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Scalable and Sustainable Shrimp Farming Strategies for SMEs in the Philippines

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Abstract

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Shrimp aquaculture is one of the most valuable sectors of the Philippine fisheries industry that plays a crucial role in food security, employment, and export earnings. However, despite high demand both internationally and domestically, the industry keeps dealing with persistent challenges such as disease outbreaks, limited access to technology, high production costs, and inadequate institutional support. These issues limit the competitiveness of Philippine shrimp producers compared with aquaculture countries like Vietnam, Bangladesh, and China. This research seeks to investigate how small and medium-sized enterprises in the Philippine shrimp aquaculture sector can achieve global competitiveness through scalable and sustainable business strategies. A qualitative secondary data design was used, drawing information from credible sources, institutional reports, academic publications, and comparative studies of successful shrimp farming models in other Asian countries. The data were analyzed thematically and through comparative and SWOT analysis to identify key drivers of sustainability factors in regional counterparts. The study finds that aligning value-chain competitiveness with sustainability principles and institutional support can help strengthen Philippine shrimp farming SMEs, although achieving sustained competitiveness will depend on consistent policy implementation and coordinated industry efforts. In line with this, the recommendations highlight the significance of public-private collaboration, increased access to sustainable technologies, and stronger policy integration as viable ways for long-term sectoral development.

Keywords: Shrimp Aquaculture, SMEs, Sustainability, Philippines, Competitiveness

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Contents

Glossary

ASC	Aquaculture Stewardship Council
ASEAN	Association of Southeast Asian Nations
BAFS	Bureau of Agriculture and Fisheries Standards
BAP	Best Aquaculture Practices
BFAR	Bureau of Fisheries and Aquatic Resources
BFT	Biofloc Technology
DENR	Department of Environment and Natural Resources
DTI	Department of Trade and Industry
ECC	Environmental Compliance Certificate
EIA	Environmental Impact Assessment
EHP	Enterocytozoon Hepatopenaei
EMS	Early Mortality Syndrome
EU	European Union
FAO	Food and Agriculture Organization
FEWC	Food-Energy-Water-Carbon
GDP	Gross Domestic Product
IHHNV	Infectious Hypodermal and Hematopoietic Necrosis

IMTA	Integrated Multi-Trophic Aquaculture
NGO	Non-Governmental Organization
PCAARRD	Philippine Council for Agriculture, Aquatic, and Natural Resources Research and Development
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
SDG	Sustainable Development Goals
SEAFDEC	Southeast Asian Fisheries Development Centre
SME	Small and Medium Enterprises
SWOT	Strengths, Weaknesses, Opportunities, and Threats
UNDP	United Nations Development Program
VASEP	Vietnam Association of Seafood Exporters and Producers
WSSV	White Spot Syndrome Virus
WTO	World Trade Organization

1 Introduction

The Philippines is an archipelago where shrimp farming is a lucrative business that aligns well with the country's overall conditions. However, despite the country’s potential for aquaculture and geographic advantages, local shrimp farmers still face several challenges that hinder their ability to achieve sustainability, competitiveness, and scalability.

For developing countries in Asia, such as the Philippines, Small and Medium Enterprises (SMEs) are very important because they have a great contribution to the economy and social well-being by creating jobs, empowering local communities, and some are also fostering sustainable practices. SMEs play an important role in the Philippine economy, reflecting their importance in both global and regional contexts. Globally, SMEs represent over 90 percent of the businesses, and they contribute more than half of employment and GDP in many economies (WTO, 2016: 6). In the Philippines, this role is even more noticeable as SMEs make up 99.5 percent of all the registered firms and they employ more than 63 percent of the national workforce (United Nations Development Program, 2020: 3). They are widely seen as engines of inclusive growth, poverty reduction, and innovation, especially in rural and coastal communities or areas where aquaculture is more concentrated. However, despite their scale and significance, they often face barriers such as limited access to financing, insufficient infrastructure, and weak integration into global value chains. For shrimp aquaculture SMEs in particular, these barriers can be interpreted as higher production costs, limited adoption of new technologies, and restricted access to export markets. For that reason, strengthening SMEs is not only critical for employment and livelihood security but also for ensuring competitiveness and sustainability of the Philippine shrimp aquaculture industry because they offer a more balanced approach, integrating production with community benefit and providing a pathway to higher incomes for local farmers.

As the population and demand for shrimp increase locally and globally, the need for sustainable shrimp farming becomes more critical. Yet, this growth

must be managed carefully to avoid repeating the ecological and social problems that have been seen in the past. While various Philippine government agencies have made efforts to support shrimp farming through hatcheries and technical programs, the country continues to lag behind regional competitors, such as Vietnam, Thailand, and China, in terms of scale, efficiency, and sustainability.

1.1 Statement of the Problem

This thesis explains how small and medium-sized shrimp producers in the Philippines can enhance their competitiveness and sustainability in a more globalized environment. While the focus remains on the Philippine industry, comparative experiences in Southeast and South Asia are considered. This includes countries like Vietnam, Bangladesh, and China, which will be used to identify practical strategies and policy recommendations. This is aimed at promoting the goals of environmental protection, inclusive aquaculture development, and national growth through the application of best global practices while maintaining a business-oriented approach. The proposal combines environmental management and regulation elements, which drive entrepreneurship and guide national policy debate related to the sustainability of rural aquaculture. In doing so, it addresses the following question:

How can the Philippines develop scalable and sustainable shrimp farming strategies for SMEs by adapting best practices from Vietnam, Bangladesh, and China?

1.2 Research Objectives

This study aims to determine how small and medium sized shrimp producers in the Philippines can enhance their competitiveness and sustainability within a globalized aquaculture industry. To achieve this, the research focuses on both broad and specific objectives that guide the analysis and ensure that the study remains aligned with its main question: How can the Philippines develop

scalable and sustainable shrimp farming strategies for SMEs by adapting best practices from Vietnam, Bangladesh, and China?

The general objective is to examine how Philippine shrimp aquaculture SMEs can achieve global competitiveness and sustainability through technological innovation, community-based systems, and institutional support. Specifically, it seeks to analyze global best practices in shrimp aquaculture (Vietnam, Bangladesh, and China); identify barriers facing Philippine SMEs; explore feasible business model opportunities; and recommend policy and market strategies that integrate sustainability and competitiveness.

1.3 Significance of the study

This research attempts to provide an answer to a question of growing importance to many critical purposes. To begin with, demand for shrimp continues to grow both domestically in the Philippines and globally. Shrimp is a valuable seafood product and contributes significantly to global seafood consumption. Despite the growing demand, it can be observed that many Philippine shrimp farmers continue to experience challenges that are not enabling them to compete competitively with neighbors from countries such as Thailand and Vietnam. Those nations have much more efficient shrimp farming industries, which are a result of better infrastructure, enhanced farming technology, and government support (FAO, 2024). As such, the Philippines lags in meeting market demand, with lost potential for economic gains from shrimp exports. Second, shrimp culture has been associated for decades with serious ecological problems. Unsustainable and improperly managed aquaculture has led to the destruction of essential coastal ecosystems, particularly mangrove forests. Intensive shrimp culture has been demonstrated to lead to water pollution, habitat loss, and soil erosion (Primavera, 2005). These environmental impacts not only threaten biodiversity but also compromise the long-term sustainability of shrimp culture itself. It is therefore critical to resolve these environmental issues through sustainable production. Lastly, there is an urgent

need to conceptualize and develop farming systems that enhance the capabilities of local shrimp farmers. These systems must be scalable, user-friendly, and cost-effective to be accessed on a large scale by small to medium-scale producers who typically do not have access to substantial capital. This research aims to support business growth and discussion about sustainable shrimp farming in the country.

This study supports the country's national development goals, particularly those outlined in the Philippine Development Plan 2023-2028 and the ASEAN Blue Economy Framework, which emphasize inclusive growth, environmental sustainability, and innovation in marine-based industries. By analyzing the factors that influence the competitiveness and sustainability of SMEs in shrimp aquaculture, this research contributes to understanding how the sector can generate rural employment, strengthen food supply, and promote environmentally responsible aquaculture practices.

Furthermore, the study adds value to policy development and industry strategies by identifying pathways to balance profitability with ecological stewardship. The findings may assist government agencies such as the Bureau of Fisheries and Aquatic Resources and the Department of Trade and Industry in making targeted programs related to enhancing SME participation, promoting innovation, and aligning with the Sustainable Development Goals, particularly SDG 2 (Zero Hunger), SDG 8 (Decent Work and Economic Growth), and SDG 14 (Life Below Water).

1.4 Scope and Delimitation

This study focuses on the shrimp aquaculture sector in the Philippines, specifically small and medium-sized enterprises. It draws from secondary data, which includes peer-reviewed journals, government reports, and international case studies, to analyze the challenges and opportunities facing the sector. Comparative insights are derived from Vietnam, Bangladesh, and China to highlight lessons relevant to Philippine SMEs. Focusing on SMEs as they

represent the majority of shrimp producers in the country and are essential to rural economic development due to their role in employment generation and local food production. The study examines three core dimensions: technology adoption, community-based knowledge systems, and institutional and policy support, with sustainability integrated as a cross-cutting theme.

The study is limited to a secondary analysis and does not include primary surveys or interviews with stakeholders. It focuses exclusively on shrimp aquaculture and excludes other aquaculture species such as milkfish or tilapia. Large-scale corporate aquaculture operations are outside the scope, as the emphasis is on SME. The study primarily addresses farm-level production and upstream value chain concerns, with a lesser focus on consumer behavior and retail-level marketing.

2 Literature Review

This chapter examines existing studies and theoretical discussions surrounding sustainable aquaculture and the role of small and medium enterprises in the shrimp industry. It reviews both international and Philippine literature to understand how environmental, technological, and policy factors influence competitiveness. The review is organized into key themes that connect sustainability principles, business models and institutional frameworks that forms the foundation of the present research.

2.1 Global Overview of Shrimp Aquaculture

Seafood businesses are sought after by the market, and a big part of it is shrimp farming, even though it might not look that way. According to the Food and Agriculture Organization (2024: 96), shrimp comprises over 17% of the world’s aquaculture trade. This means that a significant amount of buying and selling occurs with shrimp.

Shrimp aquaculture is one of the fastest-growing segments of the global seafood production, with output steadily increasing over the past three decades. According to the Food and Agriculture Organization (2025: 5), global farmed shrimp production is projected to reach approximately 6 million tons, reflecting consistent growth driven by rising consumer demand and advancements in farming technologies. However, the global shrimp trade has been unpredictable due to a lot of reasons, such as disease, and the most recent one is due to tariffs imposed by the US and other countries. In Europe, shrimp imports remained relatively stable, with countries such as Spain, France, and Germany showing growth despite broader market uncertainty. This shows that the global shrimp trade is increasingly influenced by tariffs, seasonal production, and shifts in consumer demand rather than just production capacity alone.

Aquaculture is growing, and this growth is good for food security, but it also creates problems such as habitat loss, water pollution, and competition for land and water. A recent global assessment using the Food-Energy-Water-Carbon (FEWC) nexus approach shows that aquaculture systems worldwide score low on sustainability with an average composite index of only 26 out of 100 (Jiang et al., 2022). The study found that developing countries, which produce almost 90% of farmed seafood, account for the largest share of water consumption, energy use, and greenhouse gas emissions. These findings highlight that while aquaculture is essential to meet demand, it also puts pressure on natural resources. Addressing these challenges needs integrated strategies rather than focusing on production volume. Subasinghe, Soto, and Jia (2009) explain that to make aquaculture sustainable, farmers should be involved in decision-making, follow good management practices, and work with governments to protect the environment.

2.2 Comparative Case Studies

Aquaculture of shrimp is a key sector of Asia’s economies, and Bangladesh, China, and Vietnam each have their own approaches to addressing disease management, environmental sustainability, and smallholder participation.

2.2.1 Bangladesh

In Bangladesh, smallholder shrimp farming is more extensive, which is based on traditional ecological knowledge. According to Paul and Vogl (2011), even though farmers operate in conditions of limited resources, they employ social networks and local system knowledge to maintain productivity. For example, a recent study in the Southwestern Region of Bangladesh shows that shrimp farmers utilize indigenous ecological knowledge, which is transmitted orally through generations, to manage almost every aspect of their farm operations, from pond preparation to disease management, even with limited technical or formal institutional support (Rahman, Hasnat, and Mithen, 2023). Such bottom-up strategies compensate, to some extent, for limited state support and technical resources. It confirms that, despite resource constraints, extensive shrimp farmers rely on local traditions to maintain productivity. The Philippine case, with its similar high concentration of smallholders with limited access to formal training and infrastructure, could also gain from similar community-centered knowledge-exchange mechanisms and farmer cooperatives.

2.2.2 China

Shrimp aquaculture in China has experienced rapid expansion, particularly near the coast. However, as Biao and Kajin (2007) illustrate, this expansion was followed by numerous severe environmental problems, including mangrove degradation, wastewater pollution, and irregular disease outbreaks resulting from pond overcrowding and unregulated activity. Another study by Chang et al. (2023) evaluated the ecological footprint of different culture modes for Penaeus vannamei in northern China. Their results showed that the factory-based intensive systems produce a significantly higher environmental impact compared with pond-based systems, and this is mostly because of the energy use and waste generation. However, integrated models, such as multi-trophic pond aquaculture, demonstrate improved resource efficiency and a lower ecological footprint, as noted by Chen et al. (2020). China’s transition toward

integrated multi-trophic aquaculture (IMTA) represents a significant shift toward environmental recovery, as it enables nutrient recycling and reduces pollution.

Although China eventually adopted stricter environmental controls, this only occurred after significant ecological deterioration had taken place. China's ability to integrate regulation, innovation, and scale has established it as a leader in global aquaculture production. Its experience highlights both the opportunities and the risks of intensification, showing that uncontrolled shrimp growth can cause costly and long-lasting damage, but also emphasizing the importance of environmental regulation, technological innovation, and long-term planning in sustaining shrimp aquaculture growth.

2.2.3 Vietnam

Vietnam is one of the leading exporters in the world, and one reason is its supportive government and integration into international markets. The Vietnamese government has provided long-term policies and investments in infrastructure, farmer training, and disease monitoring, which have enabled producers to scale productivity (Nguyen, Nguyen, Jolly, 2019). These measures allowed Vietnam to expand production, improve quality control, and strengthen its position in export markets. Recent initiatives in Vietnam province in Ca Mau have accelerated certification efforts to improve export value and ensure compliance with eco-label requirements (VASEP, 2025).

However, not all evidence is fully supportive of the effectiveness of certification. A study by Watanabe and Ubukata (2023) found that international environmental certification in southern Vietnam had a limited influence on local production practices and only partially affected trade behaviors. This occurred because local shrimp farmers operate in unique environments and informal markets where certification standards do not always align well. This indicates that Vietnam's approach to certification and policy has been successful at some level, but its local adoption still depends on the social and economic resilience of farming communities. The Philippines has support, but it is not particularly

strong, and its technology adoption is limited. While Vietnam is making significant progress in securing access to global value chains through certifications and large-scale export promotion, the Philippines continues to face challenges in market positioning, as well as diseases and inconsistent product quality. This comparison suggests that enhancing its competitiveness and sustainability in shrimp farming will require not only strong policies but also mechanisms that ensure alignment with the everyday realities of smallholder farmers.

2.3 The Philippine Context

2.3.1 Historical Development of Shrimp Farming

Globally, shrimp aquaculture evolved from traditional, low-yield tidal systems in Asia to intensive, technology-driven production in the late 20th century. Chamberlain (2010) notes that the first modern breakthroughs occurred in Japan in the 1930s, when Dr. Motosaku Fujinga, who is considered the father of shrimp farming, successfully completed the life cycle of Penaeus japonicus in captivity, laying the foundation for global hatchery techniques. These innovations were then transferred to Taiwan and the United States, which drove the commercial production of other species. As aquaculture systems diversified from open ponds to semi-closed and recirculating systems (Stickney and Treece, 2012), shrimp farming became one of the fastest-growing segments of aquaculture in the world. In the 1970s, the Philippines began adopting shrimp farming technologies developed in Japan and Taiwan, resulting in a rapid expansion of Penaeus monodon production. According to Yap (1999), the transfer of hatchery and grow-out systems from neighboring Asian countries marked the start of intensive shrimp aquaculture in the Philippines.

2.3.2 Current Status and Challenges

- Market Trends

In today's shrimp farming in the Philippines, the production in the country is not at its best and has declined. According to PCAARRD (n.d.), the total shrimp and prawn production in 2020 was 70,470.77 MT. In terms of exports, the World Integrated Trade Solution (n.d.) reported that the Philippines' exports in 2023 were of shrimps and prawns that are prepared and preserved, valued at $5,065.80 with a quantity of 1,103,250 kg.

In the Philippines, the Bureau of Fisheries and Aquatic Resources (BFAR) supports shrimp farming to help people make a living. This support comes through their hatchery programs. However, despite these efforts, the country still has a small portion of the global shrimp market. According to the 2021: 128 National Shrimp Industry Roadmap by BFAR, in 2019, the Philippines made approximately 35 million euros by exporting 8% of all the shrimp it produced. And Japan, which imports the most Philippines shrimp (43%), followed by the United States, South Korea, Taiwan, and France, is the reason for this revenue. Yet, the Philippines barely accounts for 1% of Japan's total shrimp imports, resulting in it being left behind by other Asian countries like Indonesia, Vietnam, and India. And let's not forget the fact that over the previous ten years, illness outbreaks and the COVID-19 pandemic have caused fluctuations in export volumes. 2019 saw the highest export volume, which has yet to be surpassed, despite earnings peaking in 2017.

- Consumer Behavior

In today's generation, there is a rising health consciousness, urbanization, and the demand for convenient food, which drives shrimp consumption both locally and globally.

On the consumer side, a study by Schrobback et al. (2025) reveals that, in all markets, taste and food safety are the most important factors, followed by sustainability aspects such as having healthy fish stocks, compliance with regulations, and minimizing pollution.

Domestically, people have been consuming more over the past years. Back in 2003, each person consumed about 0,30 kg, but by 2020, this amount increased to 0,80 kg. It is expected that by 2025, the total demand will be over 67,000 metric tons (BFAR, 2021: 88). This data highlights the country's need to increase local production, and to achieve this, they must manage their resources more effectively and improve the transportation of products from producers to consumers. Producers should pay attention to selling products within the Philippines and aim to create higher-value products for exporting to other countries. By doing this, they can increase profits.

2.3.3 Challenges

- Disease

The shrimp farming industry comprises a mix of small-scale producers and commercial farms, with production sites located in Central Luzon, Western Visayas, and parts of Mindanao. However, comprehensive documentation of dominant corporate players remains limited.

The sector has been greatly affected by disease outbreaks. Diseases such as Enterocytozoon hepatopenaei (EHP), Infectious Hypodermal and Hematopoietic Necrosis Virus (IHHNV) and White Spot Syndrome Virus (WSSV) are causes of large financial losses and reduced production cycles (Macusi et al., 2022). According to Corre (1993), the degradation of the environment, including runoff pollution from watersheds and improper handling of organic waste, makes these problems even worse by reducing the water quality and making it more susceptible to illness.

Successful shrimp farms distinguish themselves despite these obstacles by complying with strict biosecurity procedures, managing water quality appropriately, and providing access to high-quality fry and feed. Additionally, a study showed that practices such as low-stocking densities and environmental monitoring are important, as well as the help of the government, so they can

make use of the more advanced technology (Clapano et al., 2022). To keep the industry strong for many years, it is crucial to have better management practices, provide training for farmers, and invest funds in researching diseases. It is also important to develop systems that can give early warnings about potential problems.

- Technology

Shrimp farming in the Philippines has different methods that they use, like traditional and intensive farming. Traditional farming uses low stocking densities and relies on natural food, which makes it low-cost but less productive (BAFS, 2023). On the other side, intensive farming uses high densities, formulated feeds, and controlled growing processes to boost yields, but this requires strict biosecurity and water quality management due to higher disease risks (Lio-Po, Lavila, and Cruz-Lacierda, 2001).

Technology is a crucial thing in shrimp farming today. Such as IoT sensors and Biofloc technology. IoT sensors make sure the water quality is safe for shrimp through continuous monitoring. Automatic feeders save waste and encourage the growth of shrimps (Kasu et al., 2022). Biofloc technology, as explained by Hargreaves (2013), offers a way to rely less on chemical treatments and use less water. There is strong evidence showing that these systems can boost productivity and save water. However, the article does not mention the high costs or the kinds of training needed to set up these systems, especially in developing countries. Mangrove conservation, wastewater treatment, and certification program participation are examples of sustainability activities that guarantee market access and environmental compliance.

- Financing and Credit Access Challenges

One of the major barriers facing shrimp aquaculture SMEs in the Philippines is limited access to formal financing. As highlighted in the literature, aquaculture producers in developing countries often encounter strict lending requirements,

such as credit history, which smallholder farmers rarely possess (Clapano et al., 2022). Therefore, many SMEs depend on informal credit from traders or input suppliers, which ties them into unfavorable repayment terms and reduces their bargaining power within the value chain. This financing gap limits investments in critical areas such as technology adoption, certification, and biosecurity measures, leaving them vulnerable to outbreaks and volatile market conditions. Overcoming financing constraints is essential in the Philippines, where shrimp aquaculture remains largely dominated by SMEs, for them to improve their overall operations.

- Environmental and Regulatory Challenges

Shrimp farming plays a key role in producing food and boosting the economy. As shrimp farming becomes more well-known worldwide, there are concerns about its impact on society and the environment. In the Philippines, a study using the PRISMA framework (Macusi et al., 2022) found that shrimp farms have harmed natural habitats, polluted water, and destroyed mangroves. Furthermore, the practice has had negative social and economic effects, which include marginalization of small-scale fishermen, disputes among workers, and problems over land and water use. Moreover, Primavera (2005) offers a fundamental analysis of the ecological harms resulting from shrimp aquaculture, particularly in Southeast Asia. The study makes a strong case for integrated systems of mangrove shrimp. However, while conceptually strong, Primavera's work lacks detailed business modeling, which limits its direct application to new enterprises.

To handle the environmental and social effects of shrimp farming, the government of the Philippines has created different rules and systems. Two main government bodies are involved in this effort. The first organization is the Bureau of Fisheries and Aquatic Resources, and the second one is the Department of Environment and Natural Resources. Both groups work closely together. Their goal is to make sure shrimp farming respects local communities

and keeps the environment safe. They create guidelines to help manage resources well and protect the natural habitats in the country.

2.3.4 Institutional Support

Beyond regulation, a number of institutions play a critical role in shaping the development of shrimp aquaculture in the Philippines. The Bureau of Fisheries and Aquatic Resources (BFAR) leads in aquaculture governance by issuing permits, supporting hatchery programs, and implementing the National Shrimp Industry Roadmap. The Department of Environment and Natural Resources (DENR) is tasked with ensuring ecological safeguards through environmental Impact Assessment and the issuance of Environmental certifications.

The country's aquaculture and fisheries industries are mostly under the control, development, and enhancement of BFAR. They offer permits for the aquaculture activities and also monitor adherence to technical standards for farm management, biosecurity, and stocking density. On the other hand, DENR is the one in charge of protecting the environment, ensuring that farming is sustainable. The DENR plays a key role in protecting the environment and making sure that farming is done in a way that can last for a long time without damaging nature. They are the ones who issue crucial documents such as the Environmental Compliance Certificate (ECC). This certificate involves an Environmental Impact Assessment (EIA) process, which aquaculture operations meet all the necessary environmental safety standards.

Internationally, the Food and Agriculture Organization (FAO) provides technical assistance and creates frameworks for responsible management, like a code of conduct for responsible fisheries. At the regional level, the Southeast Asian Fisheries Development Center (SEAFDEC) provides training, research, and extension programs, particularly on hatchery management and disease control. At the same time, academic institutions such as the University of the Philippines Visayas and state universities contribute to the development of research, innovations, and human resources. Despite these efforts, challenges persist in

scaling up innovations, strengthening enforcement, and ensuring that institutional support reaches small and medium-sized enterprises effectively.

Institutional coordination remains weak. While the government expresses support and policies are in place, many small producers find that overlapping mandates between national and local agencies delay access to permits and funding. Strengthening coordination among BFAR, SEAFDEC, and local governments could improve technology dissemination, hatchery regulation, and training.

2.4 Business and Sustainability Perspectives

The literature highlights that shrimp production poses not only ecological and technical challenges but also business challenges for small and medium-scale enterprises. Profitability is constrained by several factors, including costly feeds, perennial outbreaks of disease, and limited access to affordable funding and quality post-larvae (Villarael, 2023). These constraints reduce the efficiency of production and increase the risk of financial loss to small producers.

Another key issue is value chain inefficiency, particularly in areas of certification, compliance, and market integration. A study by Van Duijn, Beukers, and van der Pijl (2012) identified that there are three main bottlenecks in the export of the Philippines. These bottlenecks include a lack of EU-certified processing establishments, a lack of competitiveness among white shrimp, and, lastly, a lack of traceability. For the Philippine shrimp farmers, it was expensive to get certifications, and at the same time, EU buyers have limited knowledge that shrimps are produced in the Philippines. This issue is also connected with sustainability, which is increasingly associated with business competitiveness, with foreign consumers now demanding certified, traceable, and eco-labelled products. Participation in certification schemes can grant access to high-value markets, but compliance can be expensive and technologically challenging for SMEs.

In recent years, digitalization has emerged as a critical enabler of transparency and certification in the global shrimp value chain. Digital traceability systems using technology product tracking are now being adopted in leading countries to verify shrimp origin, production practices, and environmental compliance. These innovations reduce fraud risks, strengthen consumer trust, and simplify audit process for certification bodies. For Philippine SMEs, adopting low-cost traceability tools, especially when organized under cooperatives or clusters, could significantly enhance compliance with eco-labeling standards. Furthermore, digital traceability can open new market opportunities by allowing exporters to showcase sustainability credentials directly to buyers through easily accessible digital platforms. Such systems would not only reduce certification costs but also integrate Philippine shrimp farming more effectively into global supply chains that increasingly demand verified sustainability information.

To address these issues, eco-certification and sustainability standards have emerged as strategic tools to improve competitiveness and export value. Programs such as the Aquaculture Stewardship Council (ASC) Best Aquaculture Practices (BAP), and Global G.A.P. have become benchmarks for responsible shrimp production worldwide. A study by Dong et al. (2021) found that quality assurance certifications might increase the profitability of the Vietnamese shrimp farms. However, in Vietnam, certification has provided access to higher-value export markets and price premiums for larger farms that can meet sustainability and traceability standards; however, it is not viable for small producers (Marschke and Wilking, 2014). For shrimp farmers, certification enhances their brand reputation and provides access to high-standard markets, just as those in Europe and Japan, where buyers mostly demand environmentally and socially responsible products.

While certification and market integration improve external competitiveness, internal financial constraints still limit the adoption of technology and sustainable investment. In the Philippines, financing remains a persistent barrier for aquaculture SMEs, yet there are emerging efforts to integrate sustainability into

lending programs. The Land Bank of the Philippines offers the Agricultural Competitiveness Enhancement Fund Credit program, which provides loans to aquaculture enterprises for the purchase of equipment and upgrading of production facilities at concessional interest rates. Meanwhile, the Development Bank of the Philippines manages the sustainable Agribusiness Financing Program, which supports projects that promote efficient resource use, renewable energy, and waste reduction in food production, including aquaculture. These initiatives aim to make financing more accessible while promoting responsible production.

In summary, the integration of eco-certification and sustainable financing demonstrates that environmental and economic goals can mutually reinforce one another. Certified farms gain stronger market access and brand credibility, while access to financing enables SMEs to invest in innovation and long-term resilience. These developments reflect a shift toward a value-driven aquaculture model that rewards responsible production as a core element of competitiveness. For Philippine shrimp SMEs, aligning with these mechanisms through institutional and policy support can accelerate their transition toward a more inclusive and sustainable industry.

2.5 Synthesis and Research Gap

Taken together, global and regional studies reveal a clear set of lessons: (1) technological innovation, such as biofloc and IoT monitoring, can raise productivity and reduce disease risk. (2) strong institutional frameworks, as seen in Vietnam, that align aquaculture growth with environmental protection. (3) Farmer empowerment and community-based knowledge sharing are essential for scaling practices among smallholders.

However, the literature shows that the Philippines' case shows a persistent gap. First, most domestic studies focus on environmental and ecological issues such as disease management or water quality, but few integrate business modelling and financial innovation into sustainability research. There is limited analysis on

how shrimp SMEs can practically access eco-certification or financing mechanisms despite their proven success in other ASEAN nations. Similarly, while policy documents like the BFAR National Shrimp Industry Roadmap emphasize productivity and disease control, they provide limited guidance on financing frameworks or market-based incentives for adopting sustainability.

Research has focused on disease impacts and environmental issues but has paid less attention to integrated business models that link profitability with sustainability for SMEs. There is also limited empirical analysis of how current Policies, such as BFAR programs and BAFS standards, work at the farm level and whether they effectively reach small-scale producers. Furthermore, Philippine shrimp exports remain underrepresented in key markets, such as Japan, the U.S., and Europe. Still, few studies analyze the country's strategic positioning within the global shrimp trade.

Finally, few studies assess how the Philippines can strategically position itself within the global shrimp trade through sustainable branding and certification. While Vietnam, Indonesia, and Thailand have established recognized eco-labels that enhance their international presence, the Philippines remains underrepresented in high-value markets. This study addresses these gaps by systematically comparing best practices from Vietnam, Bangladesh, and China to identify scalable strategies that can enhance competitiveness, improve environmental performance, and empower the Philippines' SMEs. The synthesis of these findings provides the foundation for developing a practical analytical framework that connects technology adoption, farmer-led knowledge systems, and policy interventions to improve business performance and sustainable growth.

3 Theoretical/Conceptual Framework

The Philippine shrimp farming industry faces challenges in balancing profitability with sustainability. SMEs are still constrained by high input costs, recurring disease outbreaks, and weak value chain integration, especially in premium

markets. In addition to that is the demand for sustainable or eco-certified shrimp is putting pressure on producers to be sustainable. This study seeks to examine how Philippine shrimp farming can adopt integrated strategies to improve competitiveness while ensuring long-term environmental and social sustainability by drawing lessons from successful approaches in Vietnam, Bangladesh, and China.

To address these challenges, this study examines how Philippine shrimp farming can adopt integrated strategies that improve competitiveness while ensuring long-term environmental and social sustainability. The theoretical and conceptual framework guides the analysis by identifying how business efficiency, sustainable principles, and institutional support interact to shape the overall performance of shrimp aquaculture SMEs.

3.1 Theoretical Basis

This research is based on three interconnected theoretical frameworks, and these are Porter's Value Chain Framework, Sustainable Development Theory, and Institutional Theory.

As shown in Figure 1, Porter's Value Chain Framework (1985) provides a view for analyzing efficiencies across the shrimp farming supply chain from input procurement for fry and feeds, and production to processing, logistics, and market access. By examining input on supply, production, processing, and marketing activities, the value chain perspective highlights opportunities for SMEs to improve cost efficiency, increase product quality, and gain stronger positioning in both domestic and international markets.

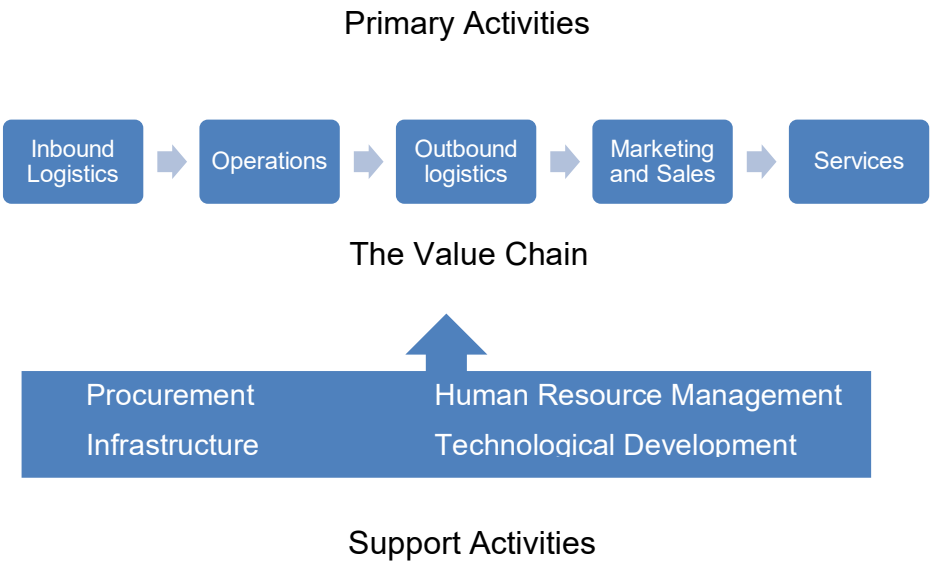

Figure 1. Porter's Value Chain

Figure 2 shows that the Sustainable Development Theory, as outlined by Brundtland (1987), sets the industry's growth within the triple bottom line, encompassing economic viability, environmental integrity, and social equity. This perspective is essential for understanding how shrimp aquaculture can meet current profitability goals without compromising future resources, particularly in the context of disease management, mangrove conservation, and water use.

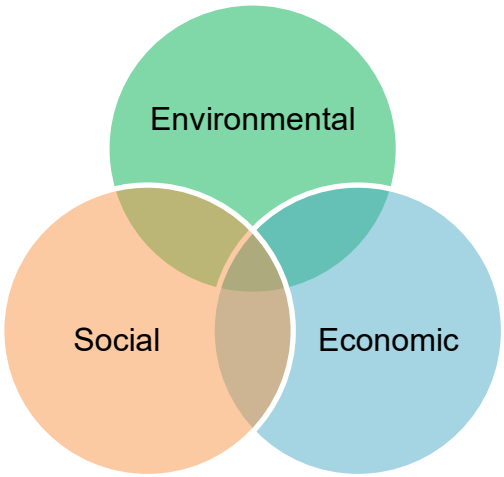

Figure 2. Sustainable Development Theory

As seen in Figure 3, Institutional Theory (North, 1990) emphasizes the role of rules, norms, and governance structures in shaping farmer practices and market participation. In the shrimp industry, government regulations, such as BFAR programs and environmental standards, as well as global certifications, significantly influence producer strategies, compliance costs, and export potential.

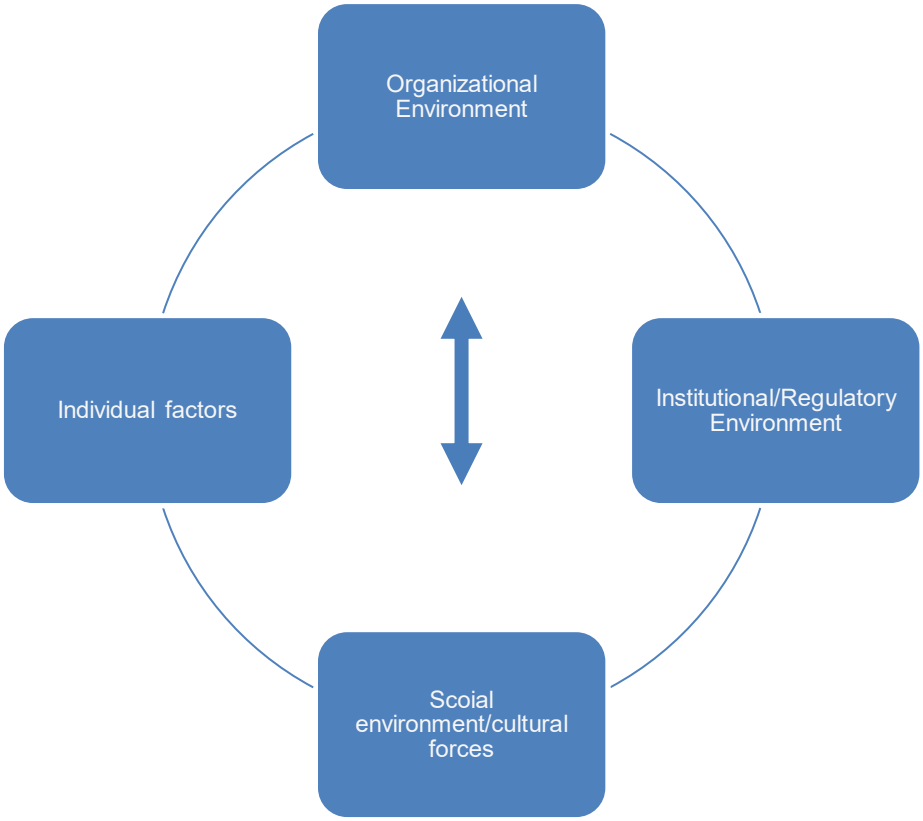

Figure 3. Institutional Theory

Taking into account all these theories to address how Philippine shrimp aquaculture SMEs can achieve global competitiveness and sustainability. Porter's Value Chain Theory emphasizes the importance of strengthening linkages between key activities, including hatchery operations, feed supply, grow-out farming, processing, and marketing, in order to increase efficiency and add value throughout the shrimp production system. Brundtland's framework ensures that these value chain improvements promote long-term sustainability by balancing economic profitability with environmental protection and social

responsibility. North's Institutional Theory complements both by emphasizing that effective governance, clear policies, and institutional support are necessary for these business and sustainability strategies to work. Taken together, Table 1 summarizes these theories that guide the study in analyzing shrimp aquaculture as a system where value creation, sustainability, and institutional alignment must interact to drive SME competitiveness in both domestic and global markets.

Table 1. Summary of Theories and Their Application

Theory	**Key concepts**	**Relevance of the Study**
Porter's Value Chain Framework (1985)	Primary and support activities that add or reduce value along production.	Explains how SMEs can improve efficiency, coordination, and product differentiation through better management of each stage of the shrimp production chain.
Brundtland's Sustainable Development Framework (1987)	Integration of economic, environmental, and social dimension.	Provides the foundation for evaluating sustainability strategies ad their alignment with long-term ecological balance and community welfare.
North's Institutional Theory (1990)	The role of formal and informal institution in economic performance.	Highlights how policy frameworks, governance systems, and institutions shape SME competitiveness and sustainability outcomes.

3.2 Conceptual Framework

The conceptual framework integrates these theories into an analytical model (see Figure 4). It proposes that the competitiveness and sustainability of the Philippine shrimp SMEs depend on the interaction of three factors:

- Technological Innovation – It increases productivity and reduces disease risk.
- Community-based Knowledge and Farmer Networks – This strengthens capacity and reduces value chain inefficiencies.
- Policy and Institutional Support – Aligns local industry with global sustainability standards that will open export markets.

Together, these elements influence business performance outcomes such as profitability, market competitiveness, and long-term environmental sustainability.

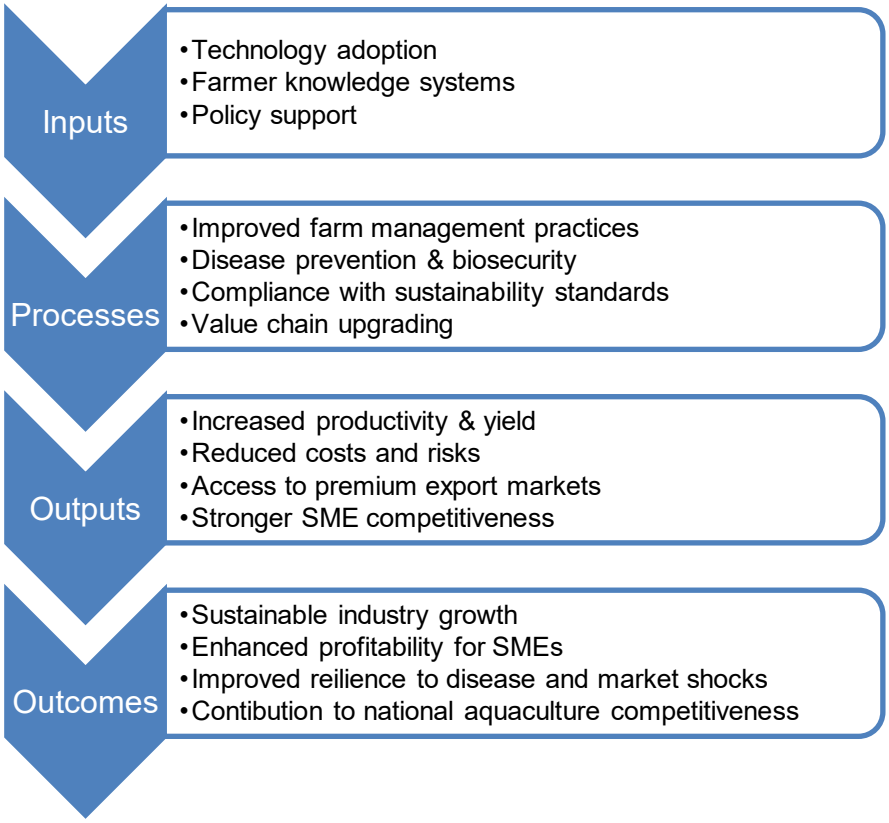

Figure 4. Conceptual Framework for Achieving Competitive and Sustainable Shrimp Farming in the Philippines

This framework will guide the study's comparative analysis with Vietnam, Bangladesh, and China by identifying how each country implements the three critical factors. These include Vietnam's strong policy frameworks and adoption of certification, as well as Bangladesh's farmer cooperatives and community-driven production systems, and China's rapid technological intensification and subsequent environmental improvements.

By mapping these lessons onto the Philippine context, the study will evaluate how SMEs can integrate innovation, community knowledge, and policy support into scalable models. This analytical perspective makes sure that both business competitiveness (value chain performance and profitability) and sustainability (environmental and social impacts) are addressed simultaneously. Together, these three theories form the analytical foundation of this study. Porter's competitive advantage theory explains how shrimp aquaculture SMEs can improve productivity and market positioning through differentiation, value chain efficiency, and innovation. The Brundtland Sustainable Development Framework integrates the environmental and social dimensions, emphasizing that competitiveness must be achieved without compromising ecological balance or community welfare. Meanwhile, North's Institutional Theory emphasizes the significance of governance structures, policies, and regulatory systems in shaping economic behavior and fostering sustainable industry growth. This theoretical integration directly aligns with the research objectives of identifying scalable business models, assessing sustainability challenges, and proposing strategies that balance profitability with long-term environmental and social responsibility.

4 Methodology

This study employed a structured methodological approach to explore scalable and sustainable shrimp farming strategies for small and medium enterprises in the Philippines. The chapter presents the research design, data sources, and analytical methods used to interpret secondary data from reputable institutions such as FAO, BFAR, and SEAFDEC. It also explains the steps taken to ensure

the validity and reliability of the analysis, providing a clear foundation of the study's findings and conclusions.

4.1 Research Design

This study employs a qualitative secondary data research-based analytical approach as the primary data source due to several methodological and practical considerations. This design will be suitable because it allows for an in-depth exploration of industry challenges and opportunities, considering both business and sustainability sides. Secondary data provides access to historical, sensitive, or otherwise difficult-to-reach information that may be challenging or unethical to collect firsthand. This study systematically reviews and synthesizes existing academic literature, government reports, and international case studies. Many existing data sets, including interviews, case studies, and organizational reports, offer depth and contextual richness that support a complex understanding of the noteworthy facts under investigation. This design enables the integration of global lessons from Vietnam, Bangladesh, and China. Finally, re-analyzing qualitative secondary data enables the generation of new interpretations and theoretical contributions, ensuring that the study builds upon existing knowledge while addressing the current research questions in a more in-depth and ethically responsible manner.

4.2 Data Sources

This study relies on secondary data resources to identify viable business and sustainable strategies for shrimp farming in the Philippines. Peer-reviewed journal articles on shrimp farming in the Philippines and other Asian countries were accessed from databases such as ScienceDirect, Google Scholar, and ResearchGate, focusing on themes of aquaculture sustainability, shrimp value chains, SME competitiveness, and environmental management. Key reports, industry roadmaps, academic studies, and international guidelines were taken from institutions such as the Food and Agriculture Organization (FAO), the Bureau of Fisheries and Aquatic Resources (BFAR), the Southeast Asian

Fisheries Development Centre (SEAFDEC), and the Department of Environment and Natural Resources (DENR). This combination of academic, institutional, and government sources ensures that the findings are both globally relevant and locally grounded.

4.3 Data Collection Procedure

This study relies on secondary data collection through a systematic review of existing literature, policy documents, and industry reports. A systematic literature search strategy was employed to collect data from credible academic and institutional sources. The process involved reviewing over 30 peer-reviewed journal articles, FAO and BFAR reports, SEAFDEC publications, and industry documents. The search strategy involves searching different databases using keywords including “Sustainable Shrimp Aquaculture”, Philippines shrimp industry”, “Shrimp Farming Challenges”, and “Shrimp Farming in the Philippines”. The inclusion criteria to include are Literature focusing on shrimp aquaculture production, sustainability, technology adoption, policy frameworks, and SME participation. Both global and Asia-Pacific regional studies, but with a priority given to countries that are comparable or similar to the socio-economic and environmental context of the Philippines. The publication also considered reports published between 2000 and 2025 to capture recent industry developments as much as possible. However, a few exceptions were made for foundational theoretical works and historically significant sources published before 2000, such as the theories used, which are Porter’s Value Chain (1985), Brundtland’s Sustainable Framework (1987), North’s Institutional Theory (1990), and one empirical study from 1999 considered relevant to the historical development of shrimp aquaculture. These materials were retained due to their ongoing theoretical importance and contextual value in understanding long-term industry trends. The exclusion criteria, on the other hand, eliminated studies focused only on capture fisheries, aquaculture species other than shrimp, and large-scale corporate aquaculture unrelated to SME contexts. The selected literature was organized by themes, which include technology, policy, community knowledge, business perspective, and sustainability outcomes.

4.4 Data Analysis Technique

The collected data will be analyzed using three complementary techniques. First is thematic Analysis which the collected studies were reviewed to identify recurring themes such as technological innovation, disease management, policy frameworks, value chain performance, and certification practices. These themes provided the basis for understanding patterns in aquaculture development across countries. Second is the Comparative Matrix to evaluate the experiences of Vietnam, Bangladesh, and China. Each country's strategies were assessed in terms of strengths, weaknesses, and lessons learned, and these findings are contrasted with the Philippine context to identify feasible applications. Lastly, SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis was applied specifically to the Philippine shrimp aquaculture sector. These tools highlight internal industry characteristics as well as external environmental factors that build and shape the competitiveness and sustainability of SMEs. The integration of all three ensured both depth and structure in interpreting the secondary data.

4.5 Ethical Considerations

However, the use of secondary data also carries an inseparable limitation. The researcher has limited control over how the data was collected in which may affect its relevance, accuracy, or completeness in addressing the current research questions. Furthermore, the data may be shaped by the original researchers' perspective, interpretations, or methodological choices, which could introduce biases. To address these concerns, the study critically evaluates the source, context, and quality of the data, ensuring transparency in analysis and interpretation.

As this research is based only on secondary data, it does not involve direct interaction with human or animal subjects. Ethical considerations were still upheld throughout the study. All sources of information were cited properly using the Harvard style to avoid plagiarism. Only credible and verifiable data

were included, and interpretation of the findings was carried out objectively to avoid biases toward any particular country, institution, or stakeholder group.

While this study relied primarily on secondary data sources such as journal articles, government reports, and international publications, certain limitations must be acknowledged. Secondary data may not fully capture the most recent developments in the Philippine shrimp aquaculture industry, and it may lack real-time validation from current field conditions. In addition, the generalizability of findings is constrained by variations in regional practices, data reporting quality, and contextual differences between countries used in the comparative analysis. These limitations mean that while the study offers valuable insights and theoretical contributions, its conclusion should be interpreted as indicative rather than definitive. Future research incorporating primary data collection through surveys, interviews, and field observations would strengthen the reliability and applicability of the findings at the operational level.

To address these limitations, future studies should adopt a triangulated research approach that combines both secondary and primary data sources. Conducting interviews and surveys with shrimp farmers, cooperative leaders, policymakers, and exporters would provide firsthand insights into operational challenges and emerging innovations. Field-based observations from pilot farms or government programs such as those under BFAR or SEAFDEC can further validate existing data and offer practical perspectives that secondary data sources alone cannot provide. This mixed-method strategy would not only enhance the validity of results but also allow for a deeper contextual understanding of how theoretical models and policy frameworks translate into real-world aquaculture practices.

5 Results and Discussions

This chapter presents the results and discussion of the study, integrating findings from international case studies, a SWOT analysis, and a thematic synthesis of the literature in shrimp aquaculture. The analysis is primarily from

the experience of Bangladesh, China, and Vietnam, which represent three different pathways toward competitiveness. Community-driven systems, technology-intensive production, and policy-enabled export strategies. These are compared to the Philippine context to identify barriers, opportunities, and lessons for small and medium enterprises. The discussion is organized around the three critical factors of the conceptual framework, which are technological innovation, community-based systems, and institutional support, that are essential for ensuring both competitiveness and sustainability.

5.1 Comparative Analysis of Best Practices

To synthesize the findings from the literature review and peer-reviewed studies, a comparative review matrix was constructed to evaluate the strategies, strengths, and weaknesses of shrimp aquaculture in Vietnam, Bangladesh, and China. Table 2 presents the matrix that highlights the different approaches by each country to aquaculture growth and the sustainability of Philippine shrimp farming SMEs.

Table 2. Comparative Matrix: Shrimp Aquaculture

Country	Key Strategies	Strengths	Weaknesses	Lesson for the Philippines
Vietnam	Government-led policy frameworks and certification schemes	Strong export growth and institutional alignment with global standards.	Recurring disease outbreaks and environmental degradation risks	Align policies with global standards and provide certification support for SMEs

Bangladesh	Farmer networks, community-based knowledge sharing, and low-cost production	Resilient SMEs through collective action and low-cost entry barriers	Limited technology adoption and poor export competitiveness	Encourage cooperative community knowledge systems to build resilience
China	Rapid intensification, technological adoption, and large-scale production	High productivity and global leadership	Severe ecological impacts and costly corrective measures	Adopt technology with safeguards to prevent ecological damage
Philippines	Traditional / semi-intensive farming, limited certifications, and limited tech adoption	Growing domestic demand and existing government roadmaps	High input costs, weak technology adoption, barriers to certification, and export competitiveness	Leverage domestic market while scaling up sustainable technologies and certification access

The comparative matrix analysis reveals that each country offers valuable yet distinct lessons. Vietnam's experience demonstrates the importance of aligning government policies with global standards and facilitating certification to secure export competitiveness. Bangladesh shows that community-driven and

cooperative models can help SMEs remain resilient despite limited financial and technological resources. China serves as a cautionary example of how rapid intensification and technology-driven growth can lead to severe ecological damage if sustainability is overlooked. For the Philippines, the results emphasize the need to build on its growing domestic demand and existing government roadmaps while addressing systemic barriers such as high input costs, limited access to certification, and slow adoption of modern technologies. Collectively, these findings underscore the need for the Philippines to integrate policy support, farmer networks, and technological innovation to develop a more competitive and sustainable shrimp aquaculture sector.

5.2 SWOT Analysis of Philippine Shrimp Aquaculture

Table 3. SWOT Analysis of Philippine shrimp aquaculture SMEs

Strengths	Weakness	Opprotunities	Threats
• Growing domestic demand fo shrimp products • Favorable natural resources (coastal areas and climate for shrimp farming) • Existing government roadmaps /BFAR shrimp Industry Roadmap • Strong presence of academic and research institutions (SEAFDEC and state universities)	• High production costs (feed and fry) • Limited adoption of modern technology (biofloc and IoT) • Weak biosecurity and disease management (WSSV and EMS outbreaks) • Barriers to international certifications (costly and complex compliance)	• Rising global demand for sustainable and certified shrimp • Potential to access premium makrets (Japan, U.S., and EU) • Adoption of affordable and scalable technologies • Public-private partnership for infrastracture and cold chain development	• Recurring disease outbreaks that threaten production stability • competition from Vietnam, Thailand, China, and India with stronger export positioning • Climate change impacts on coastal ecosystems such as extreme weather • Policy and regulatory gaps and weak enforcement of environmental laws

As seen in Table 3, the SWOT analysis provides a structured perspective on the internal and external factors that influence the Philippine shrimp aquaculture sector.

In terms of strengths, the Philippines benefits from favorable natural conditions, a long coastline, and farmer experience in aquaculture. Local demand for shrimp remains strong, ensuring a baseline market even without fully exporting to other countries. However, weaknesses such as disease outbreaks, high feed costs, inconsistent seed supply, and a lack of affordable certification create structural barriers for SMEs. Weak value chain integration further reduces their competitiveness. Despite these challenges, opportunities exist, such as the increasing global demand for sustainably produced shrimp, which offers a potential market for eco-certified Philippine shrimp. Lessons from ASEAN neighbors also provide a representation of scalable practices. Technological innovations create new opportunities for SMEs to improve efficiency. Nonetheless, the industry must contend with serious threats, including climate change, global price volatility, and the emergence of stronger competitors, which pose significant risks. Without institutional changes or improvements, the Philippines risks being locked into a low-value domestic market, resulting in a loss. The Philippines has so much potential.

5.2.1 Philippine Shrimp Value Chain

The structure of the shrimp value chain in the Philippines involves several interconnected stages from input supply to final distribution. Figure 5 presents the major actors and flow of products as illustrated by Van Duijn et al. (2012: 28).

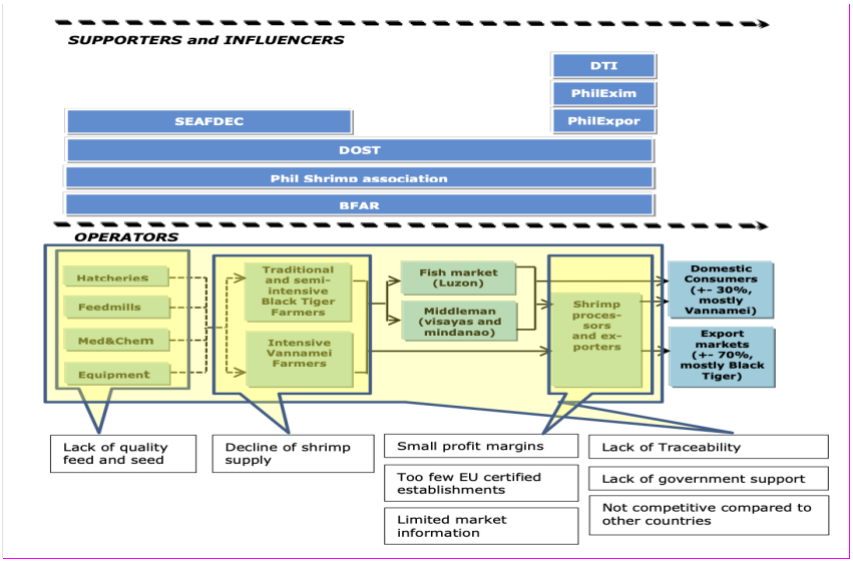

Figure 5. Philippine Shrimp Value Chain and its main bottlenecks: Adapted from Van Duijn et al. (2012: 28).

As shown in Figure 5, the value chain begins with hatcheries, feed input suppliers, medicine and chemicals, and Equipment, then moves through grow-out farms to traders and processors before reaching both domestic and export markets. This structure showed the presence of multiple intermediaries, which reduces profit margins and weakens traceability. Understanding this flow highlights key leverage points for improving competitiveness and sustainability.

5.3 Barriers in the Philippine Context

Despite its favorable climate and coastal resources, the Philippine shrimp farming industry faces multiple barriers that prevent SMEs from achieving global competitiveness. High production costs, particularly in feed and fry, remain a persistent challenge. Many SMEs continue to rely on semi-intensive production methods, which offer limited access to modern technologies such as biofloc and IoT-based water monitoring. Weak biosecurity practices expose farms to more disease outbreaks, including Early Mortality Syndrome (EMS) and White Spot Syndrome Virus (WSSV), which cause heavy financial losses.

Market-related barriers also slow down SME growth. International certifications, which are important, require a significant amount of investment in compliance, which smallholders find expensive and complex. As a result, most SMEs remain low-margin domestic markets, while competitors like Vietnam and Thailand expand in high-value export markets.

Lastly, institutional barriers, which include inconsistent policy support, weak enforcement of hatchery regulations, and the absence of affordable certification schemes, further worsen challenges that create uncertainty for farmers and investors.

5.4 Business Model Opportunities for SMEs

Three potential business models emerge from the analysis of international best practices. Each addresses key barriers faced by small and medium enterprises in the shrimp aquaculture sector. These are the Cooperative-based model, inspired by Bangladesh, Technology-driven Model observed in China, and the Policy-aligned Value Chain Model adapted from Vietnam. For the Philippines, a hybrid model is the most suitable approach. One that combines cooperative organization, selective adoption of technologies, and institutional reforms to create a supportive ecosystem for SMEs.

5.4.1 Cooperative and Cluster-based Model (Bangladesh)

Organizing SMEs into a cooperative or cluster can reduce input costs, enable collective certification, and improve bargaining power in both domestic and export markets. This model emphasizes inclusivity and community resilience, providing small producers with the structural and social foundation to compete with larger, capital-intensive farms.

Even though there are a lot of obstacles, SMEs can still find a way to earn more and compete better by using innovative business models. One good approach is to develop a farmer cooperative and cluster farming, similar to the one in Bangladesh. SMEs can increase their bargaining power with suppliers and

exporters by combining their resources, such as infrastructure, like hatcheries or cold storage, to lower input prices through bulk purchases and collectively market their products.

The Bureau of Fisheries and Aquatic Resources promotes this approach under its National Shrimp Industry roadmap and Cluster Farming Program, emphasizing regional organizations and capacity building. An example can already be seen in different regions in the Philippines, where farmers' cooperatives are supported by BFAR and local governments. Cooperatives also serve as effective channels for shared certification schemes, which are otherwise unaffordable for individual farmers. This collective approach not only improves production efficiency but also builds community resilience, empowering small farmers while encouraging environmental stewardship.

5.4.2 Technology Driven Model (China)

SMEs that adopt affordable or non-innovation can improve productivity, reduce disease risks, and achieve greater efficiency. This model reflects China's approach, where technological modernization has been central to improving yield and environmental control.

Low-cost and scalable technologies also have a great way to have more opportunities for the Philippine shrimp SMEs to overcome productivity and sustainability barriers. One promising innovation is biofloc technology (BFT), which enhances water quality and shrimp performance while reducing dependence on expensive feeds. Studies show that BFT recycles nitrogenous waste into microbial protein that improves water quality and lowering environmental impacts (Caipang et al. 2022). Another recent study showed that the use of BFT in Macrobrachium rosenbergii significantly improved weight gain, yield, and survival rates compared to traditional systems while maintaining optimal water parameters and lowering feed protein requirements (Camarin et al, 2023). These findings demonstrate that biofloc systems not only improve productivity but also provide SMEs with a cost-effective and sustainable

production strategy, particularly when integrated into cooperative or cluster farming models.

In addition to biofloc technology, digital technologies such as IoT-based water quality monitoring can improve farm management and efficiency. An IoT-enabled prototype tested in aquaculture farms in Dapitan City showed high levels of acceptance among farmers and proved to be cost-efficient for monitoring critical parameters such as pH, temperature, and turbidity (Gallemit, 2023). By providing real-time data, such systems allow SMEs to make timely decisions that reduce disease risks and optimize feeding, thereby improving survival rates and profitability.

In the Philippines, SEAFDEC and BFAR have already initiated pilot projects. These programs show potential to reduce feed cost and enhance production efficiency. However, adoption remains limited due to high initial investment and the lack of training. To overcome these constraints, credit programs or low-interest loans could help SMEs invest in sustainable technology.

5.4.3 Policy Aligned Value Chain Model (Vietnam)

Vietnam’s success demonstrates how aligning local practices with international standards and certification can enhance global competitiveness. Strengthened institutional frameworks and coordinated export policies have enabled Vietnamese SMEs to access premium markets, including those in European countries.

Institutional support is one of the essential things for Philippine shrimp aquaculture SMEs to overcome structural barriers and compete globally. Because they have the ability to support, and it is also for the economy. Strengthening biosecurity and hatchery quality control should be a priority as disease outbreaks like WSSV and EMS remain the industry’s most disruptive threats. BFAR can play a central role in this through stricter enforcement of hatchery standards, proactive surveillance systems, and farmer extension programs.

Another is Certification access, which also requires urgent policy intervention. International eco-labels open premium export markets but remain hard or out of reach for most SMEs due to cost and complexity. Subsidy programs, simplified compliance procedures, and cooperative-based certification models would reduce these barriers.

Infrastructure investment is another area of opportunity that needs public and private partnerships that can expand cold chain capacity, modernize processing facilities, and improve rural transport systems, which can directly reduce post-harvest losses and raise export readiness. On the market side, initiatives such as a “Sustainably Farmed Philippine Shrimp” brand could enhance product visibility and consumer trust both domestically and abroad. Partnerships with exporters, NGOs, and private investors would further enable SMEs to diversify into value-added products and expand into higher-value markets.

For the Philippines, the most realistic path forward is a hybrid business model that combines the strengths of all three approaches. Cooperative-based organization can empower smallholders, technology adoption can improve productivity and environmental performance, and policy-aligned value chain reform can connect SMEs to global markets.

By integrating these strategies, the shrimp aquaculture sector can achieve economies of scale, reduce production risks, and meet the increasing global demand for certified sustainable seafood. Moreover, a hybrid model can serve as a foundation for inclusive and resilient growth that ensures economic gains translate into improved livelihoods, food security, and environmental stewardship.

5.5 Sustainability Integration

Sustainability must be integrated into competitiveness rather than treated as an external requirement. The analysis has three dimensions of sustainability:

- Environmental Sustainability through the adoption of biofloc systems, polyculture with other species, and better waste management.
- Social sustainability by empowering SMEs through cooperatives, capacity building, and inclusive business models that protect smallholder farmers.
- Economic sustainability through product diversification, eco-certification, and stable access to domestic and export markets.

Sustainability is increasingly important to the competitiveness of global aquaculture, and the Philippines' shrimp industry cannot afford to separate business performance from environmental responsibility. Sustainability must be viewed as a strategic advantage for long-term industry growth, rather than an added cost. As highlighted in the international literature, unsustainable practices often lead to ecological degradation and long-term losses, as seen in China, while eco-friendly approaches secure both market access and resilience. This can also be proven in other industries, as it is not limited to the aquaculture sector, but rather applies to every sector.

Three main advantages are provided by sustainable practices for Philippine aquaculture SMEs. First, eco-technologies such as biofloc and recirculating aquaculture systems enhance feed efficiency, recycle nutrients, and reduce water usage, thereby cutting costs while minimizing environmental impacts. Second, eco-certification schemes provide access to high-value export markets, ensuring stable revenues even if compliance requires initial investment. Third, sustainability enhances climate resilience, helping farmers adapt to shifts in salinity, extreme weather, and disease risks associated with environmental stress.

Embedding sustainability with business models ensures long-term success for both the shrimp industry and coastal communities. These opportunities align directly with global and regional sustainability frameworks, particularly the United Nations Sustainable Development Goal 14 (Life Below Water), which emphasizes the sustainable use of marine and coastal ecosystems. By promoting responsible aquaculture, reducing waste discharge, and ensuring

equitable economic participation. Philippine shrimp SMEs can contribute to achieving SDG 14. Moreover, the ASEAN Blue Economy Framework emphasizes the need for stronger regional collaboration in eco-friendly aquaculture, innovation, and inclusive trade. The integration of these frameworks supports that competitiveness should not only be measured by output but also by social and environmental outcomes. Adopting global standards and aligning local practices with these sustainability goals would help position the Philippines as a responsible and competitive player in the international shrimp market.

Therefore, sustainability becomes no longer an optional extra but a foundation for competitiveness. By implementing practices that conserve natural resources, adhere to international standards, and enhance operational efficiency, SMEs can secure their position in both domestic and international markets.

5.6 Synthesis of Findings

The findings confirm that Philippine shrimp SMEs can achieve competitiveness and sustainability only through the alignment of three key factors: technological innovation, community-based knowledge systems, and institutional support.

- Technology (biofloc, IoT monitoring) raises efficiency and reduces risks when adopted responsibly.

- Community systems (cooperatives, shared training) lower costs, spread risks, and empower smallholders.

- Institutional Support (Policies, certification programs, infrastructure investments) creates the enabling environment needed for SMEs to scale up.

The comparative review emphasizes that no single model is enough. Vietnam demonstrates the importance of policy alignment, Bangladesh highlights community resilience, and China reveals both the promise and risks of

technology-driven intensification. For the Philippines, a hybrid strategy is needed, so combining lessons from all three while avoiding their weaknesses.

In summary, competitiveness and sustainability are not separate objectives but mutually reinforcing goals. For SMEs, the path forward lies in integrating innovation, collective action, and institutional support into a unified strategy that ensures both profitability today and resilience for the future.

6 Conclusion and Recommendations

This study examined how Philippine shrimp aquaculture SMEs can become more globally competitive while also being sustainable. Drawing lessons from Vietnam, Bangladesh, and China, the research highlighted that no single strategy could guarantee success because it is somewhat interconnected. Instead, competitiveness depends on the integration of three factors, which are technological innovation, community-based systems, and institutional support.

For SMEs

- Adopt cost-effective technologies such as biofloc and IoT-based monitoring to improve efficiency.
- Form cooperatives or clusters to strengthen bargaining power, reduce costs, and pursue shared certification.
- Diversify into value-added shrimp products to capture higher margins and access broader markets

For Policy Makers and Institutions

- Strengthen hatchery regulations and enforce stricter biosecurity protocols
- Provide subsidies and technical support for certification, especially for SME cooperatives.
- Invest in cold-chain logistics, processing facilities, and market access infrastructure.

- Develop branding initiatives such as Sustainably Farmed Philippine Shrimp” to boost domestic and international market visibility.

For Research and Future Studies

- Conduct applied studies on practical, low-cost aquaculture technologies tailored for SMEs.
- Expand research on value chain efficiency, post-harvest handling, and product diversification.
- Strengthen extension services and training programs to ensure innovations reach smallholder farmers.
- Undertake primary data collection, such as surveys and interviews with SMEs, policymakers, and exporters, to validate findings based on secondary sources.
- Explore the financial feasibility of cluster-based certification and cooperative farming models in the Philippine context.
- Broaden comparative studies to include other ASEAN shrimp producers such as Thailand and Indonesia.
- Assess the long-term impacts of climate change on shrimp aquaculture and potential SME adaptation strategies.

Achieving sustainable competitiveness in the Philippine shrimp aquaculture industry requires a coordinated implementation framework involving the government and the private sector. The government, through agencies such as BFAR, DENR, and DTI, should lead policy harmonization, funding, and regulatory oversight. This includes effective employment of certification processes, expanding access to credit for SMEs, and providing subsidies for sustainable technologies. Academe, particularly institutions like state universities in the Philippines, should focus on applied research and farmer training that translates scientific advances into accessible practices for local producers or farmers. Exporters can support the adoption of innovation by building inclusive value chains, investing in cold-chain logistics, and offering contract farming arrangements that integrate smallholders into high-value markets. Collaboration among these sectors should be formalized through multi-stakeholder partnerships and demonstration farms that serve as learning hubs for SMEs. Such a unified approach will ensure that sustainability is not

only theoretical but also deeply implemented in practical, profitable, and scalable business models.

To translate the study's findings into actionable outcomes, a coordinated policy roadmap is essential. All agencies, such as BFAR, DTI, and SEAFDEC, should jointly develop shrimp farming clusters and demonstration farms in producing regions. These sites can serve as testing grounds for technology systems like biofloc, and cooperative-based certification models, providing real-time learning for SMEs. Local governments can complement these initiatives by improving farm-to-market roads, cold-chain infrastructure, and facilitating access to financing programs. Through such integrated collaboration, the government can create a sustainable aquaculture environment that directly connects research, technology transfer, and market access for small producers.

This study contributes to both academic understanding and practical policymaking by integrating the fields of sustainable development, SME competitiveness, and aquaculture management into a single, comprehensive framework. Academically, it extends existing literature by applying sustainability and business theories to the specific context of shrimp aquaculture SMEs in the Philippines. Practically, the research provides a roadmap for aligning technology adoption, community participation, and institutional support to strengthen the resilience and profitability of local producers. By comparing the experiences of Bangladesh, China, and Vietnam, the study offers a more solid lesson on how collaboration and policy alignment can transform a vulnerable industry into a globally competitive and sustainable enterprise. The lessons from other nations are clear, but their true value lies in how they are adapted to the Philippine context. With the right blend of innovation, policy, and stewardship, shrimp aquaculture can become not only a driver of economic growth and prosperity for SMEs but also a model of sustainable enterprise for the upcoming future generations.

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