must be carefully managed to ensure long-term sustainability. Natural capital is a critical asset, encompassing land, forests, water, erosion protection, biodiversity, and air quality. Financial or economic capital reflects an individual's capacity to obtain and accumulate financial and economic resources (such as cash, insurance, savings, pensions, income, credit, and other funding sources) essential for sustainable livelihoods (Tan et al., 2021).

These five capitals provide a comprehensive framework for understanding the assets necessary for sustainable livelihoods, with each type of capital contributing uniquely to household resilience and adaptability.

3. Research Methodology

This study utilizes a quantitative approach with descriptive analysis to examine the role of the Sustainable Livelihood Approach (SLA) in supporting aquaculture households facing structural shifts. The research location was purposively chosen as Sidoarjo Regency, East Java Province, an area experiencing rapid industrial growth. Sampling was conducted in Tambak Kalisogo Village, Jabon Sub-district, where aquaculture land has been converted into industrial zones, including factories, warehouses, and residential developments.

This study employs non-probability sampling with a purposive sampling technique. According to Sugiyono, non-probability sampling does not provide each population member an equal opportunity to be selected (Sugiyono, 2018). Purposive sampling involves selecting participants based on specific criteria that align with the research objectives. In this study, sampling criteria included: (1) Pond Location: Respondents are aquaculture households who own or work on ponds in Tambak Kalisogo Village, directly impacted by structural shifts in Sidoarjo Regency; (2) Experience in the Aquaculture Sector: Respondents have at least five years of experience in pond management or aquaculture activities to ensure they understand economic changes affecting the sector; (3) Dependency on Aquaculture as the Primary Income Source: Respondents rely primarily on aquaculture income, allowing the study to assess how economic changes impact livelihood stability. These criteria were set to gather data that is both valid and representative of the challenges faced by aquaculture households amid structural shifts.

Once data were collected, quantitative analysis was conducted using Structural Equation Modeling Partial Least Squares (SEM-PLS) version 3.0 to identify nonlinear relationships between latent variables and adjust path coefficients accordingly. Fan et al. noted that SEM-PLS is a robust analytical tool that does not require assumptions about data distribution or specific measurement scales, making it suitable for smaller sample sizes (Fan et al., 2016). The objective of SEM-PLS is theory development or prediction. Its use in this study provides flexibility and accuracy in understanding complex variable relationships in the context of SLA, particularly concerning structural shifts in the aquaculture sector in the Sidoarjo Regency.

The data analysis process followed these stages:

1) Data Processing
   Questionnaire responses were cleaned and checked for completeness, with incomplete or erroneous entries removed to ensure data quality.
2) Descriptive Analysis
   A descriptive analysis was conducted to outline the demographic characteristics of respondents and the distribution of responses across study variables. This analysis provides

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an initial overview of respondent profiles and general perceptions of SLA in the context of structural shifts.

3) SEM-PLS Model Testing
The outer model was tested following descriptive analysis to assess the validity and reliability of measurement variables. Once validated, analysis proceeded with inner model testing to examine relationships between latent variables according to the hypotheses.

4) Interpretation of Results
After model testing and obtaining significant results, findings were interpreted by linking the results to the study's theoretical framework and hypotheses. This interpretation addresses the research questions regarding the role of SLA in navigating structural shifts and the adaptive strategies of aquaculture households in Tambak Kalisogo Village.

4. Results and Discussion

4.1. Village Profile

Tambak Kalisogo Village, located in Jabon Sub-district, Sidoarjo Regency, is a community whose residents predominantly work in aquaculture, particularly fish and seaweed farming. Geographically, Tambak Kalisogo is between 7°21′–7°31′ south latitude and 110°10′–111°40′ east longitude. Administratively, the village is bordered by neighboring villages: Permisan to the north, Kedungpandan to the east, Semambung to the south, and Balongtani to the west. Based on 2021 administrative data, Tambak Kalisogo has 848 households and a total population of 2,468, consisting of 1,229 males and 1,239 females.

4.2. Descriptive Analysis

Field research was conducted among workers in Tambak Kalisogo Village, with a sample size of 33 respondents. This study aims to assess the impact of the Sustainable Livelihood Approach (SLA) on aquaculture households amidst structural shifts. The analysis includes both descriptive and hypothesis testing to address the research objectives. The characteristics of the respondents, based on gender, are shown in **Table 1**.

Table 1. Respondent Characteristics

Gender	Frequency	Percentage (%)
Male	33	100%
Total	**33**	**100%**

Source: Data processed by the researcher

4.3. Data Quality Testing

4.3.1. Validity Testing

The outer loading (measurement model) results for each variable are presented in **Table 2**.

Table 2. Outer Loading (Measurement Model)

Indicator	Structural Shift (Z)	Aquaculture Household (Y)	Sustainable Livelihood Approach (X)
X.1			0.870
X.2			0.942

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Indicator	Structural Shift (Z)	Aquaculture Household (Y)	Sustainable Livelihood Approach (X)
X.3			0.824
X.4			0.704
X.5			0.950
Y.1		0.828	
Y.2		0.771	
Y.3		0.730	
Y.4		0.781	
Y.5		0.741	
Y.6		0.746	
Z.1	0.816		
Z.2	0.807		
Z.3	0.893		
Z.4	0.872		

Source: Data processed with PLS

As shown in **Table 2**, all indicators for each variable achieved a loading factor above 0.5, indicating that all indicators are convergently valid and suitable for measuring the respective variables.

The convergent validity testing results based on the Average Variance Extracted (AVE) values are provided in **Table 3**.

Table 3. Average Variance Extracted (AVE)

Variable	Average Variance Extracted (AVE)
Structural Shift (Z)	0.719
Aquaculture Household (Y)	0.588
Sustainable Livelihood Approach (X)	0.744

Source: Data processed with PLS

As shown in **Table 3**, all variables have AVE values above 0.5, confirming that each indicator is valid in convergent terms and can effectively measure the respective variable.

4.3.2. Reliability Testing

Reliability testing criteria indicate that a construct is considered reliable if the composite reliability value is greater than 0.7 and Cronbach's alpha value is greater than 0.6. The composite reliability and Cronbach's alpha results are shown in the tables below.

Table 4. Composite Reliability

Variable	Composite Reliability
Structural Shift (Z)	0.911
Aquaculture Household (Y)	0.895
Sustainable Livelihood Approach (X)	0.935

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Source: Data processed with PLS

Based on **Table 4**, the composite reliability values for all variables exceed 0.7, indicating that each variable—Sustainable Livelihood Approach (0.935), Aquaculture Household (0.895), and Structural Shift (0.911)—meets the reliability criteria. Therefore, all three variables are considered reliable.

Table 5. Cronbach's Alpha

Variable	Cronbach's Alpha
Structural Shift (Z)	0.869
Aquaculture Household (Y)	0.859
Sustainable Livelihood Approach (X)	0.911

Source: Data processed with PLS

As shown in **Table 5**, Cronbach's alpha values for all variables exceed 0.7, affirming that each variable—Sustainable Livelihood Approach (0.911), Aquaculture Household (0.859), and Structural Shift (0.869)—is reliable according to the set criteria.

Table 6. Discriminant Validity (Cross Loading)

Indicator	Structural Shift (Z)	Aquaculture Household (Y)	Sustainable Livelihood Approach (X)
X.1	0.893	0.735	0.870
X.2	0.858	0.715	0.942
X.3	0.745	0.684	0.824
X.4	0.594	0.630	0.704
X.5	0.872	0.733	0.950
Y.1	0.808	0.828	0.737
Y.2	0.692	0.771	0.775
Y.3	0.662	0.730	0.547
Y.4	0.694	0.781	0.607
Y.5	0.659	0.741	0.539
Y.6	0.635	0.746	0.513
Z.1	0.816	0.804	0.664
Z.2	0.807	0.813	0.631
Z.3	0.893	0.735	0.870
Z.4	0.872	0.733	0.950
Total	**11.509**	**11.179**	**11.123**

Source: Data processed with PLS

The cross-loading results in **Table 6** indicate that indicators X1 to X5 for the Sustainable Livelihood Approach variable have higher loading values on this variable compared to Aquaculture Household and Structural Shift, establishing their validity in measuring the Sustainable Livelihood Approach. Similarly, the cross-loading values for indicators Y1 to Y6 are higher on the Aquaculture Household variable than on the Sustainable Livelihood Approach

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and Structural Shift, confirming their validity for Aquaculture Households. Finally, indicators Z1 to Z4 show higher loading values on the Structural Shift variable, confirming their validity for measuring it.

4.3.3. Hypothesis Testing

Table 7. Hypothesis Testing Results

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values
Structural Shift (Z) -> Aquaculture Household (Y)	1.094	1.134	0.175	6.234	0.000
Sustainable Livelihood Approach (X) -> Structural Shift (Z)	0.928	0.933	0.016	57.939	0.000
Sustainable Livelihood Approach (X) -> Aquaculture Household (Y)	0.203	0.236	0.192	1.056	0.000

Source: Data processed with PLS

The analysis results indicate significant relationships among the variables in this study. The coefficients show positive effects of the Sustainable Livelihood Approach (SLA) on aquaculture households (0.203), SLA on structural shifts (0.928), and structural shifts on aquaculture households (1.094).

4.3.3.1. Hypothesis 1: The Influence of the Sustainable Livelihood Approach on Aquaculture Households

Table 8. Hypothesis Testing for Hypothesis 1

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values
Sustainable Livelihood Approach (X) -> Aquaculture Household (Y)	0.827	0.843	0.036	22.783	0.000

Source: Data processed with PLS

The results in **Table 8** indicate that the impact of the SLA on aquaculture households yields a t-statistic of 22.783 with a p-value of 0.000, below the 5% significance level (0.05). The coefficient of 0.827 (positive) suggests that a stronger SLA positively affects aquaculture households in Tambak Kalisogo Village, Jabon Sub-district, Sidoarjo Regency.

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4.3.3.2. Hypothesis 2: The Influence of the Sustainable Livelihood Approach on Structural Shifts

Table 9. Hypothesis Testing for Hypothesis 2

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values
Sustainable Livelihood Approach (X) -> Structural Shift (Z)	0.942	0.947	0.010	94.042	0.000

Source: Data processed with PLS

The analysis in **Table 9** shows that the impact of SLA on structural shifts has a t-statistic of 94.042 and a p-value of 0.000, below the 5% significance level. This indicates a significant effect of SLA on structural shifts, with a coefficient of 0.942 (positive), meaning that stronger SLA implementation positively influences structural shifts in Tambak Kalisogo Village, Jabon Sub-district, Sidoarjo Regency.

4.3.3.3. Hypothesis 3: The Influence of Structural Shifts on Aquaculture Households

Table 10. Hypothesis Testing for Hypothesis 3

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values
Structural Shift (Z) -> Aquaculture Household (Y)	0.913	0.923	0.016	56.743	0.000

Source: Data processed with PLS

The results in **Table 10** indicate that the effect of structural shifts on aquaculture households yields a t-statistic of 56.743 with a p-value of 0.000, confirming the hypothesis at the 5% significance level.

4.3.3.4. Hypothesis 4: The Influence of the Sustainable Livelihood Approach on Aquaculture Households Mediated by Structural Shifts

Table 11. Hypothesis Testing for Hypothesis 4

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values
Structural Shift (Z) -> Aquaculture Household (Y)	0.906	0.913	0.019	47.703	0.000
Sustainable Livelihood Approach (X) -> Structural Shift (Z)	0.929	0.934	0.014	64.297	0.000

Source: Data processed with PLS

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In **Table 11**, the results show that the effect of SLA on structural shifts has a t-statistic of 64.297 with a p-value of 0.000. The impact of structural shifts on aquaculture households shows a t-statistic of 47.703, with a p-value of 0.000, indicating significance at the 5% level. These results confirm that structural shifts partially mediate SLA and aquaculture households in Tambak Kalisogo Village, Jabon Sub-district, Sidoarjo Regency. The indirect influence coefficient is lower than the direct impact, demonstrating that structural shifts partially mediate the effect of SLA on aquaculture households.

4.4. Discussion

4.4.1. The Influence of the Sustainable Livelihood Approach on Structural Shifts

Based on the statistical analysis results, it can be concluded that the Sustainable Livelihood Approach (SLA) contributes significantly to creating a balanced structural shift and fostering social equity within the community. SLA is essential in helping aquaculture households adapt to structural shifts in areas affected by land-use change and industrialization. Structural shifts, primarily driven by industrialization and land conversion, significantly impact the livelihoods of households dependent on primary sectors like aquaculture in Tambak Kalisogo Village, Sidoarjo Regency.

Comparative studies in other regions highlight the effectiveness of SLA in diverse contexts. For example, research by Shang et al. in the Qin-Ba Mountain Area, Shaanxi, South China, shows that SLA positively influences the economic stability of aquaculture households facing structural shifts due to urbanization. In Qin-Ba, adaptation through livelihood diversification and social capital development helps households maintain income despite reduced land access (Shang et al., 2023). This aligns with findings in Sidoarjo, where households leveraging social networks for credit or non-aquaculture business opportunities exhibit stronger resilience.

A study by Wibisono et al. in Sidoarjo also supports the effectiveness of SLA in enhancing adaptability to environmental and economic changes among aquaculture communities (Wibisono et al., 2023). Households in this area rely on human and natural capital to sustain livelihoods and use financial resources, such as microcredit, to support their businesses. The study emphasizes the importance of institutional support for SLA implementation, showing that partnerships with the government or local financial institutions can help households manage economic challenges arising from structural shifts.

The SLA significantly impacts economic structural shifts, especially in rural areas. According to Sapkota, SLA encourages livelihood diversification to reduce reliance on traditional agriculture, facilitating a transition to non-agricultural sectors (Sapkota, 2021). Israr et al. add that this approach strengthens community resilience to global economic changes by utilizing environmentally friendly local resources (Israr et al., 2017). SLA promotes social inclusion, enabling broader economic participation, and fosters inclusive, sustainable structural changes. These findings underline the importance of SLA in preparing communities for global economic transformations.

4.4.2. The Influence of the Sustainable Livelihood Approach on Aquaculture Households

Statistical analysis shows that SLA significantly impacts aquaculture households. It enables aquaculture farmers to manage natural resources like water and land sustainably, which is crucial for the continuity of aquaculture activities. SLA emphasizes skill enhancement and knowledge acquisition through technical training, outreach, and education, covering improved farming techniques, pond management, and product marketing. By enhancing skills

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and knowledge, strengthening social capital, and securing policy and institutional support, SLA positively influences aquaculture households, making them more resilient and improving their long-term welfare.

Research in other regions shows similar outcomes, with SLA positively affecting the resilience of aquaculture households. Gai et al. highlights the importance of natural and social capital in supporting household adaptation (Gai et al., 2020). SLA encourages households to maintain sustainable aquaculture by practicing sound environmental management and leveraging local social support. However, limited access to financial capital remains a major challenge, hindering households from investing in productivity-enhancing activities. This challenge is also seen in Tambak Kalisogo, where financial limitations restrict adaptation strategies.

SLA has a substantial impact on the economic resilience of aquaculture households. It promotes livelihood diversification, strengthening income sources and reducing reliance on a single source, thereby mitigating economic risks (Singh et al., 2024). Additionally, SLA prioritizes sustainable resource use, allowing farmers to maintain long-term productivity without harming the environment (Diartho, 2018). Tan et al. further highlight that SLA enhances aquaculture households' adaptive capacity to climate change, which often affects the fisheries sector (Tan et al., 2021). Thus, SLA supports aquaculture households' economic and environmental well-being.

4.4.3. The Influence of Structural Shifts on Aquaculture Households

The study results show that structural shifts impact aquaculture households, as indicated by respondent assessments of the structural shift variable. Structural shifts have widespread effects on aquaculture households, requiring them to understand market trends, technology, regulations, and evolving environmental conditions to adapt effectively. Aquaculture households that can successfully adapt to these structural shifts tend to achieve greater sustainability and welfare in the long term.

Studies in other regions demonstrate similar patterns, where structural shifts lead to economic instability for aquaculture households. Research by Yoga & Pinasti found that converting aquaculture land to industrial land significantly impacted household economies, forcing many to transition to other sectors or diversify income sources to cope with economic uncertainty (Yoga & Pinasti, 2021). This is similar to Tambak Kalisogo, where job diversification has become essential for aquaculture households affected by structural shifts.

Structural shifts in the agricultural sector, especially aquaculture, profoundly affect farming families. According to Rinaldi et al., these transformations are often driven by globalization and trade policies that influence prices and market access, altering family production patterns and income stability (Rinaldi et al., 2022). Research by Bakri et al. notes that structural shifts also encourage adopting sustainable farming practices necessary for maintaining environmental and social sustainability (Bakri et al., 2023). Therefore, understanding structural shifts is crucial for developing policies that support aquaculture farming families.

4.4.4. The Influence of the Sustainable Livelihood Approach on Aquaculture Households through Structural Shifts

The findings show that SLA, mediated by structural shifts, affects aquaculture households, as evidenced by respondent assessments. SLA has significant potential to help aquaculture households adapt to and benefit from structural shifts by focusing on asset

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strengthening, capacity building, income diversification, social capital enhancement, policy adaptation, and risk management. SLA enables aquaculture households to become more resilient, sustainable, and prosperous amid significant economic and social changes.

Research in other regions, such as that by Fatkhullah et al., supports the finding that SLA improves household stability when facing structural shifts (Fatkhullah et al., 2021). This study highlights SLA's effectiveness in helping aquaculture households adapt to structural changes. Aquaculture households rely on natural and social capital to sustain their activities, and support from local social groups and access to skills training help them find alternative income sources and maintain their livelihoods. This aligns with findings in Tambak Kalisogo, where social capital is crucial in helping households cope with economic and environmental pressures.

SLA significantly contributes to aquaculture household welfare through structural shifts that enhance economic resilience. SLA supports social, human, and financial capital strengthening, which aids aquaculture households in adapting to changing structural environments, including technology integration and better market access (Meraj et al., 2021). These shifts benefit the aquaculture community by facilitating income diversification and reducing reliance on a single sector (Wibisono et al., 2023). Ulukan et al. emphasize that through asset strengthening, SLA effectively creates long-term economic sustainability, allowing aquaculture households to become more resilient to economic fluctuations (Ulukan et al., 2022).

5. Conclusion

This study examines the influence of the Sustainable Livelihood Approach (SLA) on aquaculture households in Tambak Kalisogo Village, Sidoarjo Regency, in response to structural shifts resulting from industrialization and land conversion. These structural shifts have altered land use and forced aquaculture households to seek sustainable livelihood strategies amidst reduced access to productive land. The findings indicate that SLA provides a strong foundation for aquaculture households to maintain economic stability by optimizing human, social, natural, physical, and financial capital. SLA enables households to adapt through income diversification and community engagement.

The key findings of this study reveal that SLA significantly reduces aquaculture households' dependency on the aquaculture sector, creating opportunities to transition to non-agricultural sectors, primarily through community support and skills training. Social capital has proven to be a critical pillar for aquaculture households, offering a support network that helps them face economic and ecological challenges. Additionally, in the form of relevant knowledge and skills, human capital enables households to explore alternative income sources beyond aquaculture.

The study implies that implementing SLA in industrial regions like Sidoarjo requires adjustments and strong institutional support to function optimally. Government and financial institutions must provide supportive policies to protect the environmental quality of aquaculture areas, inclusive access to credit, and relevant training programs to facilitate households' transitions to more stable sectors. Without such support, SLA may face limitations in addressing the challenges of structural shifts in industrial areas.

This research contributes to the existing body of knowledge by deepening the understanding of SLA implementation in the context of structural shifts and industrial regions. The findings emphasize the need for SLA adaptations to address the specific challenges faced by areas under industrialization pressures, offering concrete examples of how SLA can be customized to meet dynamic local needs.

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For future research directions, this study recommends exploring the role of specific government policies in supporting SLA, especially regarding environmental protection and financial capital provision for aquaculture households. Further research is needed to identify optimal methods for managing natural capital in industrial areas to preserve environmental quality without hindering economic development. This study also opens opportunities for in-depth analysis of SLA effectiveness in other agricultural sectors within industrialized regions, enabling the continuous development of SLA frameworks to support livelihood resilience in various economic and environmental contexts.

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7. Declaration of Conflicting Interests

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