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Enhancing Fish Farmers' Income in Bekasi: Blue Economy and Digital Transformation with Penta Helix Support

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ABSTRACT

This research explores the role of Indonesia's blue economy in promoting sustainable development and economic growth, focusing specifically on the catfish industry. With increasing domestic and export demand, the catfish sector is positioned to capitalize on the opportunities presented by marine-based activities, such as fisheries and aquaculture. To maximize this potential, stakeholders must adopt digital transformation and implement a collaborative Penta-Helix model, which integrates government, academia, industry, community, and media. This study examines critical success factors for catfish entrepreneurs, highlighting how the Penta-Helix model can facilitate digital innovation and enhance income levels. Mixed method was employed in this research. By leveraging technologies like the Internet of Things (IoT), catfish producers can improve operational efficiency, optimize resource management, and expand market reach. Real-time monitoring of essential production factors, including water quality and feed consumption, enables more efficient resource utilization, reduced production costs, and improved product quality. The findings indicate that the synergy between digital transformation and the Penta-Helix model is vital for enhancing the competitive edge of catfish enterprises and fostering sustainable economic growth in Indonesia.

Keywords: Blue Economy; Digital Transformation; Penta helix; Fisheries Industry.

1.   **Introduction**

Indonesia, the world's largest archipelago, has 65% of its territory covered by seas, with 95% of its population residing within 100 kilometers of the coastline. Around 50 million Indonesians in coastal areas rely heavily on fisheries and marine resources for their livelihoods. As part of the Coral Triangle, Indonesia's waters are globally significant, harbouring 76% of all coral species and 37% of coral reef fish species. With vast marine resources, Indonesia holds immense potential in the Blue Economy, particularly in fisheries and ocean industries. Recognizing this, the government is committed to advancing the Blue Economy as a key engine of economic growth. To drive post-pandemic recovery, the "Blue Recovery" strategy focuses on enhancing productivity, adding value, and sustainably managing marine resources for long-term development. (Donesia, Widodo, Saragih, Suwarno, Widodo, 2023).

Indonesia, the world's largest archipelago, holds immense potential in the Blue Economy, particularly in its marine and fisheries sectors. The government aims to harness this potential for post-pandemic recovery, focusing on sustainable resource management while boosting productivity and value creation. (Bidayani, Reniati, Primbada, 2023). By integrating the Blue Economy with the UN's Sustainable Development Goals

(SDGs), Indonesia seeks to balance economic growth with environmental conservation. (Lee, Noh, Khim, 2019; Alharthi, Hanif, 2020)

Globally, sustainable management of marine resources is becoming a key focus, with the Blue Economy projected to be worth up to USD 9.8 trillion. If managed responsibly, these resources could yield significant environmental and economic benefits. In Indonesia, despite an overall economic growth of 5.05% in 2023, with a GDP per capita of USD 4,919.7, the fisheries sector faced a sharp decline of -17.70% in the fourth quarter, highlighting challenges that need to be addressed. (Silvestri, Morrone, Del Vecchio, Mele,2024; Pratama,2023).

To realize its full potential, Indonesia must ensure sustainable use of its marine resources, which will not only drive its economic growth but also contribute to global efforts in preserving the oceans. In discussions surrounding the Blue Economy, fisheries productivity is integral, as it significantly affects income growth. Digital transformation stands out as a crucial driver for improving governance and efficiency within the fisheries industry. It facilitates a more responsive and cohesive approach to understanding market demands. Fishery entrepreneurs can capitalize on e-marketplaces to sell both raw and processed products, thereby broadening their market access. (Sari & Muslimah,2020)

To fully realize the potential of the Blue Economy, environmentally sustainable practices in fisheries must be implemented equitably and supported by open access to labor, digital tools, creativity, and product innovation. (Martínez-Vázquez,Milán-García,Valenciano, 2021; Rini, Handy, Hidayah, 2021). This comprehensive approach will enhance the supply chain from production to distribution. (Elia, Indrajaya, 2022). Areas where digital transformation can foster innovation in the fisheries sector include:
1. **Fintech**: Using digital solutions to streamline financial management and bookkeeping.
2. **Innovative Technology**: Employing automated feeding and water quality monitoring systems to optimize fish farming operations.
3. **Digital Workforce**: Developing tech-savvy fish farmers to increase operational efficiency.
4. **E-commerce**: Utilizing online platforms to market aquaculture products, expanding sales channels.

Aquaculture in West Java far surpasses capture fisheries in output, with production reaching approximately 16,967,518.25 tons, compared to 7,248,410 tons from capture fisheries. Indonesia's aquaculture industry possesses immense potential, and Java ranks third in national production, following the islands of Sulawesi and Maluku-Papua. Given this prominence, it is vital to examine strategies for enhancing fish farmers' income on Java.

Achieving optimal outcomes in the aquaculture sector requires a coordinated effort among the five pillars of the Penta-Helix framework: society, government, private sector, media, and academia. Effective collaboration between these elements can lead to better utilization of natural and human resources, thereby bolstering regional economic growth. The media plays a pivotal role in this dynamic, serving as a vehicle for integrated marketing and communication to raise awareness and promote the industry.

The average fish consumption in Indonesia currently stands at 43.71 kg per capita annually, reaching only 92.8% of the national target. In contrast, the fish consumption rate in West Java is significantly lower, at just 31.14 kg per capita per year, falling below the national average. Fish, as a highly nutritious food, is suitable for all age groups due to its unsaturated fatty acids, which help mitigate risks of cholesterol and hypertension. It also provides essential amino acids, which are critical for human health yet cannot be synthesized by the body. The consumption of fish not only mirrors the economic status of a region but also plays a pivotal role in public health, intelligence, and overall societal well-being. By embracing digital innovation, the fisheries sector can significantly enhance economic and health outcomes, aligning with the broader objectives of the Blue Economy.

This study specifically underscores the abundance of fisheries and marine resources in Bekasi Regency, West Java, emphasizing its potential to contribute meaningfully to both local and national aquaculture advancement. This research seeks to address the following key questions:
a) Can digital transformation contribute to enhancing job opportunities and increasing the income of fish farmers?

b) What role does the Penta-Helix model play in promoting the sustainability of the fisheries industry within the framework of the Blue Economy?

2.   **Literature Review**

Penta Helix Model on Fisheries Industry

The Triple Helix and Quadruple Helix concepts were developed into Penta Helix, which uses several different helix elements to produce innovations (Renn, 2015). Penta Helix involves the role of government and non-government simultaneously in order to realize innovations for development in various sectors. It is a concept that involves five actors, including government, academics, business, community, and media (Sudiana, Sule, Soemaryani, and Yunizar, 2020). It indicates the presence of innovation in technology and knowledge along with good service activities and promotion in the form of regulations that will provide new changes through the implementation of sustainable innovations that have an impact on overall social development. Fisheries sector will have a competitive advantage if each of the elements involved can share skills, expertise, knowledge, and other resources that can support the process of sustainable development process. Penta Helix collaboration model is also used to provide resilience and sustainability in the fisheries industry in the future so that it is not destroyed when internal and external pressures occur (Prayoga, Rahmiati, Amin, Goenadhi, Hariri, 2024). The role of each Penta Helix component can be defined as:

1. **Government**

   The government is as a regulator and controller who has the responsibility to develop the business. It designing and determining the direction of policies, regulations, and strategies in macro and micro levels; providing and developing tourism infrastructure and public facilities; encouraging investment in tourism sector; developing and protecting MSMEs in the fisheries business sector. The government also has a role in coordinating stakeholders who contribute to the development and environmental sustainability
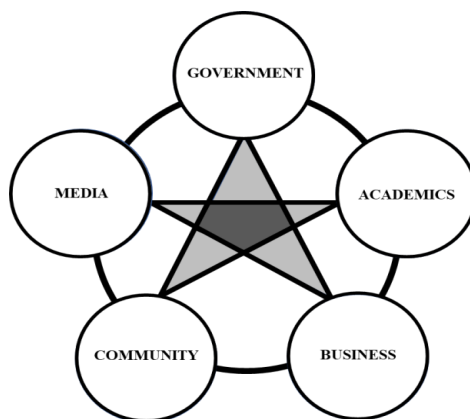

Figure 2. 1 Penta Helix Model

2. **Academia**

   Academia on the Penta Helix model serve as conception. Their responsibilities include assessing the direction of policies, regulations, and strategies through scientific studies; providing policy input based on studies conducted; providing data and information related to the fisheries sector; implementing training and development to create skilled human resources; and conducting socialization to society. They have responsibility to prepare competent, skilled, and certified future leader that have impact on this industry.

3. **Business**

   Business on the Penta Helix model acts as an enabler. The private sector is an entity that carries out business processes in creating added value and maintaining sustainable growth. The Private Sector can act as an enabler of delivering technology and capital infrastructure through Corporate Social Responsibility (CSR) and other programs. Business sector is also responsible providing assistance

in the form of goods or services for fisheries development; creating jobs for local communities; optimizing the use of technology in business implementation; and adjusting the implementation of business according to health standards.

4. Community

The community acts as an accelerator. The community play a role in monitoring the impact of fisheries sector on society and culture; engaging in planning, decision making, and evaluation; directly involved in the maintenance; exploring and developing local culture or products; and maintaining and implementing healthy products.

5. Media

The media acts as an expender. Media has a role to become a promoter, distribution of information, and image for fisheries development.

Synergy

Umiyati and Tamrin (2021) defined synergy as the combination of some stakeholders to gain better result. Good synergy between stakeholders and the participation community will reduce the level of conflict between Penta Helix actors in the sustainability development. It can be achieved through excellent communication, coordination, trust, and innovation between related parties.

Blue Economy

The concept of the blue economy has gained increasing attention as a driver of sustainable development, particularly in maritime nations like Indonesia. (Nasution, 2022) A blue economy seeks to harmonize economic growth with the sustainable management of marine resources, promoting activities such as aquaculture and fisheries that support livelihoods without degrading ecosystems. In this context, digital transformation plays a crucial role, offering technological solutions to improve efficiencies in aquaculture practices. Fish farmers in Bekasi Regency, particularly those engaged in the cultivation of freshwater species like catfish (Patin), are well-positioned to benefit from these advancements, leveraging digital tools to enhance productivity and income.

The Role of Digital Tools in Enhancing Aquaculture.

Digital transformation encompasses a wide array of technologies such as the Internet of Things (IoT), data analytics, and e-commerce platforms that can revolutionize the fish farming industry. For instance, IoT sensors can monitor water quality, temperature, and feed consumption in real-time, allowing farmers to make data-driven decisions to optimize production. Moreover, digital marketing strategies, through social media and e-commerce, expand market reach, enabling farmers to access consumers both locally and internationally. These tools not only streamline operations but also enhance profitability by reducing waste, improving fish health, and expanding market access. (Dewi, Havidz, Atmaja, Firmansyah, 2022)

3. Research Method

To achieve its goals, this research employs a mixed-method approach, integrating both qualitative and quantitative strategies. The qualitative approach is utilized to gather preliminary data on the village's potential, develop hypotheses, and design instruments for quantitative measurement. Methods such as participatory observation, in-depth interviews, and surveys will be employed for the qualitative data collection. In parallel, the quantitative approach will involve the use of structured questionnaires and comprehensive data analysis, supported by secondary data to enhance the robustness of the findings.

The initial anticipated outcome of this research is the mapping and thorough assessment of the fisheries potential among fish farmers in Bekasi Regency, West Java. Subsequently, tailored training programs will be designed to address the specific needs and characteristics of the research partners, particularly the Rizki Berkah Barokah fish farming group. Drawing from this data, the goal is to develop a digital transformation model aimed at boosting income and contributing to the local economy.

In the next phase, the developed digital transformation model and the strengthened community capacity will be implemented. A quantitative analysis will then be carried out to evaluate the impact of the digital transformation strategy on the growth and sustainability of the Rizki Berkah Barokah fish farming group in Bekasi Regency, West Java.

4. **Results and Discussion**

Mr. Haryono recognized the potential of fish ponds in East Bekasi and started a fish farming business with partners Mr. Salimin, Mr. Robet, and Mr. Aci, raising Rp 20 million (Rp 5 million each) to buy catfish fingerlings and pellets. However, a drought in the fifth month limited growth, resulting in a harvest of only 2 tons of catfish, which sold for Rp 20 million, leading to a loss of Rp 1 million. Despite this setback, Mr. Haryono remained committed to the business while his partners opted out, allowing him to expand from one pond to twelve. He balanced farming with other activities and improved management by adopting digital marketing strategies, which could significantly increase the profitability of his fish pond business, currently relying on middlemen to sell the fish in Jakarta.

Mr. Haryono has effectively sold his catfish, achieving decent profits; however, his limited workforce has hindered the diversification of marketing strategies and the implementation of digital transformation. To advance in this area, he would need to hire additional local workers.

The adoption of digital technologies can significantly boost fish farmers' incomes by enabling automation and precision farming through the Internet of Things (IoT), which enhances monitoring efficiency, reduces labor costs, and minimizes traditional farming risks. Furthermore, leveraging digital platforms allows farmers to engage directly with consumers, bypassing intermediaries and securing better prices.

This digital shift not only increases profitability but also generates new employment opportunities in tech-driven aquaculture services such as IT support, data management, and digital marketing. As demand for skilled workers in these areas grows, it fosters economic diversification in rural regions. Ultimately, as fish farming expands with digital innovations, it can drive local economic growth and support Indonesia's sustainable development objectives within the blue economy framework.

Digital transformation aligns with the goals of the blue economy by promoting sustainable and efficient use of aquatic resources. By leveraging digital tools, fish farmers in Bekasi can improve their environmental footprint, reducing waste and optimizing resource usage such as water and feed. This aligns with the blue economy's principles of maintaining ecological balance while promoting economic growth. As the demand for sustainably farmed fish increases, particularly in export markets, fish farmers who adopt digital practices will be better positioned to capitalize on these trends, contributing to Indonesia's overall blue economy strategy.

The Penta-Helix model is a collaborative framework that integrates five critical sectors—government, industry, academia, community, and media—to promote the achievement of sustainable development goals (SDGs). This model aims to facilitate inclusive innovation by leveraging the distinct strengths of each sector to address intricate societal issues. Within the context of fish farming, the Penta-Helix model can aid in the adoption of digital technologies by encouraging the sharing of knowledge, resources, and expertise.

Government agencies can implement essential policies and provide funding to support digital transformation, while academic institutions offer crucial research and development support. Industry players contribute innovative technological solutions, and active community engagement is vital for the effective integration of these advancements. Additionally, the media plays a key role in highlighting best practices and increasing awareness of the benefits of digital transformation in the blue economy.

Indonesia's blue economy has emerged as a crucial catalyst for sustainable development and economic growth, particularly within the marine sectors, including fisheries and aquaculture. The catfish industry, responding to rising domestic and international demand, has become a key player in this landscape. To maximize the opportunities afforded by the blue economy, stakeholders in the catfish sector must harness digital transformation and adopt a collaborative Penta-Helix model, which integrates government, academia, industry, community, and media.

This research paper explores the essential success factors for catfish entrepreneurs in Indonesia, emphasizing the Penta-Helix model's role in driving digital innovation and enhancing income levels. By

leveraging digital technologies like the Internet of Things (IoT), catfish businesses can improve operational efficiency, optimize resource management, and broaden their market reach. The integration of IoT facilitates real-time monitoring of production variables, leading to reduced costs and improved product quality, thereby bolstering competitiveness.

Furthermore, an entrepreneurial mindset, combined with digital capabilities, allows small-scale fishers to maintain a sustainable competitive advantage. The collaborative nature of the Penta-Helix model enables catfish businesses to access diverse resources, knowledge, and support, enhancing their long-term viability. The government can provide policy frameworks and funding, while academic institutions contribute research and innovation. Industry players share best practices, communities offer consumer insights, and media promotes industry achievements.

Digital transformation also enhances marketing and distribution through e-commerce platforms, allowing producers to reach wider audiences and gain insights into market trends. Successful implementation of this model requires coordinated efforts among all stakeholders to address challenges and seize opportunities. (Puspitasari, Chasanah, Wardhani, 2022)

In summary, by leveraging the synergistic potential of the Penta-Helix model and embracing digital transformation, catfish entrepreneurs can significantly improve their competitiveness, operational efficiency, and income. This collaborative approach not only fosters sustainable development within the blue economy but also positions catfish businesses for long-term success in an increasingly digital marketplace.

Figure 2.2. Focus Group Discussion

Figure 2.3. Interview and Observation
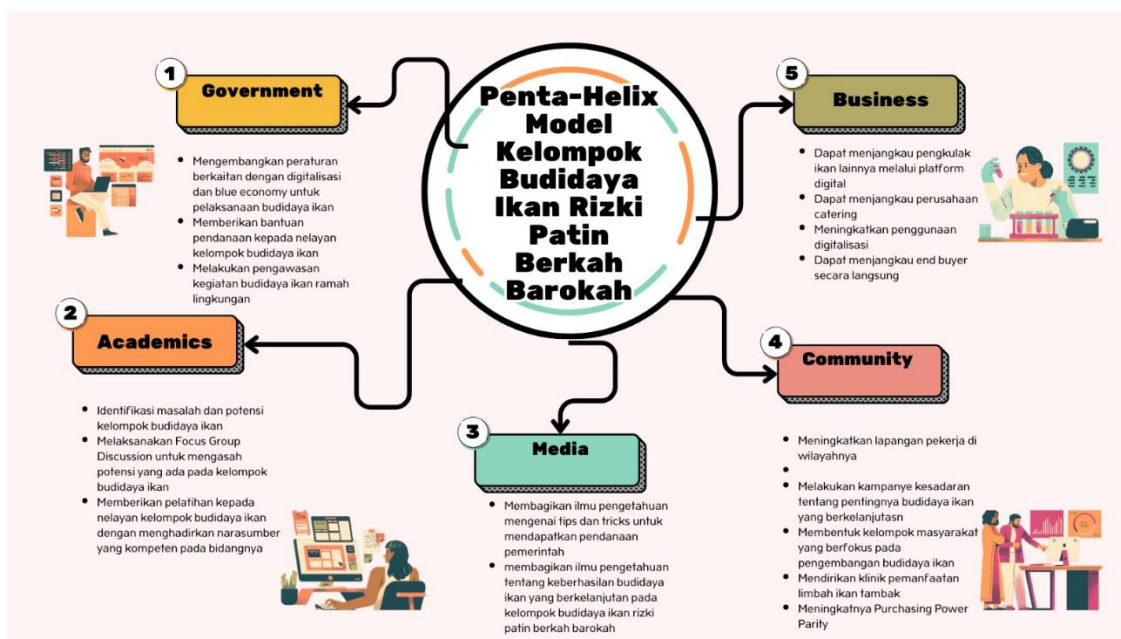

Figure 2.4. Fish farmers

Figure 2.5. Penta helix

5.   **Conclusion and Implications**

The integration of the blue economy with digital transformation offers significant opportunities for fish farmers in Bekasi Regency to enhance their income and operational efficiency. By adopting digital technologies such as the Internet of Things (IoT), e-commerce platforms, and data analytics, farmers can optimize production processes, reduce costs, and expand their market access. This alignment with the principles of sustainability positions them to meet the growing demand for sustainable aquaculture products while contributing to Indonesia's economic and environmental goals.

The Penta-Helix model serves as a collaborative framework that involves five key stakeholders—government, academia, industry, communities, and media—to facilitate this digital transformation. It ensures that fish farmers receive essential policy support, training, and technological resources needed for effective implementation. The collective engagement of these stakeholders fosters innovation and creates an environment conducive to growth, enhancing farmers' competitive advantage and profitability.

Moreover, embracing digital transformation within the blue economy not only improves operational efficiency but also promotes long-term sustainability. By optimizing resource use and enhancing product quality, digital technologies align fish farming practices with environmental conservation objectives. With continued support from the Penta-Helix model, fish farmers in Bekasi can overcome challenges related to digital literacy and infrastructure, ultimately driving economic growth, job creation, and sustainable development in the region.

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