

EMPOWERING FISH FARMERS: INTEGRATING HUMAN RESOURCE CAPACITY AND APPROPRIATE AQUACULTURE INNOVATION IN LUMAJANG REGENCY



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Abstract

This study aims to analyze the effectiveness of fish farmer empowerment strategies implemented by the Fish Farmer Group (Pokdakan) in Lumajang Regency, with a focus on strengthening human resources (HR) and applying appropriate fish farming technology. The approach used is descriptive qualitative, with data collection techniques including interviews, participatory observation, and documentation. Informants include the Head of the Fisheries Department, fisheries extension officers, and active members of the Pokdakan. The research findings indicate that empowerment strategies through technical training, continuous mentoring, and the utilization of innovative technologies such as circular ponds, aerators, and probiotics have a positive impact on enhancing HR capacity, cost efficiency, and business productivity. The application of appropriate aquaculture techniques has also successfully promoted technical independence among farmers and strengthened the institutional framework of the group. Additionally, market access and social networks among members have expanded, indicating improved competitiveness of aquaculture businesses. In conclusion, the empowerment strategies implemented are effective and have the potential to serve as a model for other regions, although equitable access to training and financial support for all groups remains necessary. Recommendations are provided to ensure future empowerment programs are more inclusive and sustainable.

Keywords: Empowerment, Human Resources, Fish Farming, Appropriate Technology

INTRODUCTION

The aquaculture sector is one of the strategic areas in local potential-based economic development, especially in rural areas such as Lumajang Regency. Amid challenges related to poverty alleviation, job creation, and food security enhancement, community groups such as the Fish Farmers' Group (Pokdakan) play a crucial role as drivers of community-based microeconomics. However, on-the-ground realities indicate that most Pokdakan groups in Lumajang have not yet been able to develop independently, whether in terms of production techniques, management, or institutional capacity. According to the Lumajang Regency Fisheries Department report (LKIP Dinkes, 2024), out of 334 registered Pokdakan, only a small portion are active and have high business productivity. The majority remain dependent on government assistance and face various issues, ranging from low human resource capacity, lack of technological literacy, to limited market access.

In this context, community empowerment strategies are a very important approach to overcoming this stagnation. Empowerment theory emphasizes the importance of increasing individual and collective capacity so that communities are able to control resources, make decisions, and build socio-economic empowerment independently. A community empowerment approach based on human resources and appropriate technology has proven to be an effective strategy in strengthening the position of community groups within the local economic value chain. For example, (Ridhotin & Ardini, 2022) demonstrate that digital marketing training and the implementation of automated feeding technology can enhance the efficiency and productivity of tilapia farming groups in East Java. This study highlights the importance of combining managerial capacity building with the application of simple technology to enhance group competitiveness. Research by (Pawirosumarto et al., 2017) supports these findings, revealing that solar-powered automatic feeding technology can reduce feed costs and simplify daily management, particularly in areas with limited access to electricity.

Furthermore, the development of digital-based systems and management software also shows great potential in improving the operational efficiency of farming groups. Rianto et al. (2023) in their study on the Smart Fishery system explain that the use of feed management and harvest scheduling software facilitates Pokdakan members in making data-driven decisions. Not only from a technical perspective, institutional and social aspects are also important considerations. (Anas et al., 2020; Huang, 2023; Ni Wayan Rismayanti et al., 2023) emphasize that intensive mentoring that includes digital literacy and strengthening the organizational structure of the group has a significant impact on improving the productivity and sustainability of Pokdakan. In the context of rural community empowerment, (Del Arco et al., 2021; Lapuz, 2023) demonstrate that continuous technical training, strengthening community participation, and utilizing simple technology can increase household income and promote overall economic independence.

Although the above studies have discussed the importance of technological innovation and training in the context of empowering farming communities, most are still partial and do not discuss the integration of the two within a comprehensive strategic framework. On the other hand, there are still few studies that evaluate empowerment strategies at the Pokdakan level using an integrated approach, particularly those that combine human resource training, the application of appropriate technology, and institutional

strengthening simultaneously in a local context such as in Lumajang. This is the basis for the importance of this study.

This study aims to analyze the effectiveness of Pokdakan empowerment strategies based on human resource strengthening and the application of appropriate fish farming technology in Lumajang District. The research focuses on three main areas: (1) how empowerment strategies are implemented by government agencies and technical partners toward Pokdakan, (2) to what extent human resource capacity building impacts group effectiveness, and (3) how the application of aquaculture technologies—such as circular ponds, biofloc, probiotics, and aerators—can enhance productivity and operational efficiency. With this approach, the study is expected to contribute theoretically to the development of literature on technology-based community empowerment in the fisheries sector, while also providing practical contributions as a basis for developing a sustainable and contextually appropriate empowerment model for Pokdakan.

REVIEW OF LITERATURE

The theoretical review in this study integrates three main perspectives supported by recent literature (2020–2025): Knowledge-Based View (KBV), Social Exchange Theory, and the organizational cultural contingency approach. First, based on the Knowledge-Based View (Grant, 1996), collective knowledge in farmer groups or fish farmer groups becomes a strategic asset that drives innovation and operational efficiency. In the context of empowerment, technical training such as feed management, probiotic use, and biofloc systems strengthens the knowledge capacity of Pokdakan members, as evidenced by Roy et al. (2021a), who showed that practice-based training significantly increased the adoption of aquaculture innovations among fish farmers in India. Similar findings were also reported by Ayuzar et al. (2025) in Aceh, where training in independent feed production was able to reduce dependence on commercial feed and increase business efficiency.

Second, Social Exchange Theory (Cropanzano & Mitchell, 2005) explains that active participation in knowledge sharing and collaboration is driven by trust, mutual respect, and reciprocal benefits. In the context of Pokdakan Lumajang, regular discussion forums and social networking among members create a conducive climate for social exchange, in line with the findings of Kencono et al. (2023), which emphasize the importance of fish health and environmental management training to build solidarity and collective awareness in reducing fish mortality. These social interactions not only strengthen technical capacity but also expand market access through collaboration with digital platforms such as eFishery, as observed by Sari et al. (2024).

Third, the organizational cultural contingency approach (Hartnell et al., 2019) asserts that empowerment strategies must be aligned with local characteristics, including communal values, social structures, and technological readiness. In rural areas such as Lumajang, “appropriate” aquaculture technologies—such as round ponds, simple aerators, and energy-efficient water circulation systems—are more effective when combined with institutional strengthening of groups and continuous mentoring by fisheries extension workers, as recommended by Sulistyono Rini (2025). This approach is also in line with the principles of community-based empowerment promoted by Del Arco et al. (2021), which emphasize the

importance of integrating technological innovation, digital literacy, and active community participation in achieving sustainable economic development.

By combining these three theoretical frameworks, this study is able to provide a holistic analysis of the effectiveness of Pokdakan empowerment—not only from a technical perspective, but also from the social, psychological, and institutional dimensions that underlie the sustainability of community-scale fisheries.

RESEARCH METHOD

This study uses a descriptive qualitative approach, which aims to describe in depth the empowerment strategies of fish farmers based on human resources (HR) and appropriate cultivation techniques in Lumajang Regency. The qualitative approach was chosen because it is able to holistically reveal the experiences, perspectives, and practices of fish farmers and the Fisheries Service as empowerment facilitators. According to (Pérez-Lombardini et al., 2023; Somah, 2013) this approach is effective for exploring social dynamics and local strategies in the development of farmer or fish farmer groups based on local potential.

The research location was set in the working area of the Lumajang District Fisheries Office, with the research subjects consisting of the head of the office, fisheries extension workers, and fish farmers who are members of the Fish Farmers Group (POKDAKAN). The sampling technique used was purposive sampling, considering criteria such as the farmers' level of activity, involvement in empowerment programs, and experience in adopting aquaculture technology. This method aligns with the findings of (Istyadji et al., 2023) who emphasize the importance of selecting informants based on their active roles in fisheries community empowerment activities.

Data collection techniques were conducted using triangulation methods, namely through in-depth interviews, participatory observation, and documentary studies. Semi-structured interviews were conducted with primary and additional informants to obtain rich and contextual data. Observations were used to understand the activities of farmers directly in a real context, and documentation was obtained from Fisheries Department reports, production statistics, and training and policy documents. This approach was also used by (Dirgantara, 2022; Sari et al., 2024) in examining empowerment strategies for fisheries cooperatives through training and product diversification.

The data obtained were analyzed using Miles and Huberman's interactive analysis technique, namely through the process of data reduction, data presentation, and conclusion drawing and verification. Data validity was tested through source triangulation, technique triangulation, and confirmation with informants (member check). According to (Ismail et al., 2023; Rajab et al., n.d.) the triangulation approach in qualitative research allows for the collection of valid data that reflects the complex social reality at the fisheries community level.

With this approach, the research is expected to reveal the effectiveness of empowerment strategies from various aspects, such as human resource capacity building, the application of appropriate technology, operational efficiency, and institutional strengthening. The participatory approach also enables the identification of local potential and structural constraints that influence the success of empowerment programs, as emphasized by (Bista &

Prakash, n.d.; Sulistyo Rini, 2025) in the context of empowering pond fish farmers through the role of extension workers.

RESULTS AND DISCUSSION

Based on the results of the study, the following data processing results were obtained:

Table 1.

Improvement of Human Resources (HR)

Informant Name	Finding
Sutrisno	Participated in cultivation and feeding training, which was easy to understand.
Zekki	Frequently participated in training, understood the use of probiotics.
Abdul Haris	Understood water management and round ponds.
Randa	Gained more insight after joining Pokdakan.
Extension worker	Provided training on feed management, disease, and biofloc.
Fisheries Agency	Held practical training, certification, and human resource strengthening programs.

Source: processed by researcher, 2025

The training provided by the Fisheries Service has improved the technical knowledge and skills of farmers. There has been an increase in awareness of modern techniques such as probiotics and biofloc.

Table 2.

Technical Independence of Cultivation

Informant Names	Findings
Sutrisno	Make your own fermented feed (EM4)
Reza	Be independent, sell fish yourself, use a generator
Zekki	Use CCTV and KJA, reduce feed when fish are sick
Abdul Haris	Use trash fish for feed, have a generator
Randa	Consult with extension workers for technical advice
Extension Workers	Encourage farmers to innovate independently
Fisheries Service	Facilitate access to KUR, training, and licensing

Source: processed by researcher, 2025

Technical independence has increased, as seen in the ability to create local solutions such as producing their own feed, using generators during power outages, and using CCTV for cultivation control.

Table 3.

Productivity of Cultivation Businesses

Informant Names	Findings
Sutrisno	Production increased after joining Pokdakan
Zekki	Production increased, nets became more efficient

Informant Names	Findings
Abdul Haris	Production and income increased
Randa	Production increased, fish mortality decreased
Extension worker	Appropriate technology reduced fish mortality
Fisheries Agency	Production increased by 20–30% based on evaluation

Source: processed by researcher, 2025

The adoption of appropriate technology boosts business productivity. Reduced mortality and feed efficiency are key to increasing crop yields.

Table 4.

Operational Efficiency and Production Costs

Informant Names	Findings
Sutrisno	Reduce feed costs
Zekki	Use upwelling and deep nets for efficiency
Abdul Haris	Change water more efficiently
Randa	Round ponds save water and land
Extension Workers	Probiotics and aerators increase efficiency
Fisheries Agency	Biofloc, round ponds, and RAS reduce production costs

Source: processed by researcher, 2025

Round pond techniques and biofloc systems have proven to be efficient in reducing water, electricity, and feed consumption. This supports the sustainability of small- to medium-scale businesses.

Table 5.

Institutional Strengthening and Cooperation

Informant Name	Findings
Zekki	Active in meetings and cooperation with eFishery
Abdul Haris	All members actively participate
Extension Worker	Group facilitation and routine licensing
Fisheries Service	Encourage Pokdakan as a representative institution
Reza	Less active; institutionalization is not yet evenly distributed

Source: processed by researcher, 2025

Active groups have strong institutional dynamics, but there are still passive Pokdakan groups. This indicates the need for more equitable assistance..

Table 6.

Market Access and Social Relations

Informant Name	Findings
Zekki	Expand your market via eFishery & market info
Abdul Haris	Build social connections and networks after joining
Randa	Feel the positive social impact

Informant Name	Findings
Sutrisno	The forum is a place for sharing and discussion
Extension Worker/Agency	Facilitate assistance, CSR, and access to local/export markets
Source: processed by researcher, 2025	
Social relations and marketing have grown significantly. Collaboration with digital platforms has opened up access to premium markets and expanded networks.	

Table 7.
Summary of Effectiveness Indicators

No	Indicators	Brief Explanation
1	Human Resource Internal Capacity Building	training and discussions improve technical knowledge and skills.
2	Technical Independence	Farmers are able to solve problems independently and innovate technically.
3	Business Productivity	Harvest yields increase, FCR decreases, mortality rates decline.
4	Operational Efficiency	Water, energy, and feed savings are achieved through simple technology.
5	Institutional Strengthening	Meetings and cooperation are active, although not yet evenly distributed.
6	Market Access & Social Relations	Business relationships grow, eFishery and CSR collaboration increases, and solidarity improves.

Source: processed by researcher, 2025

Based on the data above, the empowerment strategy for fish farmers implemented by Pokdakan in Lumajang Regency through human resource capacity building and the application of appropriate aquaculture technology has proven to have a significant impact on the effectiveness of the aquaculture businesses carried out by the community. The enhancement of HR capacity through technical training conducted by the Fisheries Department, covering aspects such as feed management, water quality, and pond management, has proven to improve farmers' competencies in running their businesses efficiently and sustainably. This aligns with the findings (Roy et al., 2021a) who studied training in Bihar, India, and found that practice-based training can enhance participants' knowledge and attitudes toward fish farming innovations. They used the Kirkpatrick evaluation model to measure its impact and concluded that the training had a significant effect on farmers' adoption of new technologies. In the context of Lumajang, informants such as (Roy et al., 2021b) stated that the training provided was highly practical and easy to understand, and could be directly applied in daily farming activities. They were able to produce fermented feed from local materials such as snails and small fish using EM4, which is a concrete example of innovation based on local resources to reduce production costs. This finding is supported by (Ayuzar et al., 2025) study in Lhokseumawe, Aceh, which showed that training in self-made feed production can reduce farmers' dependence on commercial feed and improve production efficiency.

Furthermore, strengthening the technical independence of farmers is an important indicator in a successful empowerment strategy. Informants in the study demonstrated their ability to overcome technical problems such as oxygen supply during power outages by using mini generators, as well as the use of CCTV to monitor pond conditions and fish behavior. This shows that farmers are able to identify problems and find solutions based on experience and available resources. This ability reflects the principles of community empowerment outlined by ("The Role of Community Empowerment in the Development of a Marketing Communication Strategy for Kembang Kuning Tourism Village," 2023) where empowered communities are those that can independently manage their businesses and resolve issues. Research by (Kenconoajati et al., 2023) also confirms that training in fish health management and environmental management can enhance farmers' understanding of the importance of water quality, early disease detection, and parasite control, all of which play a crucial role in reducing fish mortality. In Lumajang, farmers have implemented probiotics, aerators, and energy-efficient manual water circulation systems to maintain water quality while reducing previously high fish mortality rates.

In terms of productivity, the empowerment strategies implemented have successfully increased harvest yields, accelerated fish growth, and reduced feed conversion ratios (FCR). Fish production in some Pokdakan has increased by 20–30% after adopting appropriate technologies such as circular ponds, simple biofloc techniques, and the use of aerators and probiotics. In line with this, (Wonde et al., 2022) noted that post-training, there was a significant increase in the productivity of farmers in India who had previously faced challenges in business growth. The Lumajang Fisheries Department noted that operational efficiency also improved. Round ponds were found to be more land and water-efficient, while four-hole aerators could maintain dissolved oxygen levels within the optimal range (6–7 ppm). This innovation resulted in production cost savings of up to 20%, as also found in the research by (Wicaksono et al., 2025) which showed that the combination of biofloc and probiotic techniques can improve business efficiency and significantly reduce the risk of disease.

Institutionally, Pokdakan has shown positive development. Several active groups hold regular monthly meetings, document decisions in minutes, develop annual work plans, and keep simple financial records. Some groups have even begun collaborating with the private sector, such as eFishery, and have successfully marketed their products to a wider market, including local hotels and catering services. This increased market access has strengthened social relations among members and enhanced solidarity within the group. In this context, (Ssajakambwe et al., 2020) Collective Action theory is relevant, where collective economic incentives, such as increased selling prices for crops due to direct market access, serve as triggers for active member participation. This strategy not only generates economic benefits but also fosters a sense of ownership and shared responsibility in managing the Pokdakan.

From the above results, it can be concluded that the human resource-based empowerment and appropriate technology strategy in Lumajang has successfully created farmers who are not only more productive but also more independent, adaptive, and innovative. Improved technical skills, operational efficiency, institutional strengthening, and broader market access are indicators of the program's success. These findings are further supported by (Stacey et al., 2021) who state that investment in training for fisheries

businesses is a form of human capital investment that has long-term impacts on business sustainability, improved product quality, and increased income. Thus, the strategy implemented in Lumajang District can serve as a replicable model for other regions with similar characteristics in developing the aquaculture sector sustainably.

CONCLUSION

The empowerment strategy for fish farmers in Lumajang Regency through collaboration between the Fisheries Department and the Fish Farmers' Group (POKDAKAN) has proven to have a positive impact on enhancing the capacity and self-reliance of fish farming businesses. The approach, which focuses on strengthening human resources (HR) through technical training, as well as the application of appropriate fish farming technologies such as circular ponds, probiotics, aerators, and efficient water management systems, has increased productivity, reduced fish mortality rates, and lowered operational costs. Fish farmers are not only more skilled but also more independent in addressing technical issues and making business decisions. Internal forums within Pokdakan, such as regular meetings and discussions through social media groups, have become platforms for knowledge sharing, strengthening solidarity, and fostering a collective learning culture that accelerates innovation diffusion. However, the results of empowerment have not been evenly distributed across all groups; some farmers still face challenges in terms of access to training, limited initial capital, and digital literacy. In addition, external factors such as fluctuations in feed prices and market dependence on middlemen also pose obstacles to business development.

To address these challenges, the Fisheries Service needs to increase the coverage and intensity of training that reaches all Pokdakan members, including through a hybrid approach that combines face-to-face meetings and online learning based on short modules. Training materials need to be expanded to include not only technical aspects of aquaculture but also financial management, marketing strategies, and business digitalization. Successful Pokdakan groups can serve as model examples for inter-group mentoring programs. Local governments and the private sector are also encouraged to establish partnerships in providing business capital, aquaculture technology tools, and broader and fairer market access. Fisheries extension workers need to be encouraged to become active, adaptive mentors who understand the needs of farmers and master modern extension methods. With a more inclusive and collaborative strategy, it is hoped that the empowerment of fish farmers in Lumajang District can transform into a high-competitive, sustainable local economic development system that enhances the overall well-being of the fisheries community.

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