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ARTICLE

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Triple Helix Collaboration Model for Improving the Performance of Socio-Economic Empowerment Programs for Traditional Fishing Families in Medang Deras

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ABSTRACT
Fishermen empowerment programs have thus far failed to sustainably improve the socio-economic conditions of fishing families. According to data from Statistics Indonesia (BPS) in 2023, the national poverty rate remains at 9.36%, far from the 0% poverty target set for 2024, with 70% of the poor population residing in coastal areas, most of whom are engaged in fishing. This failure is attributed to the government's lack of preparedness in understanding the actual conditions of coastal communities, as well as the absence of coordination with innovative university research in the design of empowerment programs. The gap between key actors has rendered intervention efforts less effective. This study aims to integrate the Triple Helix collaboration model as an innovative approach to improve the performance of socio-economic empowerment programs for traditional fishing families by utilizing local waste potential into calcium-based product innovation. The research was conducted in two hamlets of Nelayan Village, Medang Deras Subdistrict, Batubara Regency, North Sumatra, using a social engineering approach through the Participatory Action Research method over one year. The intervention involved mentoring and knowledge transfer through socialization, focus group discussions (FGDs), and training for fisher households. The findings show that the majority of fishers live in conditions of structural poverty, with daily incomes below IDR 50,000 and trapped in debt cycles with middlemen. The training and mentoring intervention on coastal waste processing into calcium-based product innovation successfully led to the formation of innovation-based fisher groups, formalized through the signing of an Institutional Arrangement (IA) with the subdistrict government, which was subsequently adopted as a policy. This study not only presents a contextually relevant collaborative model but also offers a prototype of an empowerment system that is collaborative, circular, and rooted in local needs and potential.

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Kata Kunci:
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ABSTRAK

Program pemberdayaan nelayan selama ini belum berhasil meningkatkan taraf sosial ekonomi keluarga nelayan secara berkelanjutan. Data dari Badan Pusat Statistik tahun 2023, menyebutkan bahwa kemiskinan di Indonesia masih berada di angka 9,36% dari target 0% kemiskinan di 2024, di mana 70 % di antaranya berada di wilayah pesisir yang mayoritas berprofesi sebagai nelayan. Kegagalan tersebut disebabkan oleh ketidaksiapan pemerintah dalam memahami kondisi riil masyarakat, serta belum adanya sinkronisasi kerja dengan hasil riset inovatif dari perguruan tinggi ke dalam program pemberdayaan. Kesenjangan antara aktor menjadikan upaya intervensi kurang efektif. Penelitian ini bertujuan untuk mengintegrasikan model kolaborasi Triple Helix sebagai pendekatan inovatif dalam perbaikan kinerja program pemberdayaan sosial ekonomi keluarga nelayan tradisional dengan memanfaatkan potensi limbah lokal menjadi inovasi produk berkalsium. Penelitian dilakukan di dua dusun Desa Nelayan, Kecamatan Medang Deras, Kabupaten Batubara, Sumatera Utara, dengan menggunakan pendekatan *social engineering* melalui metode *Participatory Action Research* selama satu tahun melalui pendampingan dan transfer knowledge yang melibatkan kegiatan sosialisasi, FGD, dan pelatihan kepada keluarga nelayan. Hasil penelitian menunjukkan bahwa mayoritas nelayan hidup dalam kemiskinan struktural, dengan pendapatan harian di bawah Rp50.000 dan terjebak dalam siklus utang kepada tengkulak. Intervensi pelatihan dan pendampingan dalam pengolahan limbah pesisir menjadi inovasi produk berkalsium berhasil membentuk kelompok nelayan binaan inovasi, melalui penandatanganan *Institutional Arrangement* (IA) dengan pemerintah kecamatan untuk kemudian diadopsi dalam sebuah kebijakan. Penelitian ini tidak hanya menawarkan model kolaboratif yang kontekstual, tetapi juga menyajikan prototipe sistem pemberdayaan yang kolaboratif, sirkular, dan berbasis pada kebutuhan serta potensi lokal.

A. INTRODUCTION

Indonesia's coastal regions hold immense marine resource potential; however, communities living in these areas face a high degree of economic vulnerability (Wahyuningsih et al., 2024). This condition reflects a persistent gap between abundant natural resources and the quality of life of the local population (Safaah et al., 2024). According to data from Statistics Indonesia (BPS) in 2023, the national poverty rate remains at 9.36% falling short of the 0% target set for 2024 with 70% of the poor population residing in coastal regions, most of whom work as fishers. Although various empowerment programs have been launched by the government, many are unsustainable or fail to achieve their intended objectives (Kondoy et., 2022). A key reason for this failure is the government's unpreparedness to understand the real-life conditions of coastal communities, particularly traditional fishers who remain trapped in cycles of poverty (Ramenzoni, 2021). The government's lack of direct engagement in the field has resulted in socio-economic policies that are misaligned with the needs of fishing households (B. Ginting, 2018). In many cases, authorities fail to identify the actual problems faced by these communities, leading to ineffective aid programs that have minimal or even no impact on their fundamental needs (Yudiatmaja et al., 2021). Without a clear understanding of the challenges fishers face, it becomes difficult to formulate relevant and targeted policy responses (Hamelin et al., 2024). This situation points to a serious gap between the government and the people one that must be urgently addressed.

The disconnect between government policy and local realities represents a critical weakness in the empowerment of traditional fishers (Novira et al., 2024). Without deep

research and problem identification, it is difficult for government interventions to be well-targeted and effective (Tambusay & Aisyah, 2024). This highlights the urgent need for academic involvement scholars must engage directly with communities to conduct research and help identify on-the-ground issues (Ivey & Borchardt, 2024). The role of academia is therefore crucial. Academics are not limited to teaching within university settings; they also play an essential role in community-based research and service (Perkmann et al., 2021). In this regard, universities serve as a bridge between government and society, conveying accurate insights and offering research-based, context-sensitive solutions. Through the *Tri Dharma* of Higher Education, academics have the opportunity not only to advance knowledge within classrooms but also to apply it in addressing real-world problems. Research-based community engagement can yield concrete and relevant solutions (Kisambira et al., 2024).

One particularly relevant approach to these issues is the Triple Helix model proposed by Etzkowitz & Leydesdorff (2000), which integrates the roles of three key actors: universities, government, and communities. This model emphasizes the importance of collaboration among the three pillars in fostering sustainable socio-economic innovation (Cai & Lattu, 2022). In this framework, academics provide knowledge and technology, governments offer policy and facilitation, and communities specifically traditional fishers serve as the central actors in empowerment efforts. In the context of traditional fisher empowerment, the Triple Helix model offers a practical solution to enhance program performance. Effective collaboration among academics, governments, and communities is essential to generating context-appropriate solutions that produce lasting impact (Cobo-Gómez, 2024). Governments should involve academics in both problem identification and policy formulation to ensure that implemented programs are not only well-targeted but also sustainable (Guenduez et al., 2024).

While several prior studies have examined the potential and limitations of the Triple Helix model, there remains a research gap in exploring how this model can be contextually adapted to empower traditional fishing communities in Indonesia. No specific studies have investigated the interactive mechanisms among actors (government, academia, and coastal fishing communities) within a Triple Helix framework in coastal settings, nor how local potential and community-based resources can become the core of circular economy-based social innovation. Addressing this gap, the present study aims to explore how the Triple Helix model is operationalized in Medang Deras Village, Batubara Regency, through economic empowerment of traditional fishers via innovation in coastal waste utilization, with direct involvement of the fishing community in its implementation.

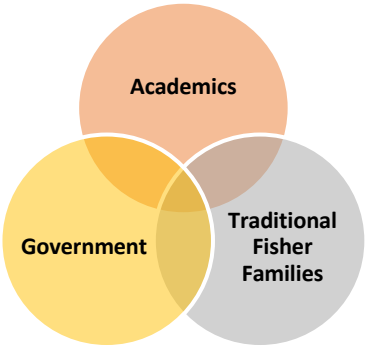
The participatory approach involves the formation of innovation-based fisher groups that process seashell and fishbone waste into high-value hydroxyapatite products. This research not only offers a context-sensitive collaborative model but also presents a prototype for a circular, empowerment system grounded in local needs and potential. It is expected to yield a more suitable collaborative framework tailored to the characteristics of marginalized communities while also expanding the practical scope of the Triple Helix model in the context of developing countries. This study addresses the following research questions: 1) How well do current socio-economic empowerment programs align with the actual needs of traditional fishers in Nelayan Village, Medang Subdistrict, Batubara Regency? 2) What innovations or interventions have been applied in the socio-economic empowerment programs targeting fishers in this area? 3) How is the Triple Helix collaboration model implemented to improve the socio-economic conditions of traditional fishers in Nelayan Village, Medang Subdistrict?

B. LITERATURE REVIEW

The Triple Helix Model: Strengths and Critiques

The Triple Helix Model, first developed by Etzkowitz & Leydesdorff (2000), has been recognized as a transformative framework for integrating the roles of universities, government, and industry in generating innovation (Murillo-Luna & Hernández-Trasobares, 2023). However, this model is not without criticism, particularly regarding its neglect of civil society's role. The primary critique lies in its tendency to reinforce the dominance of formal sectors (universities, government, and industry), while community actors often lack institutional power in decision-making and resource allocation (Masuda et al., 2022). In the context of Medang coastal village, limited community involvement can hinder the acceptance and sustainability of introduced innovations. This study adapts the Triple Helix Model by integrating community innovation elements as active participants, aiming to address its limitations in empowering communities with weak institutional capacity. Through the empowerment of fishers and innovation-based coastal waste processing, this model seeks to drive bottom-up change by actively involving coastal communities as both beneficiaries and agents of transformation.

Several studies have demonstrated the model's success in sustainable development and circular economy contexts. For example, Espuny et al. (2025) developed a Triple Helix framework in the Empower Eco HUB project in rural Ireland, where the government acted as coordinator, academics provided technical solutions, and communities served as implementers. The project successfully created new value chains from local waste and formed a sustainable cross-sectoral synergy. However, these achievements occurred in a developed country with strong institutional infrastructure and relatively equal actor capacities. In developing countries, particularly remote coastal areas, critical questions arise: Can the Triple Helix Model be effectively applied amid weak institutional structures and the dominance of informal practices? Nonetheless, the success of the Triple Helix in developed nations cannot be directly replicated in developing countries such as Indonesia. In traditional fishing communities, there are fundamental differences in institutional capacity, local actor strength, and social legitimacy toward innovation. Figenschou et al. (2025) note that in developing contexts, actor relationships are often imbalanced, with state institutions dominating and local communities and academics marginalized. Instead of serving as strategic partners, academics are often involved procedurally, and local communities are treated as development objects rather than innovation subjects (Nilson et al., 2024). This tension renders collaboration formalistic and ineffective in addressing root issues. These conditions highlight the Triple Helix Model's limitations in fostering inclusive and transformative partnerships, especially in low-capacity communities.



Source: Author's own work, 2023

Figure 1. Triple Helix Model for the Empowerment of Traditional Fishermen

Public Sector Innovation: Enhancing Social and Economic Resilience

Public sector innovation is a key element in addressing complex socio-economic challenges, especially in structurally vulnerable communities such as coastal fishers (Hilmawan et al., 2023). Innovation in this context extends beyond technological adoption and is understood as a socially transformative process rooted in the community's actual needs (Arundel et al., 2019). Hartley (2005) explains that public sector innovation involves changes in values, norms, processes, and the nature of relationships between the state and society to deliver more adaptive, participatory, and inclusive public services. In coastal fisher empowerment, such innovation encompasses both social and economic dimensions. Socially, it should strengthen community resilience against external pressures such as climate change, environmental degradation, and unequal access to resources (Raman et al., 2025). Economically, it should create new opportunities that break exploitative intermediary chains and open new economic prospects for fishers (García-Lorenzo et al., 2024).

One practical example of relevant public sector innovation is processing coastal waste into value-added products, such as calcium-rich organic powder from seashell waste (Sulistiyani et al., 2016). This innovation not only addresses ecological problems but also provides a strategy for sustainably improving fishers' socio-economic conditions. Bason (2010) argues that the success of public sector innovation depends on the extent of community participation in problem definition, solution design, and policy implementation (Wamsler & Raggers, 2018). Hence, innovations must be co-created with local communities, not imposed from the top down. In the context of Medang Deras, public innovation must adopt a place-based approach that aligns with local social, economic, and ecological characteristics (Jennings et al., 2024). This concept is reinforced by Ansell & Gash's (2008) collaborative governance model, which emphasizes building trust, horizontal dialogue, and collective policymaking among actors. In coastal areas, this approach requires mediation between local traditions, customary structures, and formal regulations to ensure that innovation aligns with community aspirations (Puteh, D. A. A., & Sa'at, 2014).

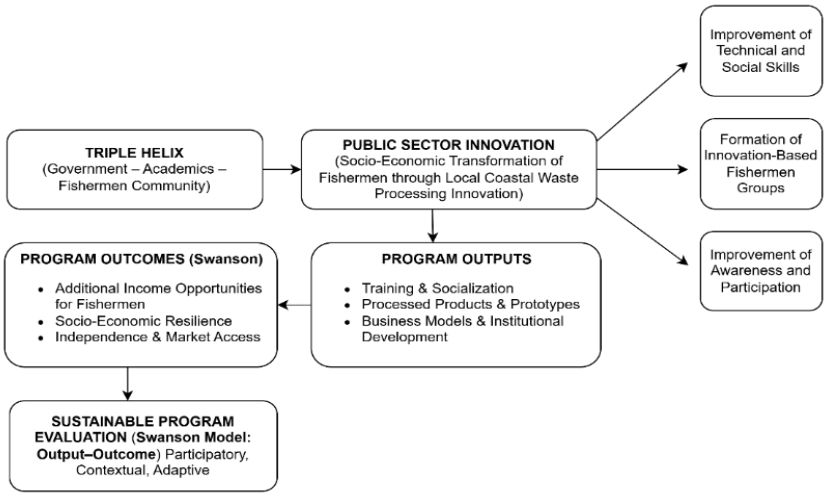
A study by Bovaird & Loeffler (2012) highlights that the most successful public innovations are co-produced, where citizens are not merely service recipients but co-creators of value. In this regard, fishers should not simply attend training or receive equipment, but be involved from the start in designing innovations such as selecting waste types for processing, organizing production distribution models, and developing cooperative- or BUMDes-based incentive systems. This approach not only increases program relevance but also builds a sense of ownership, which Moore (1995) identifies as a key condition for sustainable public innovation (Taeihagh, 2017). It also addresses the shortcomings of conventional government programs that are often instructive, technocratic, and disconnected from the social context.
Implementing public innovation in coastal waste management must also involve institutional transformation (Borrás et al., 2024). Without strengthening local institutions, innovation risks remaining a short-term project with no lasting impact (Tarabichi et al., 2025). Thus, integrating technical and institutional innovations is necessary, for example, through the establishment of innovation-based fisher groups, product legalization, and engagement of universities as research and long-term mentoring partners. Crosby et al. (2017) note that successful public sector innovations in complex environments are those that foster adaptive capacity in both bureaucracy and community. In this regard, local governments should act not only as regulators but also as facilitators of innovation, building collaborative ecosystems across sectors: communities, academia, and enterprises.

Swanson's Program Evaluation Model: Measuring Empowerment Impact

Swanson's program evaluation model (2000) offers a comprehensive framework to assess the impact of development interventions, especially in community empowerment contexts (Edwards et al., 2000). This model evaluates success not only through activity execution or administrative output achievement but also by examining outcomes real and sustained changes in the social, economic, and institutional lives of program beneficiaries (Reed et al., 2021). This perspective is especially relevant when evaluating coastal fisher empowerment programs that incorporate waste innovation, where complex social contexts demand a holistic understanding of change dynamics, beyond technical aspects. In implementation, such empowerment programs yield various outputs, including improved technical skills in waste processing, the formation of innovation-based fisher groups, and heightened environmental awareness. These outputs represent direct, short-term results of interventions, measurable through training participant surveys or activity documentation. However, Swanson's model emphasizes that evaluation must go beyond outputs. True success lies in whether the program triggers fundamental changes in community life (McGill et al., 2021).

Key outcomes include increased household income through income source diversification, reduced dependency on exploitative middlemen due to more equitable distribution networks, and the emergence of socio-economic resilience in coastal communities. These outcomes indicate deeper social transformations and require longitudinal, participatory, and contextual evaluation processes. In this sense, Swanson's model enables evaluators to determine whether a program truly fosters structural change and strengthens community adaptive capacity, beyond merely transferring skills or knowledge. Swanson's model also serves as a foundation for building dynamic, learning-oriented evaluation mechanisms. In fishing communities that often lack bargaining power with bureaucracy or markets, participatory development of success indicators becomes crucial. This aligns with Patton's (2008) utilization-focused evaluation, which positions beneficiaries as active subjects in the evaluation process (Ramírez & Brodhead, 2013). Hence, evaluation not only serves as an impact measurement tool but also as a collective reflection mechanism that drives policy innovation and continuous improvement.

Prior studies underscore the need for outcome-focused evaluations. For instance, Hawkins & Al Hudib (2013) emphasize that in resource-constrained communities like traditional fishers, conventional evaluations centered only on activities and outputs fail to capture the complexity of social change. Similarly, Kusek and Rist (2004), in their results-based management framework, stress the importance of logical connections between inputs, outputs, outcomes, and impacts as a basis for evidence-based decision-making. An empirical study by Ludwig et al. (2018) in the Philippine coastal region shows that outcome-based evaluations not only capture changes in fisher income but also reveal social dynamics such as increased women's participation and transformations in local leadership patterns. Therefore, applying Swanson's evaluation model to coastal waste innovation programs provides a fairer and more relevant metric of success while enhancing the program's social legitimacy. This form of evaluation allows local governments and development partners not only to claim administrative achievements but to design interventions genuinely aligned with community needs. In the long term, this approach supports the development of collaborative governance that is responsive to local needs and fosters sustainable socio-economic resilience in coastal communities.



Source: Author's own work, 2023

Figure 2. Conceptual Visual Framework

C. METHOD

This study was conducted in two coastal hamlets, namely Kuala Sipare and Pematang Eru, located in Nelayan Medang Village, Medang Deras Subdistrict, Batubara Regency, North Sumatra Province. The site selection was carried out purposively based on the demographic and economic characteristics of the area, which is predominantly inhabited by traditional fishing households with low income levels, limited access to technology, and suboptimal utilization of coastal waste (Aisyah & Sontang, 2022). To ensure active community participation and contextual relevance of the intervention, this study employed a Participatory Action Research (PAR) approach over the course of one year, designed as a social engineering strategy involving collaboration among three key actors: academia, government, and the community. This approach allowed full community participation in problem identification, solution formulation, and program implementation, while positioning the researcher as a facilitator in strengthening local capacities.

The recruitment process for fisher households, FGD participants, and key informants was conducted gradually and deliberatively in collaboration with village authorities and community leaders. The inclusion criteria were: (1) households whose primary livelihood is small-scale capture fishing; (2) residing in the research location for at least five years; and (3) willingness to participate in training and mentoring activities. The total number of household survey respondents was 100 fisher heads of household, selected using purposive quota sampling, with an age range of 18–60 years. For the Focus Group Discussions (FGDs), each session involved 6–10 participants representing active fishers, fisher wives, coastal youth, hamlet leaders, and informal community figures. In-depth interviews were conducted with 10 key informants, including village heads, fisheries extension workers, academics, and seafood processing business actors.

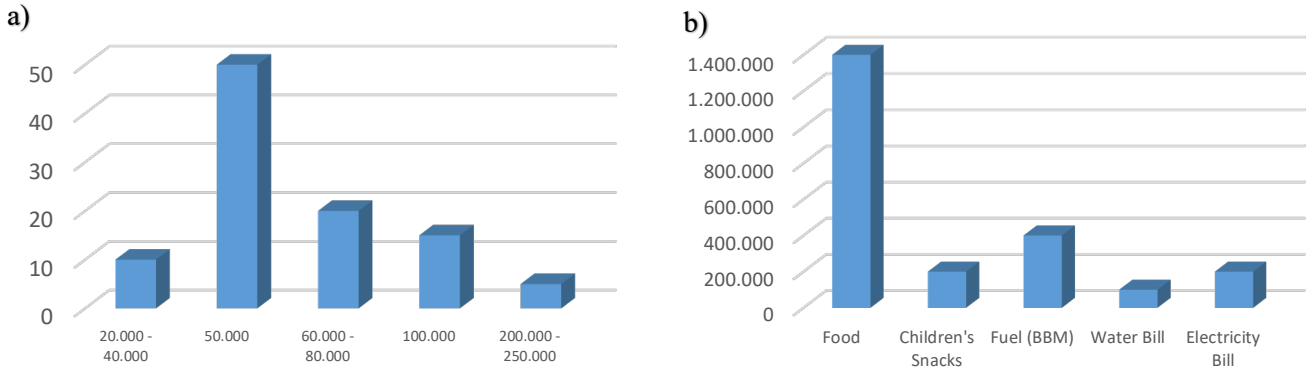
The data collection instruments included field observation guides, household survey questionnaires, FGD guidelines, and interview protocols, all of which were developed and pre-tested through a pilot test in a nearby coastal village. The language of the instruments was adapted to the local coastal Malay dialect and applied a contextual communication approach to enhance respondent comprehension. All instruments were calibrated to minimize social bias and consider local cultural sensitivities, particularly regarding gender roles and patron-client economic relations. Triangulation was conducted at three levels: (1) data source triangulation (survey, observation, interviews, and FGDs), (2) methodological triangulation (quantitative

and qualitative), and (3) temporal triangulation (pre-, during-, and post-intervention). Quantitative data were analyzed descriptively using Microsoft Excel, while qualitative data were analyzed using a narrative-reflective approach with thematic matrices.

D. RESULT AND DISCUSSION

Socio-Economic Profile of Traditional Fisher Households

The socio-economic profile of traditional fishing households in Medang Village reflects entrenched and intergenerational structural poverty. Survey data indicate that approximately 64% of fishers earn less than IDR 50,000 per day. This income must support all household expenses, including food, utilities, education for children, and transportation. These conditions place them well below the national poverty line. According to the Central Bureau of Statistics (BPS), Indonesia's poverty line as of September 2024 was set at IDR 566,655 per capita per month (BPS, 2025). In addition to low earnings, the economic burden on fishers is exacerbated by the high operational costs required for fishing activities. To cover these expenses, many are compelled to borrow funds from middlemen (tauke), which are repaid through future catch revenues. This debt-based arrangement creates an exploitative economic dependency, as tauke not only provide capital but also unilaterally set the price of the catch. When the purchase price is set below market value, the fishers' net income often becomes negative. As a result, many fishers remain trapped in a cycle of debt that repeats indefinitely. This dynamic aligns with Cahaya (2015) observation that indebtedness is a major contributing factor to economic stagnation within traditional coastal communities.



Source: Author's field survey, 2023

Figure 3a. Survey Results on Fisher Daily Income Levels, Figure 3b. Survey Results on Fisher Monthly Expenditure

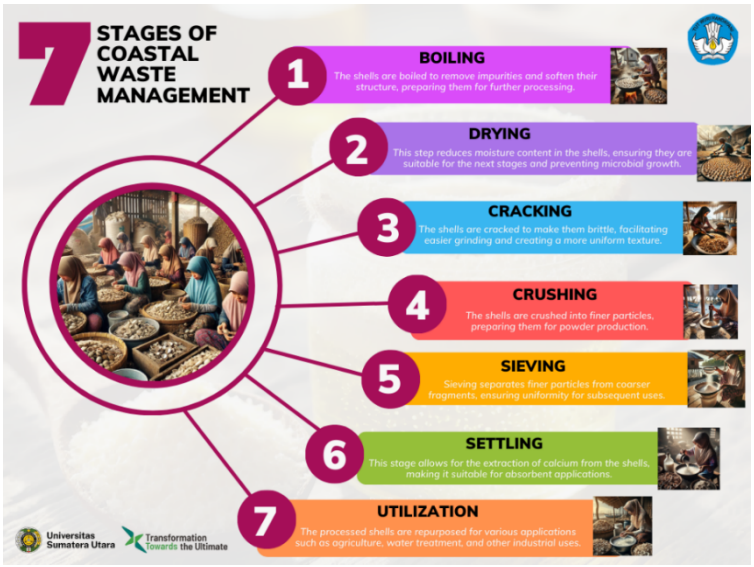
The imbalance of power between fishers and middlemen (tauke) reinforces an inherently unfair market structure. The unilateral pricing practices by tauke create conditions of information and market asymmetry, wherein fishers lack sufficient bargaining power. As Ginting et al., (2024) explain, a distribution system dominated by a few market actors leads to the erosion of economic sovereignty at the producer level. When earned income fails to meet even minimum household expenses, fishers are unable to save, invest, or upgrade their fishing equipment. This situation is further exacerbated by the fact that their debts are not limited to fishing-related costs but also extend to essential daily living needs. The impact of these conditions is not solely economic, but also deeply social. The inability to meet basic needs such as education and healthcare perpetuates a cycle of intergenerational poverty. Children of fishers are more likely to migrate to urban areas in search of low-skilled labor, often ending up in

informal sectors or factories. This trend threatens the regeneration of human capital in coastal regions. As noted by Salleh & Sulaiman (2020), upward economic mobility is difficult to achieve in the absence of adequate educational and vocational training interventions. Consequently, fishing families remain trapped in the same structural dependency as previous generations, with limited opportunities for genuine economic emancipation.

An analysis of household expenditure data reveals that the majority of fisher income is allocated to food consumption. Figures 1 and 2 in this study indicate that food-related expenses dominate household budgets, while spending on education and healthcare remains minimal. Nainggolan et al. (2024) observe that such consumption patterns are common among low-income households, where expenditures tend to focus on immediate needs rather than long-term investments. The absence of fiscal space within these households further limits their ability to participate in training programs, invest in more efficient fishing equipment, or engage in other productive economic activities. Considering the available data and supporting literature, it can be concluded that traditional fishers in Medang Village face a highly vulnerable socio-economic condition, characterized by persistently low income, chronic indebtedness, and a market system dominated by external actors who unilaterally set prices. To break this cycle of vulnerability, there is an urgent need for policy-driven interventions that address the structural roots of these issues.

Source: Author's field survey, 2023

Figure 4. Types of Coastal Waste Identified in Medang Village



Source: Author's own work, 2023

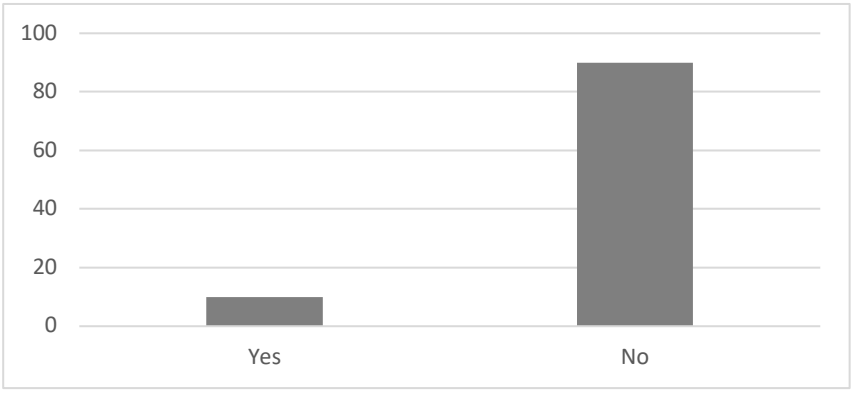
Figure 5. Stages of Coastal Waste Management Governance

Fishers' Perceptions of Government

Survey results reveal a significant level of dissatisfaction among the fishing community in Medang Village regarding the role and presence of the government in their socio-economic lives. Approximately 80% of respondents reported feeling neglected by government institutions, while 90% expressed dissatisfaction with the forms of assistance and training they had received through empowerment programs. These findings reflect a clear disconnect between public policies and the actual needs of coastal communities, particularly in terms of the relevance of aid, program sustainability, and the visible presence of state actors in supporting vulnerable groups. The dissatisfaction stems largely from assistance that lacks local contextual relevance, and from training initiatives deemed either inappropriate or entirely absent. As illustrated in Figure 6, the majority of fishers stated that the aid they received failed to address their primary needs such as suitable fishing gear, access to working capital, or practical technical skills training. According to Chambers (2002), the effectiveness of development programs depends heavily on the level of community participation and the government's understanding of local realities. In this context, the lack of a participatory approach has resulted in numerous policies missing their intended targets.

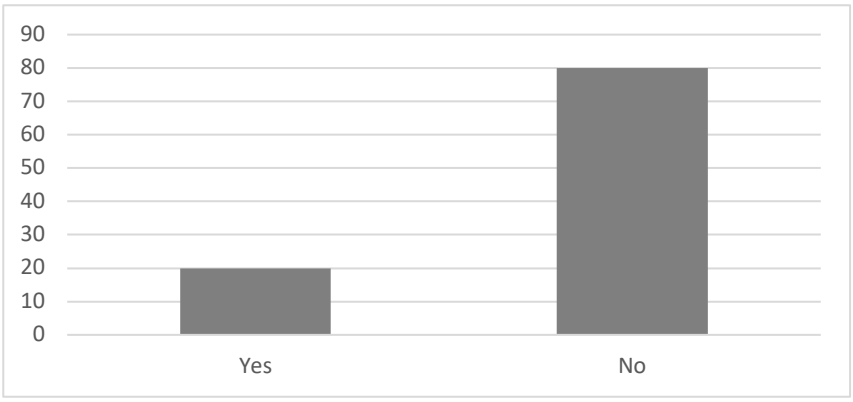
Further data reveal that within government-supported fisher group programs, 90% of participants reported not receiving training aligned with their expectations, as illustrated in Figure 7. The lack of practical training such as aquaculture techniques, post-harvest processing, or microenterprise management indicates a significant gap in capacity-building initiatives. Yet training constitutes a critical element of community empowerment strategies (Kabeer, 2001), as it strengthens autonomy and enhances the community's adaptability to changing market and ecological conditions. This dissatisfaction is further exacerbated by unequal access to government programs, both in terms of material support and technical assistance. Fishers who are not part of formally recognized groups experience greater marginalization, as they are excluded not only from direct aid but also from access to information and empowerment opportunities (Kabeer, 2012). Such disparities highlight a tendency toward exclusivity in the distribution of state-sponsored support, which, ideally, should be inclusive and accessible to all segments of the fishing population (Ostrom, 1990).

This situation is further compounded by the fact that most fishing households rely heavily on a single source of income fish catches which are highly susceptible to market fluctuations and weather conditions. When this primary income stream is disrupted, there are no economic buffers within the household to absorb the shock. Ironically, many fisherwives lack access to productive employment or programs aimed at women's economic empowerment. The absence of household income diversification exacerbates the structural vulnerability of fishing communities, as described by Ellis (2000) in his concept of livelihood diversification. Additionally, survey results indicate that 89% of fishers enrolled in government-supported groups feel they receive insufficient attention in terms of intensive mentoring or continued capacity development. These groups, which are intended to serve as the front line of empowerment, have failed to address the core challenges facing the community. Meanwhile, fishers who are not part of formalized groups remain virtually invisible in the policy distribution system. Overall, the level of distrust toward government programs is notably high, serving as an indicator of the weak legitimacy of public policies in the eyes of the fishing community. The absence of meaningful state presence both in terms of physical engagement and policies tailored to local needs has widened the gap between fishers and the government. To bridge this gap, a shift in public policy approach is required one that is more participatory, responsive, and rooted in the real needs of coastal populations. Program formulation must begin with participatory needs assessments (bottom-up) and be accompanied by collaborative evaluation mechanisms to ensure that government interventions generate tangible benefits for the communities they are meant to serve.



Source: Author's field survey, 2023

Figure 6. Percentage of Fishers Who Have Received Assistance That Met Their Expectations



Source: Author's field survey, 2023

Figure 7. Survey Results on Fishers' Perceptions of Government Attention

The Triplehelix Model and Actor Role Analysis for Enhancing Fisher Empowerment

The persistent poverty of traditional fishing households in Medang Village, coupled with limited effective governmental support, highlights the necessity of adopting a new approach to coastal community empowerment. In response to this need, the Talenta Research Team from Universitas Sumatera Utara (USU) initiated a program consisting of community outreach, focus group discussions (FGDs), and skills training aimed at equipping fishers with technical competencies to process coastal waste into calcium-based products. This program was designed to address field survey results indicating that 77% of fishing households had never received skills training, while 96% acknowledged the untapped economic potential of coastal waste.

The program employed the Triplehelix Model, which conceptualizes the university (academia), government, and community/entrepreneurs as the three core actors in local innovation ecosystems (Etzkowitz & Leydesdorff, 2000). In this framework, the university plays a central role in developing and delivering knowledge and technology, the village government acts as a local mobilizer and provider of policy legitimacy, and the fisher community functions as the primary agent of socio-economic transformation. The university's contribution includes the design and implementation of training modules focused on transforming waste into organic calcium powder a product with wide-ranging applications in

food fortification, health supplements, and natural cosmetic manufacturing. The production process is tailored to local contexts, making it feasible with simple, environmentally friendly equipment. Concurrently, the village government facilitates participation by organizing activities through village heads and local administrative apparatus.

This empowerment model further integrates inclusive innovation by establishing Innovation-Based Fisher Groups that involve fisherwomen many of whom previously lacked access to productive activities as well as fisher children with disabilities. This inclusive strategy ensures that empowerment efforts are not confined to economic sectors but also engage the broader social units within fishing families. By involving diverse household members, the program promotes new social structures that support both economic productivity and community solidarity.

The outcomes of the training program are designed to foster the formation of community-based micro and small enterprises (MSEs) capable of independently producing and marketing organic calcium products. Through sustained training and strong institutional support, fisher families are expected not only to enhance their technical skills but also to gain entry into economic sectors previously beyond their reach. This aligns with the concept of inclusive innovation, which emphasizes the importance of creating participatory spaces for marginalized populations to engage in innovation systems (Chataway & Hanlin, 2013). Within this context, the Triplehelix model has proven effective in bridging local resource limitations with broader institutional support. The synergistic collaboration between universities, village governments, and fisher communities has stimulated the emergence of innovative, context-specific, and sustainable solutions. Thus, the implementation of this model serves not only as a technical strategy for skill development but also as a knowledge-based community development strategy that is scalable to other coastal regions across Indonesia.

Source: Author's documentation, 2023

Figure 7. Socialization and Training Activities (Triplehelix Model) and Symbolic Handover of the Institutional Arrangement (IA) to the Acting Village Head of Medang, Mr. Rizal, S.E.

Achievements of the Triplehelix Model in the Socio-Economic Empowerment of Medang's Fishing Households

The success of the outreach and training programs is inseparable from the collaboration among the three principal stakeholders: Universitas Sumatera Utara (USU), the Medang Village Government, and the Innovation-Based Fisher Groups formed by local fishing families. This collaboration exemplifies the application of the Triplehelix model, which emphasizes the synergistic engagement of academia, government, and society in addressing complex socio-economic challenges. With USU providing research and innovation expertise, and the village government ensuring access and support for community participation, the program aims to establish Innovation-Based Micro and Small Enterprises (MSEs) capable of transforming

coastal waste into products that offer tangible value to local communities. These MSEs are envisioned to significantly improve the socio-economic well-being of traditional fishing households. Moreover, the collaboration between USU, the Village Government, and business actors in the establishment of coastal-waste-based innovative enterprises is expected to open new income-generating opportunities for coastal residents. By reducing reliance on traditional fishing an occupation highly vulnerable to market and environmental fluctuations these initiatives contribute to enhancing community resilience and improving overall quality of life.

Beyond delivering direct economic benefits to fishing communities, the transformation of coastal waste into innovative products such as hydroxyapatite also contributes to addressing environmental pollution. Previously discarded waste often scattered and foul-smelling can now be processed into high-value materials that benefit not only the local population but also the surrounding ecosystem. Research findings indicate that the empowerment program successfully established Innovation-Based Fisher Groups as a tangible outcome of the Triplehelix collaboration between academic stakeholders from Universitas Sumatera Utara (USU) and the Batubara Regency Government. This collaboration was formalized through the signing of an Institutional Arrangement (IA), involving fishing communities in Medang Village. These groups serve as village-based production hubs and innovation incubators that focus on processing coastal waste, particularly the extraction of hydroxyapatite (HA) from seashells. Moreover, the enhancement of community knowledge and technical skills in waste processing has enabled the development of a localized cleaner production base within the Medang fishing community. Overall, the empowerment program implemented by the USU Talenta research team in Medang Village has delivered dual benefits to coastal communities. In addition to improving household income and quality of life, it has contributed to environmental remediation and improved health outcomes among fisher families. The collaboration between USU, the village government, and the Innovation-Based Fisher Groups through the Triplehelix model presents an effective strategy for establishing sustainable empowerment programs, creating new employment alternatives, and fostering economic self-reliance among coastal populations. Looking forward, this model has the potential to be scaled and replicated in other coastal villages to accelerate poverty alleviation and pollution control efforts across Indonesia's coastal regions.

E. CONCLUSION

This study concludes that traditional fishing communities in Nelayan Village, Medang District, Batubara Regency have, to date, not received socio-economic empowerment programs tailored to their specific needs. The absence of relevant interventions has deprived fishers of access to essential technical training and capacity-building initiatives necessary for improving their economic well-being. This situation has perpetuated longstanding structural vulnerability, where fishers rely entirely on daily catches, have minimal economic support, and maintain a weak bargaining position in dealings with middlemen. The lack of active involvement and collaboration between government institutions and universities in designing need-responsive empowerment schemes has hindered the development of a localized innovation ecosystem capable of driving socio-economic transformation in coastal regions.

In this context, coastal waste-based interventions implemented through the collaborative Triplehelix model have proven effective. The partnership among higher education institutions, village governments, and fisher communities led to the establishment of Innovation-Based Fisher Groups, formalized through the signing of an Institutional Arrangement (IA). This agreement not only provided symbolic recognition but also established the legal and administrative foundation for the sustained implementation of participatory empowerment programs. Moreover, the collaboration facilitated the transfer of knowledge and skills that were

contextually relevant to the local potential of the Medang fishers. This approach demonstrates that innovation-based empowerment strategies and cross-sector partnerships can serve as effective alternative models for improving the socio-economic conditions of coastal communities and fostering long-term self-reliance.

Based on these findings, the study recommends that socio-economic empowerment approaches in coastal areas be developed through participatory needs assessments to ensure greater responsiveness to local conditions. Local governments and academic institutions are encouraged to replicate similar models with appropriate contextual adaptations, particularly in identifying local resource potential and developing product-based innovations. In addition, a village-level innovation ecosystem should be established involving local institutions such as village-owned enterprises (BUMDes), cooperatives, and community-based micro and small enterprises (MSEs), to institutionalize and sustain locally driven innovation.

Social inclusion must also be strengthened by involving women and other vulnerable groups in all phases of the economic value chain to ensure that empowerment reaches all social units within fisher households. To ensure program sustainability, a systematic monitoring and evaluation mechanism based on clearly defined output and outcome indicators should be developed. Further research is recommended to explore the diversification potential of other coastal waste products, including marketing strategies and market access pathways. In doing so, empowerment programs can not only enhance economic well-being but also build social and environmental resilience within coastal communities over the long term.

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Contributorship

DA was responsible for designing the research, developing the conceptual framework, coordinating stakeholder engagement in Medang Village, and leading the manuscript writing process. MS provided expertise in the analysis of coastal waste characteristics and contributed to the environmental validation and technical aspects of waste innovation. MDET contributed to the fieldwork implementation, facilitated data collection from fisher groups, and assisted in refining the innovation-based empowerment model. All authors discussed, revised, and approved the final manuscript.

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