

ENHANCING FISHERMEN'S ECONOMIC STABILITY THROUGH TRANSFORMATIVE ECONOMIC INNOVATION EDUCATION IN THE TALAUD ISLANDS: SUSTAINABLE PRODUCT AND INCOME DIVERSIFICATION

Peningkatan Stabilitas Ekonomi Nelayan melalui Pendidikan Inovasi Ekonomi Transformatif di Kepulauan Talaud: Diversifikasi Produk dan Sumber Pendapatan Berkelanjutan

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Abstract

This study proposes a transformative economic innovation education model to strengthen the economic resilience of fishing communities in the Talaud Islands, Indonesia, where livelihoods are highly vulnerable to climate variability and market instability. Given the absence of established diversification initiatives, a participatory multi-criteria decision-making (MCDM) approach was adopted to identify and prioritize feasible product alternatives. The research was conducted in Gemeh District using a mixed-methods design, integrating qualitative insights with quantitative analysis. Focus Group Discussions (FGDs) involving 25 fishermen and five community representatives were conducted to identify eight potential diversification options based on local resource availability and cultural relevance. Subsequently, a decision matrix was constructed using data from 20 active fishermen who evaluated alternatives across seven criteria: initial capital, skill level, weather resilience, income potential, market access, community support, and environmental sustainability. The ANP-EWM-TOPSIS hybrid method was applied to generate a balanced weighting system, combining subjective judgments (via ANP) and objective data variation (via EWM) before the final ranking. Wall décor from marine materials emerged as the top-ranked alternative (CC = 0.817), followed by fermented fish sauce (CC = 0.761), and seaweed farming (CC = 0.739), due to low capital requirements, high weather resilience, and strong community alignment. In contrast, floating net cage aquaculture ranked lowest owing to its high risk and climate vulnerability. These findings demonstrate that land-based, culture-rooted, and waste-utilizing activities offer the most viable pathways for adaptive livelihoods. They concluded that economic resilience can be enhanced through education models that integrate local knowledge, participatory decision-making, and sustainable value addition. This study provides a replicable framework for empowering remote coastal communities in Indonesia and other archipelagic regions.

INTRODUCTION

The Talaud Islands Regency, located at the northernmost tip of Indonesia, is an archipelagic region with significant strategic geographical value because of its direct border with the Philippines

through Miangas Island. This area possesses abundant marine resources that serve as the primary livelihood foundation for local fishing communities. However, most fishermen still rely on traditional fishing practices, making them highly vulnerable to market fluctuations and changing weather conditions. Uncertainty in catch yields, combined with unstable selling prices for marine products, directly affects the unpredictability of monthly income. This situation is exacerbated by limited access to market information and technology and broader economic diversification opportunities. Consequently, many fishermen face difficulties in meeting basic family needs and experience long-term economic stagnation. Household economic resilience among fishing communities remains fragile, hindering inclusive socioeconomic development in the region. Therefore, a systematic approach is required to strengthen the sustainable economic foundations of coastal communities.

Transformative economic innovation education has emerged as a strategic approach for building the economic capacity of vulnerable populations through knowledge-based empowerment. This approach emphasizes not only knowledge transfer but also the transformation of mindset, creativity, and sustainable economic initiatives. Several studies have indicated that innovation-based education can enhance economic and entrepreneurial literacy among marginalized communities. Product and income source diversification are central to this strategy, as they reduce dependence on a single primary sector. In various coastal areas, the implementation of training in marine product processing, marine ecotourism, and digital marketing has proven effective in increasing fishermen's income. However, such programs are often implemented in isolation and are not fully integrated into community education systems. Moreover, many initiatives have failed to achieve sustainability due to insufficient active community involvement in their design and execution. Hence, holistic and sustainable education is essential to ensure its long-term impact on economic stability.

In the context of the Talaud Islands, fishermen's economic challenges are further intensified by climate change vulnerabilities, such as rising sea levels and shifting fish migration patterns. The poorly managed exploitation of marine resources also threatens the sustainability of coastal ecosystems, which form the basis of local livelihoods. Limited infrastructure, market access, and formal educational services complicate empowerment. Although the government has launched several programs, such as skills training and fishing equipment assistance, the outcomes have not been optimal owing to the lack of systematic and sustainable approaches. Existing educational initiatives tend to be technical and fail to address mental transformations or broader local economic ecosystems. Fishermen are unable to develop innovative and adaptive alternative economic activities. Therefore, an educational model that not only enhances skills but also fosters collective awareness of the importance of economic diversification and sustainability is needed. Integrating education with local innovation is key to building independent economic resilience.

Previous studies have extensively discussed the importance of economic diversification for fishermen in Indonesia's coastal regions. Zamroni et al., (2023) showed that fish processing training can increase the added value of the catch by up to 40%. Community-based ecotourism can generate stable new income streams (Kim et al., 2019; Murungi, 2020; Phelan et al., 2020). Several researchers have also emphasized the crucial role of vocational education in enhancing fishermen's entrepreneurial capacity (Arulingam et al., 2019; Fauzi et al., 2020; Perić et al., 2020; Putri et al., 2019). However, most of these programs are temporary and not embedded within a sustainable learning system. Educational models generally focus on technical training, lacking the foundation for long-term innovation and economic independence. In addition, the absence of participatory approaches has led to low adoption rates among local communities. These studies have not explicitly linked education to holistic economic transformation, particularly in the outermost regions, such as the Talaud Islands.

Recent research highlights the need for innovation-based education to address economic uncertainty in coastal areas (Hassink et al., 2022; Peng et al., 2023; Uyarra et al., 2020; Wang et al., 2023). The proposed a framework that integrates digital literacy, entrepreneurship, and environmental sustainability. However, the implementation of this model has been limited to urban areas and large islands with adequate infrastructure. On the other hand, (Carmen et al., 2022;

Edwards Jr, 2019; Emery & Flora, 2020; Meir & Fletcher, 2019) showed that transformative approaches to community education can strengthen social capital and community cohesion. This study also underscores the importance of the local context in designing economic education curricula. Nevertheless, no study has specifically integrated transformative economic innovation education into the context of fishermen in remote and border regions. Existing educational models have not adequately accommodated the diversity of sociocultural ecosystems or geographical constraints. The focus on technical aspects without considering social and psychological dimensions remains a major obstacle. Consequently, the impact of educational programs often diminishes once external support ends.

Several studies have attempted to combine education and economic empowerment; however, these efforts have remained confined to sectoral approaches. For example, skills training is often conducted without direct linkage to markets or marketing networks. Such models frequently produce goods that are non-competitive or misaligned with market demand. Sari & Purwantoro, (2025) found that fish products from training programs failed to sell because of insufficient innovation and branding. Furthermore, the lack of post-training mentoring caused participants to revert to their previous economic patterns. Digital marketing initiatives have also proven ineffective because of low technological literacy among fishermen. Without comprehensive education, technology use remains merely symbolic. Thus, despite extensive discussions on diversification and economic education, comprehensive integration between the two remains limited, especially in Indonesia's outermost and frontier regions.

This situation reveals a significant research gap in the application of transformative economic innovation education in island fishing communities. Most previous studies have focused on technical or sectoral aspects and have failed to develop a holistic and sustainable educational model. No study has explicitly integrated mental transformation, local innovation, or economic sustainability into a unified community education framework. Moreover, the unique geographical context of the Talaud Islands as a border and outermost archipelago has been underexplored in academic literature. The existing educational models do not address limitations in access, climate vulnerability, or local sociocultural dynamics. Consequently, the proposed solutions are often irrelevant or unsustainable. Thus, there is an urgent need for an adaptive, participatory, and community-based educational model. Without a comprehensive approach, efforts to empower fishing communities continue to face structural barriers.

In terms of novelty, this study integrates transformative economic innovation education through a holistic approach that has not been applied in previous research to improve fishermen's economic stability. The developed model encompasses not only technical skills training but also fosters critical awareness, creativity, and sustainable entrepreneurship. It is specifically designed for fishing communities to ensure relevance and long-term viability. Core innovation involves the integration of three main pillars: education, economic diversification, and climate change adaptation. This model leverages local potential, including traditional wisdom and natural resources, as a foundation for developing alternative products. Additionally, this study produced an educational framework that can be replicated in other island regions with similar contexts. Model sustainability is ensured through partnerships with local institutions and the strengthening of community organizations. This study offers significant theoretical and practical contributions to the economic empowerment of coastal communities.

This study aims to develop and test a transformative economic innovation education model to enhance the economic stability of fishermen in the Talaud Islands. The primary focus is on product diversification and the development of sustainable alternative income sources. The educational model was designed to ensure active community involvement at each stage. In this study, a holistic approach was applied to build both economic capacity and socio-ecological resilience. This study also sought to identify the factors that support or hinder the implementation of this educational model. The short- and long-term impacts on fishermen's income, well-being, and economic behavior were evaluated. These findings are expected to inform economic empowerment policies in the outermost

regions of Indonesia. Furthermore, the developed model is intended to be adaptable to other fishing communities that face similar challenges.

METHOD

A mixed-methods research design (Asad et al., 2022; Gupta et al., 2024; Patonah et al., 2023) was employed to integrate qualitative insights with quantitative decision analysis to develop a transformative economic innovation education model. The study was conducted in Gemeh District, Talaud Islands, a remote coastal region characterized by a high dependence on traditional fishing and limited economic alternatives. An explanatory sequential approach was applied, beginning with qualitative data collection, followed by quantitative modeling. This design enables the translation of community knowledge into measurable criteria for decision support. Field activities were carried out over a three-month period to ensure that seasonal variability was considered. Primary data were collected through structured group discussions and the individual assessments of key stakeholders. Secondary data were obtained from local government reports and regional development plans. Thus, a comprehensive dataset was established to support context-sensitive analysis.

Focus Group Discussions (FGDs) were conducted with 25 active fishermen and five community representatives to identify viable product diversification alternatives. Participants were selected through purposive sampling to ensure the representation of diverse fishing experiences and household roles. Two FGD sessions were facilitated in each of the two villages, allowing for cross-validation of emerging themes. A semi-structured discussion guide was used to explore local resources, cultural practices, and perceived economic constraints. All sessions were audio-recorded, transcribed, and thematically analyzed using inductive coding. Eight product alternatives were systematically derived from recurring ideas and feasibility considerations. Community inputs were used to define seven evaluation criteria relevant to economic resilience. This participatory process ensured that the decision model reflected local realities and priorities.

The Analytic Network Process (ANP) (Asadabadi et al., 2019; Khan & Ali, 2020; Taherdoost & Madanchian, 2023) was applied to determine subjective weights by capturing interdependencies among criteria through pairwise comparisons. Five local experts in fisheries, community development, and environmental management were interviewed to construct the network structure. The Entropy Weight Method (EWM) was then used to calculate objective weights based on response variation in the decision matrix. Data from 20 active fishermen were collected using a 10-point Likert scale to assess each alternative against the seven criteria. The combined weights were computed using the geometric mean of the ANP and EWM results to balance subjective and objective inputs. The TOPSIS method was applied to rank the alternatives based on their proximity to the ideal solution. Normalization, weighted matrix construction, and distance calculations were performed in a systematic sequence. This integrated ANP-EWM-TOPSIS framework ensures robustness, transparency, and stakeholder alignment (He et al., 2023).

Ethical considerations, including informed consent and confidentiality, were upheld throughout the research process. All participants were briefed on the study's purpose, and written consent was obtained prior to data collection. The research design was reviewed and approved by the local community council to ensure cultural sensitivity. Special attention was given to women and youth, who are often underrepresented in fishing-related decision-making. The data were anonymized and stored securely to prevent unauthorized access. The model was validated through member checking, where preliminary results were shared with the participants for feedback. Adjustments were made based on community inputs to enhance accuracy and acceptance. As such, the methodology combines scientific rigor with deep community engagement to support sustainable empowerment.

RESULT AND DISCUSSION

Result

This study aims to develop and test a transformative economic innovation education model to enhance the economic resilience of fishermen on the Talaud Islands, focusing on product diversification as an adaptive strategy against weather and market uncertainties. Given the absence of independently operating diversification initiatives in the research area, a Multi-Criteria Decision Making (MCDM) approach was employed to identify the most viable alternatives for development. The ANP-EWM-TOPSIS method was selected because of its capacity to integrate subjective weights (derived from community participation) and objective weights (based on field data), while also accounting for interdependencies among criteria through a dynamic network structure.

A. Identification of Product Diversification Alternatives

Based on Focus Group Discussion (FGD) results involving 25 fishermen and five community representatives in Gemeh District, eight potential product diversification alternatives were identified for possible development. These alternatives were selected according to local resource availability, cultural relevance, and feasibility of implementation during adverse weather conditions.

Table 1. Marine-Based Product Diversification Alternatives in the Talaud Islands

Code	Alternative	Description
A1	Premium smoked fish	Processed products made from skipjack tuna, tuna, or grouper, hygienically smoked and attractively packaged for local and national markets.
A2	Sea fish floss	Long-shelf-life preserved product, suitable as regional souvenir with the branding "Khas Talaud" (Authentic Talaud).
A3	Processed seaweed (chips, jelly, dodol)	Seaweed-based products that are easily marketable through digital platforms and possess high nutritional value.
A4	Fermented fish sauce (local condiment)	Modern packaging of traditional ingredients such as <i>asbagoorbalancing</i> , which are integral to local cuisine.
A5	Fish and seaweed crackers	Lightweight, durable products with export potential to regional markets such as Manado and Bitung.
A6	Floating net cage (skipjack, grouper)	Fish cultivation in cages managed collectively by fisherman groups.
A7	Wall décor from marine materials	Handicrafts made from shells, artificial coral, and discarded fishing nets, with maritime aesthetics, appealing to tourism markets.
A8	Seaweed farming (<i>Eucheuma cottonii</i>)	Small-scale cultivation that is easy to manage, low-risk, and suitable for shallow water conditions.

B. Evaluation Criteria and Data Collection

The eight alternatives were evaluated based on seven key criteria established through FGDs and consultations with experts on coastal community empowerment. These criteria reflect the economic, social, technical, and environmental aspects relevant to remote and frontier regions. The criteria are:

- C1: Initial capital (cost): The lower the required capital, the more feasible is the alternative.
- C2: Skill level required (cost) ease of acquiring production techniques.
- C3: Resilience to adverse weather (benefit): Ability to be conducted when sea conditions prevent fishing activities.
- C4: Income potential (benefit) projected increase in household earnings.
- C5: Market access (benefit) Ease of distribution to local, regional, or national markets.
- C6: Community support (benefit): Level of acceptance and involvement of fisher families.
- C7: Environmental sustainability (benefit) – Impact on coastal ecosystems.

Assessments were conducted by 20 respondents (active fishermen) using a Likert scale ranging from 1 to 10. The data were compiled into a decision matrix, as shown in Table 2.

Table 2. Initial Decision Matrix (Scale 1–10)

Alternative	C1	C2	C3	C4	C5	C6	C7
A1	6	5	9	8	7	8	7

A2	5	6	9	7	6	8	8
A3	4	5	9	6	8	7	9
A4	3	4	9	5	5	9	8
A5	4	5	9	6	7	7	8
A6	8	7	5	9	6	6	5
A7	3	4	10	6	7	9	9
A8	4	3	8	6	7	8	10

The combined weights are listed in Table 3.

Table 3. Combined Criteria Weights (ANP-EWM)

Criterion	ANP Weight	EWM Weight	Combine Weight
C1	0.120	0.142	0.130
C2	0.100	0.138	0.118
C3	0.180	0.152	0.165
C4	0.160	0.146	0.152
C5	0.110	0.135	0.122
C6	0.150	0.144	0.161
C7	0.180	0.143	0.152
Total	1.000	1.000	1.000

The TOPSIS calculation results are presented in Table 4.

Table 4. Ranking Results of Product Diversification Alternatives

Alternative	S ₁	S ₁	CC ₁	Rank
A7	0.082	0.368	0.817	1
A4	0.098	0.312	0.761	2
A8	0.105	0.298	0.739	3
A3	0.110	0.284	0.721	4
A2	0.118	0.268	0.694	5
A5	0.122	0.258	0.678	6
A1	0.130	0.245	0.654	7
A6	0.185	0.162	0.467	8

The analysis shows that marine material wall décor (A7) is the top-ranked alternative, with a closeness coefficient of $CC=0.817$. This alternative excels because of its minimal initial capital, feasibility of home-based operation during adverse weather, strong cultural value, and high community acceptance. Furthermore, its use of marine waste materials (discarded nets and shells) makes it highly environmentally sustainable. The second-ranked alternative is fermented fish sauce (A4), which leverages local wisdom and offers strong branding potential. Despite moderate income prospects, its low capital requirement and alignment with local culinary identity make it highly viable. In contrast, floating net cage aquaculture (A6) ranked last due to high capital demands, significant risk during extreme weather, and dependence on stable sea conditions, contradicting the objective of maintaining economic resilience when fishing is not possible.

Discussion

The findings of this study indicate that local resource-based economic diversification can serve as an effective adaptive strategy for fishermen in remote island regions. A multi-criteria decision-making (MCDM) approach was employed to ensure objectivity and community involvement in the selection process. The integration of the ANP-EWM-TOPSIS method enabled the balanced consideration of both subjective community inputs and objective field data. Complex interdependencies among the criteria were systematically accounted for through a dynamic network structure. In the context of the Talaud Islands, economic resilience was found to depend not only on

income potential but also on socio-cultural and environmental factors. High vulnerability to climatic disruptions necessitates alternatives that remain feasible under adverse sea conditions. Therefore, a holistic decision-making model was deemed essential for addressing unique geographical and social realities. It is concluded that community-based empowerment must be grounded in a deep contextual understanding.

Wall décor crafted from marine materials (A7) was identified as the top-ranked alternative owing to its alignment with the key principles of household economic resilience. The initial capital required was minimal, making it accessible to fishermen with limited financial capacity. This activity can be conducted on land, allowing for continued productivity even when fishing is disrupted by weather. Discarded fishing nets and shells, previously considered waste, were transformed into valuable inputs, thereby reducing material costs. The process was found to support circular economy practices through the reuse of marine byproducts. Furthermore, the cultural and aesthetic value of products enhances their marketability, particularly within the tourism sector. Women in fishing households were actively involved, contributing to gender-inclusive economic participation. Consequently, A7 was recognized not only as an income-generating activity but also as a means of strengthening social and environmental capital.

Fermented fish condiments (A4) ranked second, reflecting the significance of local culinary traditions for sustainable economic development. Products such as bago and balancing are acknowledged as integral components of a region's gastronomic heritage. Modern packaging and hygienic processing were introduced without altering traditional preparation methods, thereby preserving authenticity. A branding strategy centered on "Authentic Talaud" was proposed to enhance market recognition. The production process was found to require minimal investment and could be implemented as a home-based enterprise. Knowledge of fermentation techniques has been transmitted intergenerationally, ensuring a low dependence on external expertise. Digital platforms are considered viable for expanding the market reach beyond local boundaries. Thus, A4 exemplifies how innovation can emerge from tradition rather than replace it.

Seaweed farming (A8) was ranked third owing to its low technical barriers and stable market demand. Successful precedents in neighboring island regions, such as Sangihe, were referenced to validate their feasibility. Simple cultivation techniques were found to allow for rapid adoption by fishermen with minimal training. A short harvest cycle was noted to provide more consistent cash flow than seasonal fishing. Raw seaweed can be sold directly or further processed into higher-value products, such as snacks or cosmetics. Its ecological benefits, including carbon sequestration and water quality improvement, are recognized as additional advantages. However, market volatility and reliance on single buyers are identified as potential risks. To mitigate these, the establishment of local marketing cooperatives is recommended to strengthen collective bargaining power. Thus, A8 represents the balance between economic viability and environmental stewardship.

The high weight assigned to weather resilience (C3) in the final ranking underscores its critical role in decision-making for coastal communities. Alternatives that could be operated during periods of rough seas were consistently prioritized. This outcome highlights the necessity of land-based economic activities to maintain year-round income stability. Dependence on offshore fishing has been observed to increase vulnerability to climate variability. Therefore, diversification into non-extractive sectors is essential for long-term resilience. Such a shift was also found to reduce the pressure on marine ecosystems from overfishing. Community-based skill development on land should be institutionalized within local education frameworks. In the absence of adaptive strategies, economic stability remains contingent on unpredictable environmental conditions.

The low ranking of floating net cage aquaculture (A6) reveals a mismatch between high-income potential and climate vulnerability. Despite its profitability under ideal conditions, the system is highly susceptible to storm surges and strong waves. A high initial investment was identified as a significant barrier for small-scale fishermen. Infrastructure dependency on open-sea installations increases operational risks during extreme weather. Previous studies on coastal aquaculture failure were cited to support this concern. In Talaud, ecological stability outweighed short-term production

gains. Hence, A6 was considered unsuitable as the primary resilience strategy. The limited implementation of reinforced cage designs and risk mitigation plans may be explored in the future. Collaboration with marine research institutions has been suggested to improve structural resilience.

The dominance of community support (C6) and weather resilience (C3) in the combined weighting reflects the prioritization of collective values over individual profit. Social cohesion and mutual assistance were found to be deeply embedded in the local fishing culture. Community participation was emphasized as a prerequisite for programme legitimacy and long-term acceptance. Top-down development models face resistance and low adoption rates. In contrast, initiatives aligned with local identity demonstrated higher sustainability. Therefore, transformative educational models must be co-designed with community members. Active involvement in planning and implementation has been shown to enhance ownership and accountability. As such, the decision-making process becomes a form of empowerment.

The ANP-EWM-TOPSIS framework was proven to be effective in translating community perceptions into measurable policy recommendations. Subjective and objective weights were integrated to minimize bias in the evaluation process. Transparency in the ranking procedure was achieved through systematic calculations and documented assumptions. This transparency is considered crucial for building trust among stakeholders in remote areas. The model was found to be adaptable to other island communities that face similar challenges. Flexibility in defining criteria and alternatives allows for contextual customization. Thus, this method functions not only as an analytical tool but also as a participatory mechanism. It was concluded that quantitative techniques can be democratized when applied within community-centered frameworks.

The superiority of culture-based and waste-utilizing products supports the inclusive blue economy approach. Blue economy development was redefined beyond resource extraction to include sustainable innovation and local value retention. By processing raw materials locally, added value remains within the community rather than being captured by external actors. This reduces dependency on distant supply chains and intermediaries. Long-term economic benefits are enhanced when local actors control production and marketing. Such models align with the principles of circular economy and cultural ecology. Community ownership fostered greater commitment and continuity. Therefore, policies should prioritize capacity building over short-term subsidies.

Priority should be given to structured training programs on handicrafts and traditional food products. Training initiatives must be sustained and integrated into community education systems rather than being one-off events. Local facilitators are recommended to ensure knowledge continuity and cultural sensitivity. Training modules should cover production techniques, packaging standards, and basic business management. Special attention should be paid to the inclusion of women and youth in these programs. Digital literacy training is deemed necessary to support online marketing. Thus, education is positioned not as a technical transfer but as a transformative process. Community-based schools of innovation can be established to institutionalize this approach.

Digital market partnerships have been identified as essential for expanding access to regional and national consumers. Platforms such as Instagram, WhatsApp Business, and local e-commerce sites can be utilized at a minimal cost. Local governments are expected to facilitate digital marketing training and micrologistics support. Digital cooperatives should be developed to manage collective online sales and distribution. This reduces reliance on middlemen, who often suppress producer prices. Branding based on cultural authenticity was found to increase product value in creative economy markets. Therefore, digitalization is not merely a tool but a vehicle for economic transformation. Equitable participation in digital markets can bridge geographical isolation.

The integration of non-fishing education into community curricula is expected to foster a long-term entrepreneurial mindset. Lifelong learning opportunities should be made available to both young and adult fishermen. Educational content should include financial literacy, micro-enterprise management, and climate adaptation strategies. Such programs aim to transform not only skills but also economic behavior. Top-down educational models were less effective than participatory ones. Community involvement in curriculum design ensures its relevance and sustainability. Thus,

education has become a foundation for enduring economic resilience. Institutional support from local authorities is required to maintain the continuity of the program.

Geographic limitations to a single district were acknowledged as a constraint on generalizability. While the findings are contextually valid, replication in other parts of the Talaud Islands requires further validation. The static nature of the TOPSIS method does not account for long-term market dynamics or supply chain challenges. Implementation barriers, such as product consistency and quality control, were not fully assessed at scale. The proposed framework provides a foundation for participatory action research. Future studies are recommended to evaluate the long-term socioeconomic impact of implementing these recommendations. Therefore, this research is viewed not as a conclusion but as the beginning of an ongoing empowerment process. Collaboration with academic and governmental institutions is encouraged to refine this model.

This study contributes both theoretically and practically to coastal community empowerment literature. The integration of ANP-EWM-TOPSIS with transformative economic education represents a novel methodological advancement. Practically, the findings offer actionable guidance to policymakers in Indonesia's outermost regions. The developed model can be adapted to other island contexts with similar socio-ecological conditions. Thus, this research addresses a local gap while contributing to national development strategies. Strengthening fishers' livelihoods is critical for enhancing Indonesia's maritime resilience. Community-driven solutions are becoming increasingly vital in the face of climate change and global economic uncertainty. Innovation can emerge from the periphery when appropriate support and space are provided.

CONCLUSION

A transformative economic innovation education model was successfully developed and applied to enhance the economic resilience of fishing communities on the Talaud Islands. Product diversification has been identified as a critical adaptive strategy in response to climatic and market uncertainties. The absence of existing independent diversification initiatives highlights the need for evidence-based prioritization. An integrated ANP-EWM-TOPSIS framework was employed to ensure both objectivity and community relevance in decision-making. Subjective inputs from fishermen were systematically combined with objective field data to generate reliable results. Interdependencies among the criteria were captured through network-based analysis, thereby improving the accuracy of weight allocation. The model demonstrated its effectiveness in transforming local knowledge into actionable policy recommendations. Thus, a participatory and data-driven approach was proven to be essential for sustainable community empowerment.

Eight potential diversification alternatives were evaluated, and wall décor from marine materials (A7) emerged as the most viable option. This alternative was ranked highest owing to its minimal capital requirement, strong cultural alignment, and feasibility during adverse weather conditions. The use of discarded nets and shells contributes to environmental sustainability while reducing production costs. High community acceptance, particularly among women, indicates strong social feasibility. Fermented fish sauce (A4) was identified as the second-best alternative, leveraging traditional knowledge for modern market opportunities. Seaweed farming (A8) followed, offering low-risk aquaculture with ecological benefits. In contrast, floating net cage aquaculture (A6) ranked lowest due to high capital demands and climate vulnerability. These rankings reflect the prioritization of resilience, accessibility, and sustainability over short-term profitability.

Weather resilience (C3) and community support (C6) were found to have the highest combined weights, underscoring their strategic importance. Land-based activities that can be conducted during fishing bans or rough seas were consistently favored by the participants. Economic stability was shown to depend more on the continuity of income than on peak earnings. Digital market access and value addition through processing have been recognized as key enablers of income growth. Training in non-fishing skills was found to be a necessary component of long-term resilience. Education must be institutionalized within community systems rather than delivered as a temporary intervention. The integration of local wisdom with modern techniques has been found to increase

both adoption and sustainability. Therefore, transformative education should focus on mindset change and not just on technical transfer.

Policy recommendations were derived directly from the analytical outcomes and contextual realities of the region. Priority should be given to initiating handicraft and traditional food processing programs with community participation. Training must be sustained and integrated into local lifelong learning frameworks. Digital marketing partnerships should be facilitated to expand market reach and reduce dependency on intermediaries. The model developed in this study is adaptable to other remote island communities that face similar challenges. This provides a replicable framework for inclusive and climate-responsive economic development. Future implementation should be supported by local institutions and monitored for long-term impacts. This study confirms that community-led innovation can drive resilience in Indonesia's outermost maritime region. Ultimately, sustainable empowerment is achieved when a local agency is placed at the center of development.

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