



HUMAN CAPITAL DEVELOPMENT MODEL BASED ON THE BLUE ECONOMY FOR THE SUSTAINABILITY OF MILKFISH AQUACULTURE BUSINESSES IN HOLTEKAMP

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Abstract

Introduction: This study aims to develop a blue economy-based human capital model to support the sustainability of fisheries businesses in Holtekamp Village, Jayapura City. It addresses the need for an integrative framework that links human capital development with blue economy principles to strengthen the long-term resilience and competitiveness of community-based fisheries.

Methods: A qualitative case study approach was employed to explore the dynamics of community-based capacity development among fisheries business actors. Data were collected through in-depth interviews, field observations, and documentation involving four key informants, comprising three milkfish farmers with different levels of experience (senior, intermediate, and junior) and one fisheries product collector. Data were analyzed using an interactive approach involving data reduction, data display, conclusion drawing, and thematic analysis.

Results: Human capital develops through intergenerational knowledge transfer, experiential learning, and adaptation to technological and environmental changes. Blue economy principles are reflected in efficient resource utilization, sustainable pond management, and the integration of economic productivity with ecological sustainability.

Discussion: The study proposes an integrative human capital development model that combines experiential learning, institutional strengthening, technological adaptation, and blue economy principles. The findings suggest that fisheries business sustainability is shaped by the interaction of individual competencies, community institutions, and ecological processes. Although derived from a specific qualitative context, the model provides a robust conceptual foundation for future empirical validation across different fisheries communities and socio-economic settings.

Keywords: Human Capital Development, Blue Economy, Milkfish Aquaculture, Business Sustainability, Qualitative Case Study.

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A. INTRODUCTION

In recent years, the transformation of marine and fisheries management has increasingly shifted toward the implementation of blue economy principles that emphasize a balance between economic growth and environmental sustainability. This approach emerged as a response to the uncontrolled exploitation of coastal resources that potentially threatens ecosystem sustainability in the long term (Bennett et al., 2021; Silver et al., 2023). Within this framework, the fisheries sector is no longer viewed merely as a production activity, but rather as part of a complex socio-ecological system. Fisheries contribute significantly to global protein supply while simultaneously serving as a primary source of livelihood for coastal communities (FAO, 2022; Gephart et al., 2021). Consequently, ensuring the sustainability of this sector has become a strategic issue requiring a more integrated approach. Increasing production output alone is insufficient without ensuring that production processes remain environmentally sustainable. As a result, the current fisheries development paradigm has gradually evolved toward a more adaptive, inclusive, and sustainable model.

Furthermore, increasing pressure on capture fisheries resources has accelerated the expansion of aquaculture as a major alternative for meeting global food demand. The aquaculture sector has experienced substantial global growth and is recognized as one of the fastest-growing sectors within the world food system (Ahmed et al., 2022). This expansion is driven not only by market demand but also by declining capture fisheries yields and growing uncertainty in marine environmental conditions. In Indonesia, aquaculture activities, particularly milkfish farming, possess considerable economic potential and represent one of the strategic commodities supporting national food security (Agustin & Hasan, 2021; Jaya, 2026). Nevertheless, the success of aquaculture development is not solely dependent on the availability of natural resources. Human factors, as the main actors within the production system, play a decisive role in determining business performance and sustainability. Therefore, strengthening the capacity of fisheries business actors has become a central issue in aquaculture development.

Within this context, human capital constitutes a critical element influencing the success and sustainability of fisheries enterprises. Human capital encompasses not only technical production skills but also managerial competence, adaptability to change, and the ability to access market networks and technological innovations (Richmond & Casali, 2022; Joffre et al., 2023). Several studies have indicated that the low quality of human resources frequently becomes a major obstacle to improving the productivity of small-scale aquaculture businesses (Kruijssen et al., 2022; Lukman et al., 2021; Zulfachry et al., 2026). On the other hand, existing capacity development approaches tend to be partial in nature and primarily focus on improving individual technical skills. Such approaches often overlook the interaction between business actors, production systems, value chains, and environmental pressures. Consequently, many capacity development programs have failed to generate substantial changes in business practices. This condition highlights the need for a more comprehensive approach to human capital development.

The issue becomes increasingly complex when examined within local dynamics that do not always align with the general assumptions commonly found in the literature. Most previous studies tend to associate coastal fisheries activities predominantly with marine capture fisheries. However, the empirical reality in Holtekamp Village demonstrates a different condition, where milkfish aquaculture has become the primary economic activity of the local community. This shift reflects a transformation in the

fisheries economic structure from capture-based fisheries toward aquaculture-based livelihoods. Such transformation did not occur incidentally but rather emerged as a form of adaptation to declining capture resources and environmental pressures. In addition, more stable market opportunities have encouraged communities to transition into aquaculture activities. This phenomenon simultaneously challenges the dominant assumptions in fisheries studies that have traditionally focused excessively on capture fishers. Therefore, a more contextual understanding of fisheries dynamics at the local level is required.

Although aquaculture activities in Holtekamp Village have shown significant development, several structural constraints continue to pose major challenges. Limited access to production inputs, such as fish seed and feed, along with dependence on inefficient marketing chains, has hindered efforts to improve business productivity (Sinafrin *et al.*, 2026; Zavina *et al.*, 2026). Moreover, the managerial capacity and adaptive capabilities of business actors remain relatively limited in responding to environmental changes and market dynamics. At the same time, existing aquaculture practices demonstrate a combination of local knowledge and the adoption of simple technologies. This condition indicates the presence of substantial human capital potential that has not yet been systematically managed. Consequently, this situation creates opportunities for developing a model capable of optimizing such capacities. Therefore, the primary issue addressed in this study is not limited to technical production aspects but also concerns the integrated development of human capacity.

Based on the foregoing discussion, a significant gap can be identified in the existing literature regarding the absence of an integrated human capital development model aligned with blue economy principles within the context of community-based aquaculture enterprises. Most previous studies remain sectoral in nature and have not adequately explained the relationship between human capacity, production systems, and sustainability in a comprehensive manner (Troell *et al.*, 2021; Gudbrandsdottir *et al.*, 2021). Accordingly, this study seeks to address this gap by developing a more contextual and systemic approach. The novelty of this research lies in the integration of human capital concepts, local aquaculture dynamics, and sustainability principles within the framework of the blue economy. In addition, this study offers a new perspective regarding the transformation of fisheries economic structures at the community level. Thus, this research not only provides descriptive findings but also contributes to the development of a broader conceptual framework.

Based on the background and research problems described above, this study aims to formulate a blue economy-based human capital development model for aquaculture businesses in Holtekamp Village, Jayapura City. The study is expected to contribute theoretically by enriching discussions on human resource capacity development within the aquaculture sector. Practically, the findings are anticipated to serve as a foundation for designing more effective and sustainable coastal community empowerment policies and programs. The proposed model is expected to function as a reference for improving the capacity of fisheries business actors in an integrated manner that aligns with production systems and environmental sustainability. Therefore, this study possesses strong relevance in both academic and practical contexts. Ultimately, appropriate human capital development is expected to support the long-term sustainability of community-based fisheries enterprises.

B. LITERATURE REVIEW

1. Blue Economy from the Perspective of Fisheries System Transformation

Contemporary literature on the blue economy demonstrates a substantial shift from a merely normative concept toward a systemic transformation framework in fisheries resource management. This approach emphasizes the integration of economic growth, ecological sustainability, and efficient resource utilization within an interconnected and dynamic system (Bennett et al., 2021; Silver et al., 2023). Within this perspective, economic activities are no longer perceived solely as extractive processes but rather as components of a cyclical system that must preserve ecosystem balance. Such transformation requires structural changes in production systems, consumption patterns, and resource governance mechanisms. Consequently, the blue economy should not be viewed only as a policy concept, but also as a paradigm that directs comprehensive changes in fisheries production systems. This perspective reinforces the argument that sustainability cannot be achieved without fundamental changes in the operation of economic systems.

Nevertheless, most blue economy studies remain largely focused on macro-level analyses, including public policy, coastal development strategies, and resource governance. Such approaches frequently overlook micro-level dimensions, particularly how blue economy principles are interpreted and implemented in the daily practices of small-scale fisheries actors. In fact, the implementation of these principles is strongly influenced by local conditions, including resource limitations, environmental pressures, and market dynamics (Ahmed et al., 2022). The mismatch between policy design and field realities often reduces implementation effectiveness. Therefore, an approach capable of bridging the gap between normative frameworks and empirical practices is required. In this regard, the capacity of fisheries business actors becomes a determining factor in the successful transformation toward sustainable fisheries systems.

2. Human Capital as Adaptive Capacity within Business Systems

Conventionally, human capital is understood as the accumulation of education, knowledge, skills, and experience that enhance individual productivity and economic performance. Classical human capital theory conceptualizes these capacities as forms of capital embodied in individuals and developed through investment in education, training, and other learning processes that improve labour quality and productive ability (Schultz, 1961; Becker, 1964). From this perspective, human capital is closely associated with the economic returns generated by improved skills, knowledge, and competence. However, within the context of small-scale fisheries enterprises, such a perspective is considered insufficient because it does not fully capture the complexity of capacity-building processes among business actors (Kruijssen et al., 2022). In practice, human capital in small-scale fisheries is developed not only through formal education or training, but also through direct experience, practice-based learning, and social interactions within community networks. These processes generate contextual and adaptive forms of knowledge that are closely connected to local environmental, economic, and production conditions. Consequently, human capital cannot be separated from the social environment and production systems in which fisheries actors operate, as it evolves through dynamic and continuous processes of learning, adjustment, and adaptation. In this sense, human capital also includes business management competence, economic decision-making ability, and the adaptive

capacity of fisheries actors to respond to ecological uncertainty, market change, and technological developments. Edwar and Mangopo (2025) explain that human capital development in remote areas contributes to improving community economic capacity through the strengthening of adaptive abilities and resource management skills. Furthermore, the study conducted by Edwar (2026) demonstrates that literacy and technological mastery can reinforce community capacity in responding to economic changes and enhancing business sustainability.

Moreover, human capital functions as an adaptive mechanism for dealing with environmental and market uncertainties. The ability of business actors to identify changes, manage risks, and adjust production strategies becomes an essential factor in maintaining business sustainability (Joffre et al., 2023). However, many capacity development interventions still focus primarily on improving individual technical skills without considering their relationship with the broader business system. Such approaches frequently create a mismatch between capacity improvement and actual business performance. This condition suggests that the effectiveness of human capital is highly dependent on the system context in which those capacities are utilized. Therefore, a more comprehensive approach is needed to position human capital as part of an adaptive system integrated with production and environmental factors.

3. The Dynamics of Fisheries Business Systems in Local Contexts

The development of aquaculture over recent decades indicates that local fisheries business systems are inherently complex and dynamic, shaped through interactions among ecological, technical, economic, and social factors. This complexity is reflected in the diverse challenges faced by fisheries business actors, ranging from limited production inputs to price fluctuations and environmental uncertainty. Under such conditions, business actors are required to possess strong adaptive capabilities to sustain their enterprises. Adaptation processes are frequently developed through experiential learning and direct practical engagement. This situation demonstrates that fisheries business systems are not static but continuously evolve in response to environmental dynamics. Accordingly, approaches used to understand these systems must be capable of capturing such complexity comprehensively.

In addition, local business practices often generate innovations rooted in local knowledge that are rarely formally documented. This knowledge constitutes an important component of production systems because it provides solutions that are highly relevant to specific local challenges (Ahmed et al., 2022). However, top-down policy approaches frequently neglect these local dimensions, resulting in interventions that do not correspond to the actual needs of fisheries actors. Consequently, many development programs fail to achieve optimal effectiveness. This condition highlights the importance of approaches grounded in empirical realities at the local level. Therefore, understanding local dynamics becomes a key element in formulating sustainable business development strategies.

4. Theoretical Gap and Research Position

Existing literature on blue economy, human capital, and fisheries enterprises reveals a significant fragmentation of approaches. Studies on the blue economy generally concentrate on policy and resource governance at the macro level (Bennett et al., 2021; Silver et al., 2023). Meanwhile, human capital research tends to focus predominantly on enhancing individual capacity without connecting it to the dynamics

of production systems (Kruijssen *et al.*, 2022). On the other hand, fisheries business studies commonly emphasize technical aspects and production efficiency while giving limited attention to socio-economic dimensions (Joffre *et al.*, 2023). As a result, understanding of the relationship among human capacity, business systems, and sustainability remains limited. In other words, there is still no analytical framework capable of comprehensively integrating these three dimensions.

Furthermore, most studies tend to overlook local contexts as factors mediating the relationship between human capital and the implementation of blue economy principles. In fact, variations in local conditions significantly influence the effectiveness of sustainability-oriented practices. These limitations indicate the need for more contextual and empirically grounded approaches. This study positions itself to address this gap by integrating human capital, fisheries business systems, and blue economy principles within a single analytical framework. The primary focus of the research is to understand how the adaptive capacity of fisheries actors contributes to business sustainability. Accordingly, this study is expected to provide both theoretical and empirical contributions.

5. Conceptual Framework and Research Proposition

The conceptual framework of this study is constructed from the literature to provide an initial analytical lens for examining the sustainability of fisheries enterprises in Holtekamp Village. As an *a priori* framework, it is not intended to represent the final empirical model, but rather to organize the key concepts identified from previous studies and to guide the field inquiry. The framework is based on the assumption that the sustainability of fisheries enterprises is shaped by the interrelationship among human capital, fisheries business practices, and the implementation of blue economy principles within the local coastal context. In this framework, human capital is positioned as the primary foundation that influences the ability of fisheries actors to manage resources, formulate business strategies, respond to market opportunities, and adapt to social, economic, and environmental changes. Knowledge, skills, experience, adaptive capacity, and creativity are therefore treated as central dimensions of human capital that may shape the continuity and resilience of fisheries enterprises.

Within this study, fisheries enterprises are understood not merely as fish production activities, but as broader local economic practices that include production processes, business strategies, resource management, and community-based economic activities. These practices are subsequently examined through the perspective of the blue economy to assess whether they reflect principles of resource efficiency, environmental sustainability, and economic value creation. In this sense, blue economy principles function both as an evaluative lens and as a normative direction for sustainable fisheries business development. The framework assumes a sequential and interconnected relationship in which human capital influences fisheries business practices, and these business practices in turn shape the extent to which blue economy principles are adopted in everyday economic activities. Collectively, these interrelated processes are expected to contribute to the sustainability of fisheries enterprises in Holtekamp Village.

Accordingly, Figure 1 presents the initial conceptual framework derived from the literature review and theoretical synthesis. It serves as the preliminary structure for data collection, coding, categorization, and interpretation during the qualitative

research process.

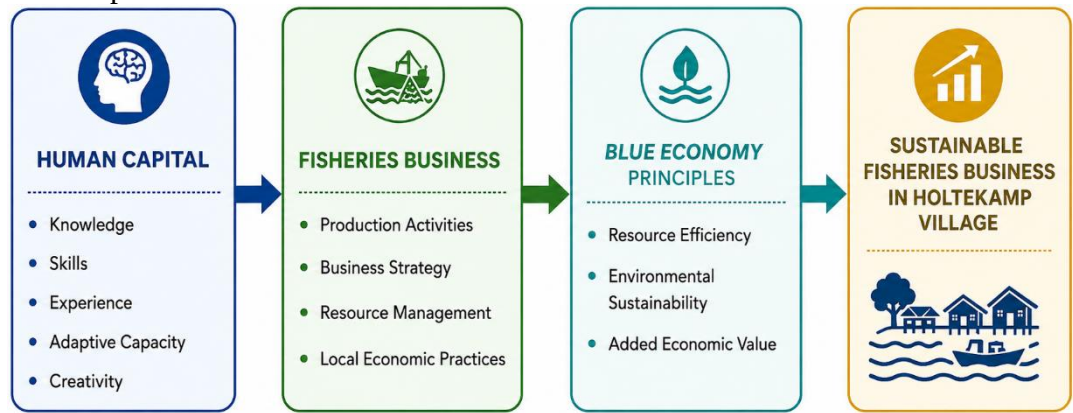


Figure 1. Initial Conceptual Framework Derived from the Literature

However, because this study adopts an empirical qualitative approach, the framework remains open to refinement during field analysis. The interaction among human capital, fisheries business practices, blue economy principles, and business sustainability may reveal contextual relationships that are more complex than those initially proposed in the literature-based framework. Therefore, the findings of this study are not only used to confirm or elaborate the initial framework, but also to develop a more contextually grounded conceptual model. Figure 2, presented in the findings and discussion section, represents the refined model developed from the empirical findings of the study. This distinction is important to show that Figure 1 functions as the initial theoretical framework, while Figure 2 reflects the contextual model emerging from the field data in Holtekamp Village. Based on the initial conceptual framework, this study is guided by the following research proposition: Proposition: Human capital development plays an important role in shaping adaptive fisheries business practices and strengthening the implementation of blue economy principles, which together support the sustainability of fisheries enterprises in Holtekamp Village.

C. RESEARCH METHOD

This study employed a qualitative approach to obtain an in-depth understanding of the dynamics of human capital development within coastal community fisheries enterprises, particularly milkfish aquaculture activities in Holtekamp Village, Jayapura City. A qualitative approach was selected because it enables the exploration of experiences, local knowledge, meanings, and social interactions that are contextually and holistically embedded within community fisheries practices (Creswell & Creswell, 2022; Creswell & Poth, 2024). The research adopted a case study design since the investigation focused on a specific phenomenon occurring within a real-life context, particularly concerning community capacity development, the implementation of blue economy principles, and the sustainability of community-based fisheries enterprises. The case study approach allowed the researcher to examine the relationships among aquaculture practices, local institutional systems, community adaptation processes, and socio-ecological factors influencing fisheries sustainability in Holtekamp Village (Creswell & Poth, 2024). The study was conducted from February 2026 to May 2026, with intensive fieldwork carried out in Holtekamp Village, Jayapura City. During this period, the researcher conducted direct observations, in-depth interviews, and documentation of

community-based aquaculture activities. The unit of analysis in this study was fisheries enterprises at the household and community level, particularly actors involved in milkfish aquaculture, including fish farmers, local fisheries groups, and supply chain actors engaged in production, management, and marketing activities. This unit of analysis was selected to capture both individual human capital attributes and collective dynamics shaping the sustainability of coastal fisheries enterprises. The selection of informants was conducted using purposive sampling based on involvement, experience, and relevance to the research focus. Although the study involved only four informants, this number is considered appropriate for a qualitative case study because the emphasis lies on analytical depth, contextual richness, and variation of perspectives rather than statistical representation. The combination of actors from both production and distribution sides enabled sufficient diversity of information to achieve data saturation. The informants consisted of three milkfish farmers representing different levels of experience, namely senior farmers (I1), intermediate farmers (I2), and junior farmers (I3), as well as one collector or distributor of aquaculture products (I4). The classification of farmers was operationally defined based on years of experience in milkfish aquaculture and level of business development as proxies of human capital accumulation in fisheries activities. Senior farmers were defined as those with more than 10 years of experience and established production systems with stable market access. Intermediate farmers had 5 to 10 years of experience with developing production capacity and improving market integration. Junior farmers had less than 5 years of experience and were still in the early stage of business development and adaptation to aquaculture practices and market dynamics. For the collector or distributor (I4), classification was based on years of involvement in fisheries product distribution and scale of marketing operations. This informant had more than 5 years of experience in handling aquaculture product distribution with local to regional market coverage, thereby playing a strategic role in connecting producers with broader market networks. To provide a clearer overview of participant characteristics, the profiles of informants are presented in Table 1.

Table 1. Profile of Informants

Code	Role	Experience Category	Years of Experience	Business Scale / Notes
I1	Milkfish farmer	Senior	>10 years	Established production system, stable market access
I2	Milkfish farmer	Intermediate	5–10 years	Developing production system, moderate market access
I3	Milkfish farmer	Junior	<5 years	Early-stage farming, limited market access
I4	Collector/Distributor	Established actor	>5 years in distribution	Local to regional distribution network

Data collection was carried out through in-depth interviews, field observations, and documentation. In-depth interviews were conducted using a semi-structured interview guide covering aquaculture practices, learning processes, skill development, business management, implementation of blue economy principles, and challenges in fisheries enterprises. Each interview lasted approximately 45 to 90 minutes and was conducted at informants' homes or aquaculture sites depending on accessibility and participant preference. Field observations were conducted using a non-participant approach supported by systematic field notes to understand pond management practices, labor activities, farmer interactions, and environmental conditions surrounding aquaculture

activities. Observations were conducted repeatedly from February to May 2026 to capture variations in production cycles and social dynamics. Documentation included field notes, group records when available, informal transaction records, photographs of aquaculture activities, and other relevant community documents.

Ethical considerations were strictly applied throughout the research process. Informed consent was obtained from all informants prior to data collection. Participation was voluntary, confidential, and participants were informed of their right to withdraw at any time without consequence. All personal identifiers were anonymized to protect participant privacy and confidentiality. The data in this study consisted of primary and secondary sources. Primary data were obtained directly through interviews and observations, while secondary data were collected from documents, reports, scientific articles, and relevant literature on human capital development, fisheries enterprises, and the blue economy concept. Data analysis was conducted using an interactive model consisting of data reduction, data display, conclusion drawing, and thematic interpretation (Miles et al., 2023). Analysis was performed simultaneously with data collection to allow iterative refinement of emerging patterns and relationships. Interview data were analyzed through a systematic coding process. First, all interview transcripts were read repeatedly to ensure familiarity with the data. Second, open coding was conducted by identifying meaningful units of text related to skills development, knowledge transfer, business adaptation, and blue economy implementation. Third, codes were grouped into categories based on conceptual similarity and contextual relevance. Finally, thematic analysis was conducted by integrating these categories into overarching themes that represent the dynamics of human capital development and fisheries enterprise sustainability in Holtekamp Village.

To enhance transparency in the analytical process, the development of themes was systematically traced from raw interview data to final conceptual categories. Direct statements from informants (I1–I4) were first broken down into meaning units, which were then assigned initial codes reflecting their explicit content. These codes were subsequently compared across informants to identify recurring patterns and similarities. Through iterative comparison, codes with conceptual proximity were merged into higher-order categories, which ultimately formed the analytical themes used in this study. This stepwise coding process ensured that each theme presented in the findings section is directly grounded in empirical data rather than pre-defined conceptual assumptions. These themes were then synthesized into a conceptual model of blue economy-based human capital development. Data validity was ensured through source triangulation, method triangulation, member checking, and prolonged engagement in the field. These strategies were applied to enhance credibility, dependability, and confirmability of the findings, ensuring that interpretations were firmly grounded in empirical evidence (Creswell & Creswell, 2022).

D. RESULTS AND DISCUSSION

1. The Context of Fisheries Enterprises in Holtekamp Village

Fisheries enterprises in Holtekamp Village represent one of the coastal community's long-standing economic activities that has continued to survive across generations. Based on interview findings, milkfish aquaculture has been practiced for a considerable period by local residents and remains an important source of livelihood for coastal households. One senior informant stated that “I have been doing this for more than 25 years” (I1), indicating that aquaculture has long functioned as a stable economic activity within the village.

Another informant explained that “since 2014, it means around 12 years already” (I2), suggesting that milkfish aquaculture is not only maintained by senior actors but also continued by farmers with different levels of experience through practical engagement and field-based learning. These findings show that fisheries enterprises in Holtekamp are deeply rooted in local livelihood practices and are sustained through the continuity of experience and community involvement.

The aquaculture process in Holtekamp generally begins with the procurement of milkfish fry (*nener*), which are supplied from Bali due to limited local availability. After arrival, the fry are first placed in nursery ponds before being transferred to the main production ponds. Interview and observation results indicate that pond management practices remain relatively simple and are still strongly dependent on practical experience, direct observation of pond conditions, and the use of locally available resources. In this context, farmers rely heavily on experiential knowledge to determine pond preparation, water management, feeding, and harvesting schedules. This condition suggests that fisheries enterprises in Holtekamp continue to be shaped by practical capabilities and the ability of local communities to manage aquaculture resources independently (Agustin & Hasan, 2021; FAO, 2022).

Aquaculture activities in Holtekamp Village also reflect a community-based management pattern supported by local institutional arrangements. Interview findings revealed that fish farmers are connected through a cooperative structure that helps coordinate aquaculture activities, facilitate access to support programs, and strengthen collective management. One informant explained that “we are more organized because we have a proper institution and a clear organizational structure” (I2). The presence of this institutional arrangement indicates that fisheries enterprises in Holtekamp are not operated solely at the individual level, but are also supported by social relationships and collective coordination among fish farmers. In addition, mutual cooperation during pond preparation, harvesting, and product distribution remains an important feature of community life in the village, reflecting the role of social organization in sustaining local fisheries enterprises.

At the same time, the findings also show that fisheries enterprises in Holtekamp face a number of structural and environmental challenges. Informants described several constraints, including limited fuel access, increasing production costs, unstable availability of production inputs, and declining environmental quality due to water pollution. These conditions affect production efficiency and create uncertainty for the continuity of aquaculture activities. The collector or distributor (I4) further highlighted that marketing and distribution are also influenced by supply conditions and the continuity of production at the farmer level. This indicates that the sustainability of fisheries enterprises in Holtekamp is shaped not only by farmers’ production capacity, but also by the interaction among local institutions, market linkages, input availability, and the adaptive capacity of coastal communities in responding to economic and environmental pressures (Bush *et al.*, 2022; Cinner *et al.*, 2021; Joffre *et al.*, 2023). To provide a clearer overview of the contextual findings emerging from the four informants, Table 2 summarizes the main themes identified from the interviews regarding the characteristics of fisheries enterprises in Holtekamp Village.

Table 2. Summary of Key Findings from Informants on the Context of Fisheries Enterprises in Holtekamp Village

Informant Code	Role	Main Contextual Findings
I1	Senior milkfish farmer	Has more than 25 years of experience in milkfish aquaculture and views aquaculture as a long-standing household livelihood. Emphasizes experience-based pond management and the continuity of traditional aquaculture practices in Holtekamp.
I2	Intermediate milkfish farmer	Has been involved in aquaculture since 2014 and highlights the role of cooperative institutions and organizational structure in supporting aquaculture activities, coordination, and access to collective support.
I3	Junior milkfish farmer	Represents the newer generation of aquaculture actors and reflects the continuation of fisheries enterprises through practical learning, field adaptation, and involvement in day-to-day aquaculture activities.
I4	Collector/distributor	Highlights the importance of distribution and market linkages in the fisheries enterprise system and shows that business sustainability is also influenced by post-harvest handling, product flow, and coordination between producers and market actors.

Overall, the findings indicate that the context of fisheries enterprises in Holtekamp Village is characterized by three interrelated features. First, milkfish aquaculture constitutes a long-standing livelihood activity that has been maintained through intergenerational involvement and practical experience. Second, fisheries enterprises are supported by community-based institutional arrangements and cooperative relationships that help organize production and strengthen social coordination among actors. Third, the continuity of these enterprises is influenced by structural and environmental constraints, including input access, production costs, and ecological pressures. These contextual conditions form the empirical foundation for understanding how human capital is developed and mobilized within local aquaculture activities, which is discussed further in the following sections.

2. Human Capital Development in Fisheries Enterprises

Human capital development within fisheries enterprises in Holtekamp Village is predominantly formed through intergenerational learning and direct field experience. Interview findings indicate that aquaculture knowledge is not acquired primarily through formal training, but through continuous involvement in family-based and community-based fisheries activities. One informant stated that “honestly, I learned this from my parents through generations” (I1), indicating that aquaculture skills are transmitted through long-term observation, participation, and repeated practice within the household and local community environment. In this context, intergenerational learning functions not merely as a mechanism for transferring technical knowledge, but also as a process of shaping work habits, production judgment, and practical problem-solving capacities that are essential in small-scale aquaculture enterprises.

The findings further show that this learning process contributes directly to the development of technical skills in milkfish aquaculture. Knowledge inherited from previous generations includes pond preparation, fry placement, water regulation, feeding management, and the recognition of environmental signs affecting fish growth. One informant explained that before fry are transferred into production ponds, the ponds are first dried and fertilized to stimulate the growth of natural feed. This practice demonstrates that local fish farmers possess accumulated ecological and technical knowledge that

supports routine cultivation activities. Through repeated involvement in such practices, fish farmers gradually develop operational skills that enable them to manage production activities more effectively and to reduce errors in pond preparation and fish maintenance. Intergenerational learning also plays an important role in strengthening decision-making capacity within fisheries enterprises. The transfer of knowledge from older to younger actors does not only provide procedural instructions, but also helps farmers understand how to make practical decisions in response to changing pond conditions, fry survival rates, feed availability, and production risks. In this sense, experiential learning allows fish farmers to interpret field conditions, compare current situations with previous cultivation cycles, and choose management actions based on accumulated local knowledge. The ability to decide when to prepare ponds, how to manage water conditions, and how to respond to production constraints reflects the role of human capital as a decision-making resource rather than merely a stock of technical competence.

These capabilities are closely linked to the sustainability of fisheries enterprises in Holtekamp Village. Skills acquired through intergenerational learning and field experience help farmers maintain production continuity, minimize avoidable losses, and sustain aquaculture operations under limited-resource conditions. Because milkfish aquaculture in Holtekamp is still strongly dependent on local resource management and practical adaptation, the ability to make appropriate production decisions becomes crucial for maintaining business stability over time. In this context, intergenerational learning contributes to business sustainability by preserving locally relevant knowledge, strengthening farmers' capacity to manage risks, and ensuring that aquaculture practices can continue across generations. These findings support previous studies emphasizing that capacity development in small-scale fisheries enterprises is often built through local knowledge transmission, experiential learning, and continuous adaptation within community settings (Bush *et al.*, 2022; Kruijssen *et al.*, 2022). In addition to relying on inherited knowledge, fish farming communities in Holtekamp have also begun to demonstrate adaptive capabilities toward technological developments in aquaculture. One informant explained that “in the past, we were fully traditional, but now we already use probiotic mixtures and super fertilizers” (I2). This statement reflects a gradual transition from conventional cultivation practices toward the use of supporting production technologies considered more effective in improving growth and productivity. The use of probiotics and supplementary fertilizers indicates that human capital development in Holtekamp is not limited to preserving traditional knowledge, but also involves the ability to evaluate, adopt, and integrate new techniques into existing aquaculture practices.

This adaptive capacity is also visible in the perspectives of younger actors. One informant expressed that “maybe in the future AI can be integrated into aquaculture techniques to make things more efficient” (I3). Although such technology has not yet been implemented in practice, the statement reflects an openness toward innovation and a forward-looking orientation in local fisheries enterprises. This suggests that human capital in Holtekamp is dynamic rather than static, as it evolves through the interaction between inherited knowledge, practical experience, and responses to technological change. The coexistence of experiential learning and adaptive innovation indicates that the sustainability of aquaculture enterprises depends not only on preserving traditional capabilities but also on strengthening the capacity of fisheries actors to respond to new production challenges and opportunities. These findings are in line with studies by Naz *et al.* (2025) and Gudbrandsdottir *et al.* (2021), which argue that the long-term sustainability of aquaculture businesses is strongly influenced by the ability of business actors to adopt

innovation while maintaining effective resource management practices.

3. The Implementation of Blue Economy Principles

The implementation of blue economy principles within fisheries enterprises in Holtekamp Village can be understood through several operational indicators identified in this study, namely resource efficiency, environmentally responsible production practices, production value creation, and the sustainability of local fisheries livelihoods. These indicators were used as analytical references to examine how fish farming communities manage aquaculture resources, maintain production continuity, and respond to ecological constraints within milkfish farming activities. In the context of this study, resource efficiency refers to the use of locally available pond resources and production inputs in a manner that supports cultivation outcomes without excessive dependence on external inputs. Environmentally responsible production practices refer to cultivation efforts that seek to maintain pond fertility, water quality, and ecological balance during the production cycle. Production value creation refers to efforts to improve aquaculture output and operational effectiveness so that fisheries enterprises remain economically viable, while local livelihood sustainability refers to the capacity of aquaculture activities to continue supporting household income and community-based fisheries businesses over time. By using these indicators, blue economy in this study is understood not merely as an environmental concept, but as an integrated approach linking ecological management, efficient production, and the long-term sustainability of local fisheries enterprises.

Based on interview findings, one manifestation of blue economy principles in Holtekamp Village can be observed in the way fish farmers utilize natural resources within pond ecosystems as part of milkfish cultivation practices. Fish farmers continue to rely on naturally growing feed in the ponds as an initial nutritional source before adding supplementary inputs. One informant stated that “we wait until the natural feed grows first” (I2) before transferring the fry into the main production ponds. In addition, pond drying and the use of fertilizers are conducted to stimulate natural feed growth and maintain pond fertility prior to cultivation. These practices indicate an effort to optimize locally available ecological resources rather than relying entirely on artificial feed from the outset of production. In this sense, the implementation of blue economy principles in Holtekamp is reflected in resource efficiency through the use of natural pond productivity, while also showing an environmental orientation through the maintenance of pond conditions that support fish growth. This finding suggests that blue economy practices at the local level are closely linked to practical strategies for balancing production needs with the ecological functions of aquaculture ponds (Tacon & Metian, 2021; Garlock *et al.*, 2024).

Blue economy principles are also reflected in community efforts to improve cultivation efficiency in order to maintain the continuity of fisheries enterprises. Informants explained that probiotic materials and supporting production technologies have gradually been introduced to accelerate harvest cycles and improve production outcomes. One informant noted that “the important thing is how production can be harvested faster” (I3), indicating that production efficiency has become an important consideration in local aquaculture management. However, in the context of blue economy, production efficiency should not be interpreted solely as the acceleration of harvest or the maximization of output. Rather, efficiency must be understood in two interconnected dimensions. From the economic perspective, the use of probiotics, fertilizers, and more calculated input management can help improve productivity, shorten production cycles, reduce avoidable losses, and strengthen the economic viability of small-scale aquaculture businesses under conditions of rising operational costs. At the same time, from the environmental

perspective, the relevance of these practices depends on whether they support pond health, reduce excessive dependence on external inputs, and contribute to more controlled use of production materials without causing additional ecological pressure. Therefore, the implementation of blue economy principles in Holtekamp should be understood as a process of balancing economic efficiency with environmentally responsible aquaculture management, rather than equating higher productivity alone with ecological sustainability. This interpretation is consistent with the view that blue economy practices in small-scale aquaculture require the integration of business efficiency and ecological considerations in order to support long-term fisheries sustainability (Ahmed et al., 2022; Zavina et al., 2026).

In addition to production practices, the findings also indicate that fish farmers have begun to pay closer attention to operational calculation as part of their effort to maintain business continuity. Informants described the need to consider fuel expenditure, fertilizer use, and other production requirements as part of day-to-day business decisions. This suggests that blue economy practices in Holtekamp are also connected to value creation and local income sustainability, as farmers attempt to keep aquaculture operations financially feasible under increasingly constrained production conditions. In this context, blue economy is not only reflected in how natural resources are used, but also in how fisheries actors manage limited inputs in order to sustain household livelihoods and maintain the economic continuity of community-based aquaculture enterprises. On the other hand, the implementation of blue economy principles in Holtekamp Village also faces significant environmental constraints, particularly in relation to declining water quality and changing ecosystem conditions. Interview findings revealed that water quality has deteriorated due to waste originating from nearby settlements and environmental changes during the rainy season. One informant explained that “water quality has declined because waste from settlements enters during the rainy season” (I2). This statement was reinforced by a senior informant who noted that current cultivation conditions differ considerably from those experienced in previous years. According to the informant, “under normal conditions, harvesting usually took about three months, but now it can take five to six months because of pollution” (I1). These findings indicate that environmental degradation directly affects fish growth, lengthens the production cycle, increases operational risk, and weakens the economic stability of aquaculture businesses.

More importantly, this environmental problem needs to be understood as a critical inhibiting factor within the proposed blue economy-based human capital development model. The findings suggest that business sustainability in Holtekamp cannot be achieved only through experience-based cultivation skills or efforts to improve production efficiency. It also depends on the capacity of fisheries actors to recognize ecological risks, adapt cultivation practices to changing water conditions, and strengthen collective responses to environmental problems affecting aquaculture systems. In this sense, water pollution is not merely an external obstacle to production, but an empirical justification for why the proposed model must integrate environmental awareness, adaptive resource management, and community-based institutional coordination as part of human capital development. The blue economy model proposed in this study therefore rests on the assumption that the sustainability of milkfish aquaculture businesses requires the interaction of three interrelated capacities: the ability to manage resources efficiently, the ability to maintain ecological conditions that support production, and the ability to sustain local livelihoods under environmental and market pressures. This interpretation is in line with Lukman et al. (2021) and Bennett et al. (2021), who emphasize that blue economy practices require a balance among economic continuity, environmental sustainability, and

the protection of coastal resources. Overall, the findings show that the implementation of blue economy principles in Holtekamp Village is not expressed through a single practice, but through a set of interconnected efforts involving resource efficiency, operational calculation, environmental management, and livelihood sustainability. At the same time, the findings also reveal that the realization of blue economy remains constrained by ecological degradation and production vulnerability. This indicates that blue economy-based fisheries sustainability depends not only on technical cultivation practices, but also on the development of human capital capable of integrating economic decision-making, ecological awareness, and adaptive community-based management in local aquaculture enterprises.

4. Supporting and Inhibiting Factors

The sustainability of fisheries enterprises in Holtekamp Village is supported by a relatively organized community institutional system through fish farmer cooperatives. Based on interview findings, communities perceived that cooperatives facilitate business coordination, access to assistance programs, and collective management of aquaculture activities. One informant stated that “we are more organized because we have a clear institution and management structure” (I2). In addition, fish farmers are provided with opportunities to exchange experiences and information regarding cultivation techniques and production needs. A senior informant explained that relationships among fish farmers in the area remain strong because most community members have lived and worked together in fisheries activities for many years. This condition demonstrates that social capital and local institutional systems constitute important supporting factors for sustaining community fisheries enterprises. These findings are in line with studies by Filipinski *et al.* (2022) and Mufti *et al.* (2025), which explain that strengthening community organizations and collective work cultures can improve business management capacity within local resource-based communities.

Despite institutional support, communities continue to face constraints related to operational and production financing aspects. Interview findings revealed that the largest production costs arise from fuel requirements for water pumps, fertilizers, probiotic materials, and the procurement of fish fry from outside the region. One informant explained that “the water does not flow in naturally, so when the tide rises, we turn on the machine to pump seawater into the ponds” (I2). Fuel consumption is relatively high because during one production cycle, communities may require nearly one hundred liters of fuel for a single cultivation pond. In addition, informants stated that “sometimes we have to buy from retailers at prices above ten thousand rupiah” (I2) due to limited access to subsidized fuel. Nevertheless, communities have recently begun receiving government support through the provision of special barcodes that enable fish farmers to access subsidized fuel. These conditions indicate that the sustainability of aquaculture enterprises is strongly influenced by the stability of operational costs and government support for production facilities. These findings support the perspectives of Zavina *et al.* (2026) and Jaya (2026), which explain that production cost efficiency and energy access are essential factors in maintaining the sustainability of milkfish aquaculture enterprises.

In addition to production cost issues, another major challenge experienced by communities concerns changes in environmental quality within aquaculture systems. Interview findings revealed that water pollution and environmental changes have prolonged harvest periods compared to previous years. A senior informant explained that “normally it used to take around three months, but now it can reach five or six months” (I1). This condition is caused by declining water quality due to residential waste and

changes in water conditions during the rainy season. Another informant explained that aquaculture systems in Holtekamp remain highly dependent on natural environmental conditions, meaning that environmental changes directly affect fish growth in production ponds. Furthermore, several ponds have started experiencing structural damage and leakage, requiring substantial repair costs. This situation demonstrates that fisheries business sustainability is not determined solely by the economic capability of communities but is also strongly influenced by ecosystem stability and the environmental quality of coastal aquaculture areas. These findings are consistent with the studies of Garlock *et al.* (2024) and Samidja *et al.* (2021), which emphasize that sustainable aquaculture systems require a balance between economic productivity and environmental protection.

Regarding market and distribution aspects, fish farming communities also encounter challenges related to fluctuating fry prices and dependence on external marketing networks. Based on interview findings, fish fry or nener are still imported from Bali because local availability remains limited. One informant explained that “when we bring them here, one box contains fifty thousand fry” (I4), with prices reaching approximately five million rupiah per shipment. A collector informant also explained that fry prices often increase when export demand rises, as reflected in the statement that “when exports are booming, the prices also become higher” (I4). After harvest, most aquaculture products are sold directly to collectors without further processing. A junior informant explained that “the fish are simply collected and sold directly” (I3) because communities do not yet possess independent processing facilities. Moreover, local collectors continue to play an important role within the distribution chain of aquaculture products in Holtekamp. These conditions indicate that the sustainability of aquaculture enterprises remains influenced by dependence on external supply chains and limited development of local product value-added strategies. These findings support the studies of Sinafrin *et al.* (2026) and Ahmed *et al.* (2022), which explain that strengthening supply chains, market access, and product value-added development are important factors in improving the economic sustainability of coastal aquaculture enterprises.

5. Blue Economy-Based Human Capital Development Model

Based on the research findings, the human capital development model within fisheries enterprises in Holtekamp Village is not formed through a linear process but evolves through dynamic and interconnected relationships among local context, human capital formation, institutional support, blue economy practices, and business sustainability outcomes. The model was developed inductively from the main themes emerging from interviews, observations, and documentation, and therefore represents a conceptual synthesis of the empirical dynamics identified in Holtekamp Village rather than a prescriptive or universally generalizable framework. In this study, the model was derived from five interrelated thematic findings, namely the local context of fisheries enterprises, the process of human capital formation, the implementation of blue economy principles, the contextual factors enabling or constraining aquaculture development, and the sustainability outcomes experienced by fisheries actors. These themes were subsequently integrated into a blue economy-based human capital development model to explain how the sustainability of fisheries enterprises is shaped through the interaction of individual capacities, collective institutions, ecological conditions, and adaptive business practices. The model is visually presented in Figure 2 below.

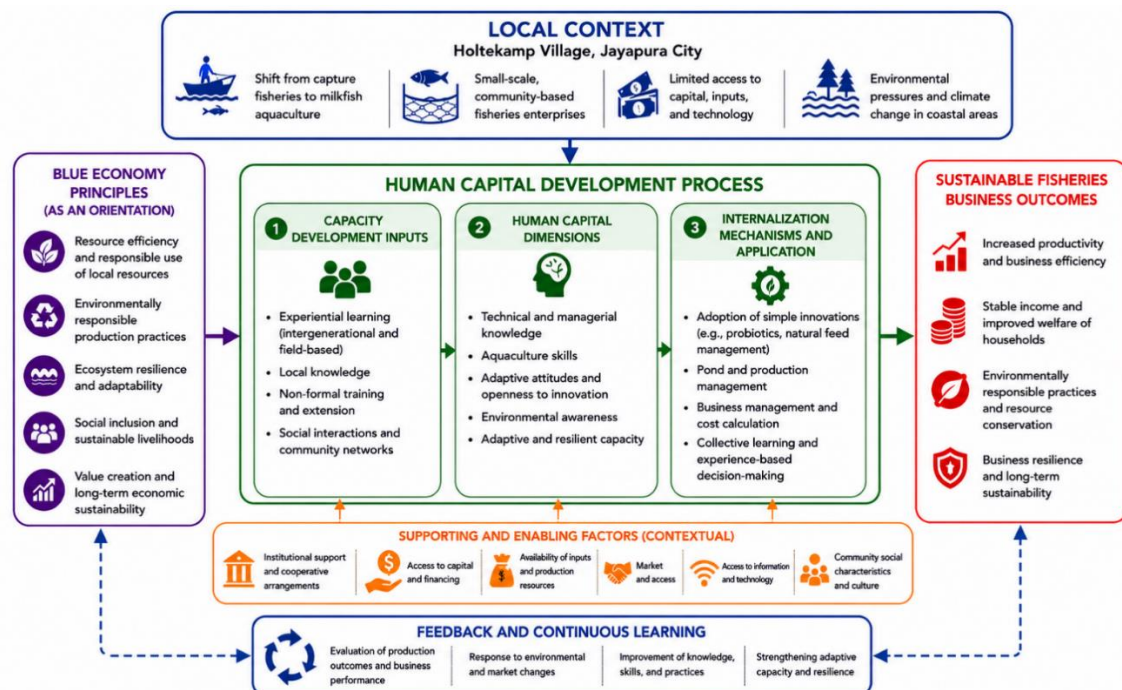


Figure 2. Blue Economy-Based Human Capital Development Model for the Sustainability of Fisheries Enterprises in Holtekamp Village, Jayapura City

Figure 2 illustrates that human capital development within fisheries enterprises in Holtekamp Village occurs through a process that is contextual, adaptive, and interconnected across multiple system components. The first component of the model is the local context, which was derived from findings showing that fisheries enterprises in Holtekamp are shaped by the transition from capture fisheries to milkfish aquaculture, the small-scale and community-based character of aquaculture activities, limited access to production inputs and supporting resources, and increasing environmental pressures in coastal areas. These contextual conditions were identified from interviews with fish farmers and the collector, who described aquaculture as a long-standing livelihood activity that continues under conditions of limited fry availability, dependence on external inputs, unstable production conditions, and environmental change. Thus, the local context in the model represents the structural environment within which human capital development takes place and within which fisheries actors continuously adapt their business practices. Furthermore, the process of human capital development in this model operates through three interconnected components, namely capacity development inputs, human capital dimensions, and internalization mechanisms within business practices. The component of capacity development inputs was derived from findings showing that fish farmers acquire and strengthen their capacities mainly through non-formal learning processes. Interview results indicate that aquaculture knowledge in Holtekamp is largely developed through intergenerational learning, practical field experience, observation of cultivation activities, local knowledge, and social interactions within community networks rather than through formal education alone. The findings also show that social relationships, mutual assistance, and collaboration among fish farmers contribute to the transfer of technical knowledge and business-related experience. For this reason, the model positions experiential learning, local knowledge, non-formal training, and community-based social interaction as the main inputs that initiate human capital formation in fisheries enterprises.

These inputs subsequently shape the human capital dimensions of fisheries actors. This component was formulated from recurring themes in the interview data indicating that human capital in Holtekamp is not limited to technical aquaculture ability, but also includes broader capacities that enable business adaptation and sustainability. The findings show that fish farmers gradually develop technical and managerial knowledge related to pond preparation, water management, feed practices, and business operations; practical aquaculture skills formed through repeated experience; adaptive attitudes toward innovation and efficiency; and awareness of environmental conditions affecting production. In addition, the interviews also reveal the importance of adaptive resilience, namely the capacity of fish farmers to continue operating under conditions of ecological uncertainty, changing input costs, and market pressures. Accordingly, the model conceptualizes human capital as a multidimensional construct consisting of knowledge, skills, attitudes, environmental awareness, and adaptive capacity that together shape the ability of fisheries actors to sustain aquaculture activities. The next component is internalization mechanisms and application, which was derived from findings showing that human capital only contributes to business sustainability when it is translated into actual cultivation and managerial practices. The interviews indicate that fish farmers internalize knowledge and skills through the adoption of simple innovations, routine pond management, collective learning, and experience-based decision-making. Practical examples include the use of probiotic mixtures and fertilizers, the management of pond preparation and fish growth cycles, the calculation of fuel and operational costs, and the sharing of knowledge among farmers regarding cultivation challenges. These findings indicate that human capital is not merely a stock of individual competencies, but becomes meaningful when it is embedded in everyday business practices, production decisions, and adaptive responses to constraints. Therefore, the model positions internalization as the mechanism through which capacity is transformed into business behavior, risk management, and operational adaptation.

Within this process, blue economy principles are not positioned as conditions that have been fully achieved, but rather as normative orientations that guide the direction of human capital development and fisheries business practices. This component was formulated from findings related to resource efficiency, environmentally responsible aquaculture practices, production continuity, and livelihood sustainability. Interview data show that fish farmers continue to utilize naturally growing feed in ponds, prepare ponds to stimulate natural productivity, and attempt to improve cultivation efficiency through more careful input management. However, the implementation of blue economy in Holtekamp remains partial and develops gradually depending on the adaptive capacity of fisheries actors and the structural limitations they encounter. Practices such as the use of natural feed, the effort to improve efficiency in the use of production inputs, and attention to environmental conditions reflect an ongoing process of blue economy internalization, although these practices have not yet reached an optimal level. For this reason, blue economy in the model is treated as an orienting framework that encourages efficient resource use, ecological awareness, and long-term livelihood sustainability rather than as a fully consolidated condition already achieved by the community. The model also positions supporting and enabling factors as contextual elements that may function either as drivers or as constraints in the human capital development process. This component was derived from findings showing that the effectiveness of human capital development depends not only on the capacities of individual actors but also on the structural conditions surrounding fisheries enterprises. Interviews and field observations indicate that

institutional support, access to capital and financing, availability of production inputs, market linkages, access to information and technology, and socio-cultural conditions within the community all influence the extent to which community capacities can be effectively implemented in business practices. In Holtekamp Village, cooperative arrangements, social coordination, and community relationships help support production and distribution processes, while limited access to fuel, rising input costs, and environmental degradation act as major constraints. Consequently, the model emphasizes that human capital development is structurally embedded and strongly shaped by the broader institutional, economic, and social systems in which fisheries actors operate.

The final component of the model is sustainable fisheries business outcomes, which represents the expected result of the interaction among local context, capacity development inputs, human capital dimensions, internalization mechanisms, blue economy orientation, and enabling factors. This component was derived from recurring findings indicating that business sustainability in Holtekamp is associated with the ability to maintain production continuity, improve operational efficiency, support household income, preserve environmentally responsible cultivation practices, and strengthen the long-term resilience of fisheries enterprises. Accordingly, the ultimate outcome of the model is not understood solely as higher productivity, but as the establishment of fisheries enterprises that are economically viable, socially supported, environmentally adaptive, and capable of withstanding external pressures over time. An important feature of the model is the inclusion of feedback and continuous learning, which reflects the finding that human capital development in fisheries enterprises is an ongoing and cyclical process rather than a one-directional sequence of stages. Interview findings indicate that fish farmers continuously evaluate cultivation outcomes, respond to changing pond conditions, adjust production practices, and refine their strategies based on experience. Evaluations of business performance, environmental change, and production constraints become sources of learning that feed back into the further development of knowledge, skills, and adaptive capacity. In this sense, sustainability is dynamic and continuously reproduced through repeated learning cycles in which fisheries actors reinterpret past experiences, modify current practices, and respond to new ecological and market challenges. Overall, the model developed in this study confirms that blue economy-based human capital development represents an adaptive, contextual, dynamic, and sustainability-oriented process. The model not only conceptually illustrates the relationships among local context, capacity development, human capital dimensions, internalization mechanisms, enabling factors, and sustainability outcomes, but also reflects the empirical realities identified in the field. More importantly, the model indicates that the sustainability of fisheries enterprises in Holtekamp cannot be explained solely by individual technical competence. Instead, it depends on the alignment among individual capacity, collective institutions, blue economy-oriented business practices, and adaptive capability in responding to environmental and market changes. Therefore, this model may serve both as an analytical framework for understanding community capacity development in small-scale fisheries enterprises and as a foundation for designing more contextual, adaptive, and sustainability-oriented empowerment policies and programs.

E. CONCLUSION

This study concludes that human capital development within milkfish aquaculture enterprises in Holtekamp Village emerges from the dynamic interaction between local ecological knowledge, practical field experience, community-based institutions, and the

adaptive capacity of fisheries actors in responding to technological, environmental, and market-related changes. Within this context, human capital is not merely an individual attribute, but evolves into a collective and socially embedded adaptive capacity that is continuously shaped through daily fisheries practices and community interactions. The findings indicate that intergenerational knowledge transfer, experiential learning in aquaculture activities, and intensive social interaction among fisheries actors constitute key mechanisms in strengthening technical competencies, managerial capabilities, environmental awareness, and adaptive attitudes toward changing aquaculture conditions. Furthermore, the implementation of blue economy principles is reflected in local efforts to improve resource efficiency, maintain production continuity, and gradually orient fisheries enterprises toward more sustainable and environmentally sensitive practices. However, these developments remain constrained by structural and ecological challenges, including environmental degradation, fluctuations in fry prices, limited access to capital and production inputs, and increasing operational costs, which collectively affect the resilience of aquaculture-based livelihoods. Based on these findings, this study develops a blue economy-based human capital development model that explains fisheries enterprise sustainability as an outcome of the interaction between local contextual conditions, capacity-building processes, multidimensional human capital, institutional support systems, and continuous learning mechanisms. This model suggests that the sustainability of fisheries enterprises cannot be adequately explained by technical skills or production capacity alone, but must also account for the extent to which human capital is embedded within supportive institutions, adaptive business practices, and ecological responsibility aligned with blue economy principles. Importantly, this proposed model should be understood as a context-specific and exploratory analytical framework rather than a universally generalizable explanation of fisheries sustainability.

From a practical perspective, the findings imply that fisheries development and community empowerment programs in coastal areas should extend beyond conventional technical training. Policy interventions need to simultaneously strengthen local institutions, improve access to financial capital and production inputs, enhance information flows, and promote environmentally responsible aquaculture practices. An integrated approach that links human resource development, institutional capacity, market accessibility, and environmental governance is therefore essential to support the long-term sustainability of small-scale fisheries enterprises. This study acknowledges several limitations that should be considered when interpreting the findings. First, the research was conducted in a single location, namely Holtekamp Village, meaning that the empirical findings are strongly influenced by specific socio-economic, institutional, and ecological conditions in this area. Second, the study involved a limited number of informants selected through purposive sampling, which is appropriate for in-depth qualitative inquiry but does not capture the full diversity of perspectives across broader fisheries communities. Consequently, the findings are not intended for statistical generalization, but rather for analytical generalization within a similar contextual setting.

Future research is encouraged to further examine and refine the proposed model through broader empirical applications and more diverse methodological approaches. In particular, mixed-methods studies combining qualitative exploration with quantitative testing are needed to validate the relationships between human capital development, blue economy implementation, institutional support, and fisheries enterprise sustainability. Comparative studies across different coastal and aquaculture settings are also recommended to assess the contextual robustness of the model under varying

environmental, market, and governance conditions. Additionally, future research may extend the model by incorporating variables such as governance quality, market integration, environmental risk exposure, and digital technology adoption to enhance its explanatory power and applicability in diverse fisheries development contexts.

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