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SMALL-SCALE *VANNAMEI* SHRIMP FARM BUSINESS SUSTAINABILITY ANALYSIS WITH MICMAC: A STUDY ON KEBUMEN COASTAL AREA, INDONESIA

Emma Dwi Ratnasari[A], Indah Susilowati[B], Nugroho Sumarjiyanto Benedictus Maria [C]

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ABSTRACT

Purpose: The objective of this study was to identify the internal and external factors of the sustainability of the vannamei shrimp farming business and the relationship of influence and dependence between the factors.

Theoretical framework: Sustainability is required to create a balance between nature and humans for the use of coastal space in Kebumen Regency as a development area for the shrimp farming business to be carried out sustainably and provide sustainable benefits, as well as to preserve existing resources for long-term sustainability (UN, 2020). Development that ignores the interaction of the two results in price increases, which leads to a general decline in human welfare (Fauzi, 2019). This is to the global development agenda and the Sustainable Development Goals(SDGs)., which call for Indonesia to become a maritime axis.

Design/methodology/approach: The research used a participatory method with semi-structured and in-depth interviews with the shrimp farming community and FGD. The data were analyzed using the sustainability analysis technique of Matrix of Cross Impact Multiplications Applied to a Classification (MICMAC).

Findings: Identification of key elements in the sustainability of shrimp farming is essential to overcome and limit the risk of uncertainty caused by external and internal disturbances and pressures on shrimp farms. Government policy is a variable that has a strong and large influence on the sustainability of the shrimp farming business, and good government policy will enable the shrimp farming business system to reduce the pressure and threat of continuity.

Research, Practical & Social implications: Future research should focus on the management of shrimp farming and waste management to reduce the ecological, social, and economic impacts and the sustainability of shrimp farming that is environmentally and socially friendly.

Originality/value: Government policy is a variable that has a strong and significant impact on aquaculture sustainability, with good government policies allowing the aquaculture system to reduce pressure and threats to shrimp. According to the facts on the ground, the shrimp farming business on the coast of Kebumen regency is operating independently due to a lack of attention, guidance, and policies governing the implementation of the shrimp aquaculture business.

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[A] *Doctoral Student of Economics Department, Universitas Diponegoro, Semarang, Indonesia, Lecturer at the Faculty of Economics, Universitas Tidar, Magelang, Indonesia. E-mail: emmadwiratnasari02@gmail.com Orcid: https://orcid.org/0000-0002-8884-3605*
[B] *Lecturer at the Faculty of Economics and Business, Universitas Diponegoro, Semarang, Indonesia. E-mail: prof.indah@gmail.com Orchid: https://orcid.org/0000-0002-0026-5899*
[C] *Lecturer at the Faculty of Economics and Business, Universitas Diponegoro, Semarang, Indonesia. E-mail: nugroho.sbm@gmail.com Orchid: https://orcid.org/0000-0002-0026-5899*

ANÁLISE DA SUSTENTABILIDADE DO NEGÓCIO DA QUINTA DE CAMARÃO VANNAMEI EM PEQUENA ESCALA COM MICMAC: UM ESTUDO NA ÁREA COSTEIRA DE KEBUMEN

RESUMO

Objetivo: O objetivo deste estudo foi identificar os fatores internos e externos da sustentabilidade do negócio de camarão vannamei e a relação de influência e dependência entre os fatores.

Estrutura teórica: A sustentabilidade é necessária para criar um equilíbrio entre a natureza e os seres humanos para o uso do espaço costeiro na Regency Kebumen como área de desenvolvimento para que o negócio da criação de camarão seja realizado de forma sustentável e proporcione benefícios sustentáveis, bem como preservar os recursos existentes para a sustentabilidade a longo prazo (ONU, 2020). Desenvolvimento que ignora a interação dos dois resulta em aumentos de preços, o que leva a um declínio geral no bem-estar humano (Fauzi, 2019). Trata-se da agenda de desenvolvimento global e dos Objetivos de Desenvolvimento Sustentável (ODS), que exigem que a Indonésia se torne um eixo marítimo.

Design/metodologia/abordagem: A pesquisa utilizou um método participativo com entrevistas semiestruturadas e aprofundadas com a comunidade de camarão e FGD. Os dados foram analisados utilizando-se a técnica de análise de sustentabilidade da Matrix of Cross Impact Multiplications Aplicada a uma Classificação (MICMAC).

Achados: A identificação de elementos-chave na sustentabilidade da criação de camarão é muito importante para superar e limitar o risco de incerteza causado por distúrbios externos e internos e pressões sobre as fazendas de camarão. A política governamental é uma variável que tem uma forte e grande influência na sustentabilidade do negócio da agricultura de camarão, e uma boa política governamental permitirá que o sistema empresarial de camarão reduza a pressão e a ameaça de continuidade.

Pesquisa, Implicações Práticas & Sociais: Futura pesquisa recomendada por pesquisadores é a gestão da camareira e do manejo de resíduos para reduzir os impactos ecológicos, sociais e econômicos e a sustentabilidade da criação de camarão que é ambiental e socialmente amigável. Originalidade/valor: A política governamental é uma variável que tem um impacto forte e significativo na sustentabilidade da aquicultura, com boas políticas governamentais que permitem ao sistema de aquicultura reduzir a pressão e as ameaças ao camarão. De acordo com os fatos em terra, o negócio de criação de camarão no litoral da regência kebumen está operando de forma independente devido à falta de atenção, orientação e políticas que regem a implementação do negócio de aquicultura de camarão.

Palavras-chave: Sustentabilidade, Vulnerabilidade, Costeiro, Camarão, Negócios Agrícolas, MICMAC.

ANÁLISIS DE SOSTENIBILIDAD EMPRESARIAL DE LA GRANJA CAMARONERA VANNAMEI A PEQUEÑA ESCALA CON MICMAC: UN ESTUDIO SOBRE EL ÁREA COSTERA DE KEBUMEN

RESUMEN

Propósito: El objetivo de este estudio fue identificar los factores internos y externos de la sostenibilidad del negocio camaronero vannamei y la relación de influencia y dependencia entre los factores.

Marco teórico: La sostenibilidad es necesaria para crear un equilibrio entre la naturaleza y los seres humanos para el uso del espacio costero en Kebumen Regency como un área de desarrollo para que el negocio de la cría de camarón se lleve a cabo de manera sostenible y proporcione beneficios sostenibles, así como para preservar los recursos existentes para la sostenibilidad a largo plazo (ONU, 2020). El desarrollo que ignora la interacción de los dos resulta en aumentos de precios, lo que conduce a una disminución general del bienestar humano (Fauzi, 2019). Esto es para la agenda de desarrollo global y los Objetivos de Desarrollo Sostenible (ODS), que piden que Indonesia se convierta en un eje marítimo.

Diseño/metodología/enfoque: La investigación utilizó un método participativo con entrevistas semiestructuradas y en profundidad con la comunidad camaronera y FGD. Los datos fueron analizados utilizando la técnica de análisis de sostenibilidad de Matrix of Cross Impact Multiplications Applied to a Classification (MICMAC).

Hallazgos: La identificación de elementos clave en la sostenibilidad de la cría de camarón es muy importante para superar y limitar el riesgo de incertidumbre causado por las perturbaciones y presiones externas e internas sobre las granjas camaroneras. La política gubernamental es una variable que tiene una fuerte y gran influencia en la sostenibilidad del negocio de la cría de camarón, y una buena política gubernamental permitirá que el sistema empresarial de cultivo de camarón reduzca la presión y la amenaza de continuidad.

Investigación, implicaciones prácticas y sociales: La investigación futura recomendada por los investigadores es la gestión del cultivo de camarón y la gestión de residuos para reducir los impactos ecológicos, sociales y económicos y la sostenibilidad del cultivo de camarón que es ambiental y socialmente amigable.

Originalidad/valor: La política gubernamental es una variable que tiene un impacto fuerte y significativo en la sostenibilidad de la acuicultura, con buenas políticas gubernamentales que permiten al sistema acuícola reducir la presión y las amenazas para el camarón. Según los hechos sobre el terreno, el negocio de cultivo de camarón en la

costa de la regencia de Kebumen está operando de forma independiente debido a la falta de atención, orientación y políticas que rigen la implementación del negocio de la acuicultura de camarón.

Palabras clave: Sostenibilidad, Vulnerabilidad, Costero, Camarón, Negocios Agrícolas, MICMAC.

INTRODUCTION

Over the past few years, research on the internal and external factors of the sustainability of the vannamei shrimp farming business and the relationship of influence and dependence between the factors has been widely conducted in many countries, such as Latin America (Monsalve & Quiroga, 2022), China (Ding et al., 2022), and Brazil (St. Louis et al., 2022). However, similar studies in the Indonesian context have not received much attention from researchers. According to the Seafood Trading Intelligence Portal's (STIP) data, Indonesia ranks third among the biggest shrimp exporters worldwide, following India and Ecuador. Indonesia exported 189,573 tons in 2018 and 200,591 tons in 2019, and until mid-2020, the shrimp exports reached 98,557 tons (Seafood Trading Intelligence Portal, n.d.). Meanwhile, according to (the Seafood Trading Intelligence Portal n.d.)., Indonesia is one of the main exporters of frozen shrimp in the global market, following India, Ecuador, and Vietnam. The global frozen shrimp export market in 2018 recorded up to US$17.2 billion or about Rp232.2 trillion (exchange rate Rp13.500/ US$). Indonesia's frozen shrimp export value in 2018 reached US$1.3 billion or Rp17.55 trillion, with a market share e up to 7.8%, and export market destinations covering the United States, Japan, and Europe Union countries. The existing shrimp brackish water pond's potential is quite good, while the homework is on enhancing farming productivity and efficiency (Widowati 2019). One hundred thousand new intensive brackish water ponds are targeted on the southern coast of Java with an annual production of 4 million tons, referring to the statement of the Ministry of Marine Affairs and Fishery (KKP). A continuous shrimp farming model is also needed to enhance productivity and environmental friendliness (Wildan 2020). The potential of the southern coast of Java is quite great for shrimp farming development and enhancement. It is commonly known that shrimp is the main export commodity that may generate foreign exchange and provide economic benefit to local brackish water pond farmers, coastal communities, and local income. Local shrimp farming development is one of Indonesia's main focuses in enhancing fish farm production (Sumarga et al., 2022). Facts show that more than a quarter of international tradeshrimpps is mostly from shrimp farms (Soebjakto 2019).

Kebumen Regency is located in the south of Java Island bordering the south coast and the Indonesian Ocean, which area is dominated by the sea. Currently, the sea space area in Kebumen Regency has commonly exploited for fishery and marine affairs, transportation, and tourism sectors. The marine affairs sector is one of the economic pillars of Kebumen Regency, since it has quite a potential location that may be exploited for brackish water pond farming, and *Vannamei* shrimp farming serves as one of those widely developed. Currently, there is a dearth of research that explores this area. Other studies in different countries also have not investigated similar characteristics that an area has. Thus, the present study contributes to the growing trend of knowledge for other researchers in different contexts.

Table 1. Land Potential and Utilization of Brackish Water Farming

Type of Farming	Potential (Ha)	Utilization (Ha)	Remarks
Brackish Water Farming			
Brackish Water Pond Farming	1,151.20	82.00	*Vannamei* Shrimp

Source: Department of Marine Affairs and Fishery of Kebumen Regency

The potential for a brackish water farming business, one of which being the *Vannamei* shrimp brackish water pond, in Kebumen Regency to develop is still significantfocant to be economic activities with multiplier effects, especially for the coastal community. Based on the interview and observation with the Department of Marine Affairs and Fishery of Kebumen Regency in February 2020, 437 plots of brackish water pond were recorded by the department covering 82.4 Ha land, absorbing manpower of more than 500 people and free daily labor up to hundreds of people.

There are some phenomena in the society and environment around the farming area. First, there is an assumption and issue that shrimp brackish water ponds may negatively impact the environment, claiming that shrimp brackish water pond waste may harm the environment. Second, there is a rumor that the coastal equivalent of shrimp brackish water ponds is prohibited. Thus, there is a limitation of land use time of 3-year operation, but there is no such regulation from Local Regulation or Regent Regulation on land use in coast equivalent area and on shrimp brackish water pond activities. Third, shrimp farming is potentially that is not used well yet by the community and local government, considering the signifficsignificantl of shrimp farming from the economic and social perspectives, especially related to farming business development in a coastal area with many multiplier effects. Fourth, there are threats to the sustainability of *Vannamei* the shrimp farming business that is still caused or affected by internal and external factors of *Vannamei* shrimp farming business activities and the role of

actors that affects the sustainability of shrimp farming business in Kebumen Regency. Fifth, there is no good risk management for shrimp brackish water pond business players, either from loss to internal factors changes in weather and natural condition, or loss to viruses and disease, expensive feed, low selling price, limited capital, and other factors (Dinas Kelautan Dan Perikanan Kabupaten Kebumen 2018). Based on the phenomena above, an in-depth study on shrimp brackish water pond business sustainability strategy is needed. This is important so that the exploitation of coastal area space in Kebumen Regency as a region of shrimp brackish water pond farming business development can be performed sustainably and provide continuous benefit by preserving the existing resources for long-term utilization and continuity. This conforms to the global agenda of development of making Indonesia the axis of marine affairs and to the Sustainable Development Goals (SDGs). Sustainability is needed to create a balance between nature and humans (United Nations 2020). Development that disregards the two's interaction causes higher price that leads to declining human well-being in the broader sense (Fauzi 2019).

Starting from the idea that business activity is directly related to the economic, social, and environmental aspects, it is very important to note the sustainability aspect. Sustainable development activity should be a necessity, and it is based on the main consideration of benefit and cost aspects. Good business activity will provide current benefits while ensuring the availability of preserved long-term natural resources, while from a cost perspective, as we may observe from some studies, it is clear that a development activity that does not apply the sustainability principles will cause quite high social, economic and environmental costs (Fauzi, 2019). One of the analyses on the sustainability of *Vannamei* shrimp farming business development is one from the perspective of "factor analysis" and in the context of sustainability here means how the internal and external variables in the *Vannamei* shrimp farming business development activities in Kebumen Regency are determined and interact. Findings from this study contribute to the economic growth of the business of shrimp pond cultivation which also has the potential to export and increases the economic welfare of coastal communities must pay attention to its sustainability by identifying key factors both internal and external. In addition, the study also adds to the academic discussion of economic sustainability.

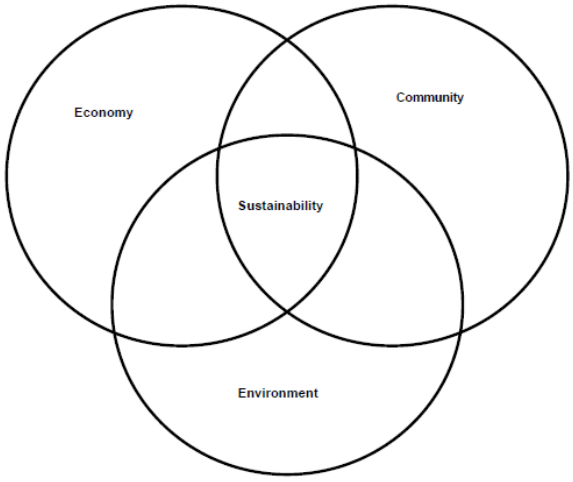
LITERATURE REVIEW

Sustainability Concept

From the perspective of the economics discipline, the concept of sustainability is defined as a justice concern between generations and a constraint in economic growth (Hackett,

Steven C., Moore, 2011). Further, in Hackett, ecologists and environmental ethicists argue that a sustainable society is based on the integrity of the ecosystem where they live on earth, and the ecologists are optimistic about t human capability to make a substitute for natural capital with human-made capital (for example, lost natural wetland is mitigated with built wetland). Based on this view, realizing sustainability requires recovery and preservation of natural Capital stock in an ecosystem. Sustainability needs a democratic and empowerment process providing significant economic security and employment opportunities and promoting resource-saving technology. Sustainability covers ethics and a series of technical processes related to ecological health and human welfare in various, mutually supporting fields, including economy social politics, and environment (Læss⊘e, 2010). Sustainability means human control and wise use of any form of capital, including natural capital, human capital and human-made capital, and cultural capital, and ensuring that the next generation will have security and achieve high economic democracy while keeping the integrity of the ecological system in all areas of life and those depending on them (Marirajan Murugan, & Natarajan, 2022; Viederman, 1993). The three pillars offered by Viederour our economy, community, city, and environment widely accepted as the sustainable central elements of the community, as illustrated in Figure 1 below:

Figure 1. Three Pillars of Sustainability (Viederman (Viederman, 1993)



It is common to consider sustainable development in a certain conceptual framework since it affects indicator development. In some context, the fourth pillar, institution, is added, as adopted by the Commission on Sustainable Development (Hák et al., 2007).

Sustainability in Vannamei Shrimp Brackish Pond Farming Business

Shrimp farming is often criticized because of a report on it causing environmental impact and social damage, its questionable sustainability, the emergence of disease outbreaks, and sometimes irresponsible development purpose or practice (Davis et al., 2021). The size of land for extensive and intensive agriculture has ledto significant conversion of coastal wetland to be shrimp brackish water pond, followed with local impact on the biodiversity and use of natural resources. There are also interrelated issues, especially regarding the development of startup industry with insufficient technical know-how and lack of development plan (Hempel et al., 1998; Kuzma, E., & Sehnem, 2021).

The World Bank states that development is needed to create human's economic opportunities and increase food production, but the development must always ensure future production capacity so as not to harm the environmental condition (FAO, 1997).

Pillay (Pillay, 1997) proposes the following factors needed to ensure long-term sustainability:

a. Sufficient agricultural business planning and responsible determination of agricultural location,
b. Local community's sufficient involvement,
c. Effective assessment of agricultural project's environmental impact,
d. Effective agricultural design including irrigation and drainage system,
e. Pursuing increased yield from time to time, instead of big benefit within a short period,
f. Adoption of appropriate technology for production and waste disposal,
g. Use of measured chemicals.

Pacific white shrimp (Litopenaeus *Vannamei*) brackish water pond farming business has been widely developed, that is in line with the reason why this shrimp farming has been widely developed, instead of tiger shrimp. According to the research conducted by Lebel (Lebel et al., 2010), white shrimp requires less resources and produces less waste than black (tiger) shrimp. Pacific white shrimp or *Vannamei* shrimp is originated from Latin America, and was first introduced to Asia in the Philippines in 1978 and 1979 and in Mainland China in 1988 (Briggs et al., 2005). Briggs et.al also state that *Vannamei* shrimp produces high profitability. The other benefits of *Vannamei* shrimp farming are from the perspective of growth, including: faster growth, especially in the first 60 days, sowing with higher density, wider tolerance to salinity, and lower protein requirements, leading to cheaper feed. The other benefit is that its growth tends to vary, making it easier for the farmers to harvest at certain size. *Vannamei* shrimp's entry into Indonesia was officially allowed in 2001 as confirmed by Decree of the

Ministry of Marine Affairs and Fisheries of the Republic of No. 41/2001. Initially, *Vannamei* shrimp was deemed to be resistant to disease, but in its development, *Vannamei* shrimp can be attacked by WSSV (White Spot Syndrome Virus), IMNV (Infectious Myo Necrosis Virus), TSV (Taura Syndrome Virus), Vibrio and EMS (Early Mortality Syndrome), thus prevention and control are needed by applying an environmentally friendly farming (WWF-Indonesia, 2014). Until now, there is universal definition for shrimp farming sustainability. The 1996 Aquaculture Industry Conference decides that sustainability does not depend on intensity level, but on site quality, management and suitability of technology for site and management. Sustainability includes "Sustainability (continuity) of supply, quality of input, social, environment and economic cost to provide input, long-term continuity (sustainability), production, financial feasibility, social impact, environmental impact and efficiency of conversion of resource into useful product (Phornprapha, 2020). Shrimp farming may produce various environmental impacts (Sivaraman et al., 2019). Thus, the Food and Agriculture Organization (FAO) and the Aquaculture Network of Farming Center in Asia Pacific, Environmental Programs of the United Nations, the World Bank, and the Worldwide Fund Commission for Wildlife developed the International Principles for Responsible Shrimp Farming (FAO/NACA/UNEP/WB/WWF, 2006). The growth of shrimp farming has caused long-term negative environmental impacts, involving imbalanced ecology, environmental pollution and outbreak. Besides, shrimp farming finds difficulty related to its management and causes bigger concern about water quality and juvenile supply (Paul & Vogl, 2011). Shrimp may provide farmers a big source of income, that shrimp is deemed to produce more money than any traditionally farmed products such as rice, and a large amount of money can be produced relatively fast. An integrated approach is, therefore, needed to handle constraints in shrimp farming for continuous farming while maintaining the sustainability principles. For sustainable *Vannamei* shrimp farming, it is necessary to have an integrated understanding of diseases, water quality parameters, social-economic issues of shrimp brackish water pond farmers, culture practice, and government intervention needed for social acceptance, economically and environmentally feasible water culture, and practice that will help in any situation for mutual benefit between the stakeholders and the government (Venkatrayulu, 2019).

Shrimp Farming's Social, Economic and Environmental Problems and Constraints

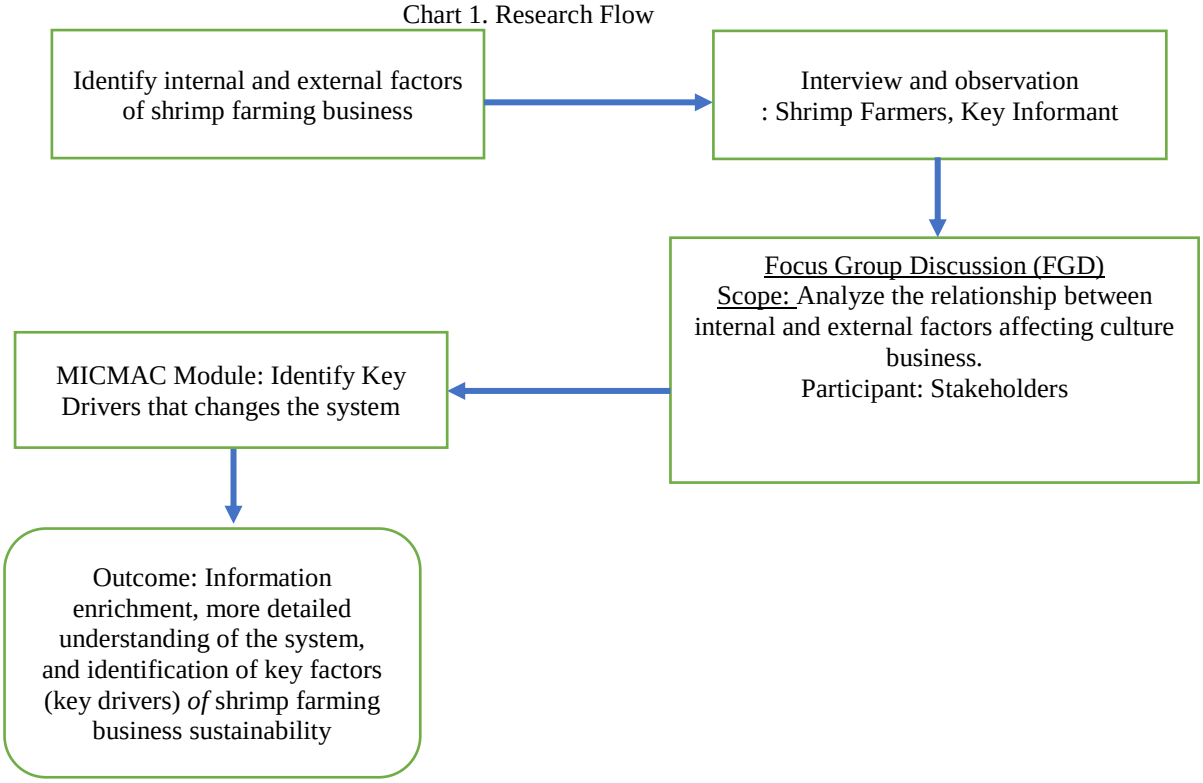
Vannamei shrimp farming faces many problems and threats and is currently struggling for sustainability because of many diseases reported, lack of quality juvenile, parent breeding problems, juvenile production from non-registered breeders, high feed cost, fake medicine circulation, chemicals, prohibited use of antibiotic and probiotic, vessel rejection, traceability issue, non-registered agriculture and fluctuating national and international market price (Venkatrayulu, 2019). These are a sustainable cycles that constraints on efficient and sustainable aquaculture production affect the food resilience, social-economic development, profitability and trade (Arthur et al., 2002). Besides diseases, shrimp farmers commonly face unavailability of quality juvenile, bad water quality, lack of cooperation between farmers, lack of credit and insurance facilities, and lack of government's support. These conform to the research findings (Kumaran et al., 2017).

Therefore, a strategic approach for sustainable shrimp business and production can be stopping environmental damage and enhancing industrial courage and economic performance as follows: 1. Improving *Vannamei* breeding and shrimp farming, including breeding technical standards, facilities, and farming methods; 2. Applying certification standards and good management practice; 3. Improving technical skills and training for small-scale farmers; 4. Establishing collaboration between different segments of the supply chain, such as between nursery and farm; 5. Stopping using antibiotics and chemicals (Rubel et al., 2019).

In the shrimp business and industry, there are interconnected value chains, including feed factory, breeder, farmer, middleman, processor, exporter, and reseller. Feed is generally distributed by shops or middlemen instead of indirectly by feed factories. The feed business is fragmented, where one big player commonly controls most of the market. In contrast, most farthe mers operate in a small scale with limited know-how of efficient agriculture, and new technology management. Only some farmers have access to capital and financing. Intermediary serves to help farmers financially, such as by offering credit, while the processor serves in processing and export, commonly dealt with by a medium to big-scale company (Rubel et al., 2019). The most important thing in the sustainability of the shrimp business and industry is the capability to analyze internal and external factors of shrimp farming, from input (operational capital) to output (social, economy, and environment) of shrimp farming business activities.

Research Framework

Chart 1. Research Flow



MATERIAL AND METHODOLOGY

This research was conducted in a brackish water pond area on the coast of Kebumen Regency covering four coastal districts: Mirit District, Klirong District, Petanahan District, and Ayah District. Kebumen Regency covers an area of 1,281.11 km^2 or 128,111.50 hectares, with area conditions in the form of the coastal area, flatland/rice field and mountain and mostly lowland, with borders of Kebumen including; in the west bordering with Cilacap and Banyumas Regencies, in the east bordering with Purworejo Regency, in the north bordering with Wonosobo and Banjarnegara Regencies, and in the south bordering with the Indonesian Ocean.

The research focused on structurally analyzing important internal and external factors and the role of each factor in the sustainability of the *Vannamei* shrimp brackish water pond business on the coast of Kebumen. This research formulated a strategy for the sustainability of the shrimp brackish water pond farming business in Kebumen. Using a qualitative approach, the research observed objective phenomena and studied them using the sustainability analysis technique, that is MICMAC analysis instrument.

The research participants were brackish water pond businessmen, farmer groups, feed agents, hatchery, the Department of Marine Affairs and Fisheries, and the Brackish Water Pond

Water Group. It was possible to add more participants to the research in line with the development of observation results and field research. The research instruments used to collect the data were questionnaires, semi-structured interviews, observation, and Focus Group discussions (FGD). FGD was conducted to identify the internal and external factors affecting the *Vannamei* shrimp farming business and inter-factor influences. The interview was done with brackish water pond businessmen, farmer group, feed agents, hatchery, the Department of Marine Affairs and Fisheries, and Brackish Water Pond Water Group. Each of them was interviewed for 45 minutes to 1 hour. The interview was recorded via mobile phone using the participants' national language. The FGD was done by the researchers. The first author of this study served as the moderator leading the discussions among the participants. It was conducted for around 2 hours to 3 hours.

MICMAC (Matrix of Crossed Impact Multiplication Applied to a Classification) Analysis

Analysis using the MICMAC method was developed by Godet et al. (1994), who introduced MICMAC as part of the "strategic foresight" focusing on development analyses, including sustainable development (Fauzi, 2019). In Fauzi, MICMAC starts with 1) problem definition, 2) internal and external variables identification, and 3) analyzing the inter-variable relationship and weighing of the relationship with mobility and inter-variable dependence (Benjumea-Arias et al., 2016).

The MICMAC analysis in this research served to identify the variables or key factors of the sustainability of the *Vannamei* shrimp brackish water pond arming business in Kebumen Regency. The factors affecting the system in this research were obtained from experts' FGD, the department of marine affairs and fisheries of Kebumen Regency, specialists of brackish water pond culture and brackish water pond farmers, and the stakeholders. The respondents were intentionally chosen under their respective expertise or background related to the objective of data to be achieved, and the respondents had been selected in such a way that they surely understood that they were to provide appropriate information and data related to the objective or data and information the researcher wished to obtain.

The first step of MICMAC analysis was identifying the main variables essentially affecting and affecting shrimp brackish water pond farming business in Kebumen Regency. After identification, the variables were categorized into 2, internal and external groups. This categorization was the dimension of sustainability. The MICMAC was used to structurally analyze the components of system variables in shrimp farming an inter-variable interaction and to identify the key variables used as drivers for developing and sustainable *Vannamei* shrimp

farming business. The results of the MICMAC analysis may be used to design a better and more effective policy strategy (Paulus & Fauzi, 2017).

RESULT AND DISCUSSION

Identification of internal and external factors in the shrimp farming business

Based on the results of FGD conducted with the Vannamei shrimp brackish water pond farming community and relevant stakeholders, 18 elements or variables of *Vannamei* shrimp culture business sustainability in Kebumen were identified as presented in Table 2. The data in Table 2 was obtained through FGD (pond farmers, Kebumen District Maritime Affairs and Fisheries Service in the Cultivation Sector, Academic Experts) and semi-structured interviews with key informants.

Table 2. Identification of Factors/Variables of Shrimp Farming Business Sustainability

No	Classification	Factor	Short label
1	Internal Factor	Human Resources Capacity	HRC
2		Capital	Capital
3		Seawater Quality	SeaQual
4		Technology	Tech
5		Waste Management	WstMng
6		Disease Treatment	DissTreat
7		Infrastructure	Infrstkr
8		Death Rate	DethRat
9		Business Partner	BusPartnr
10	External Factor	Feed Price	FedPrc
11		Selling price	SellPric
12		Seed Quality	SdQual
13		Environmental Quality / Pollution	EnvQualPol
14		Marketing	Mrktg
15		Shrimp Disease / Virus	ShrmpDisVr
16		Government policy	GovPolcy
17		Institutional	Inst
18		Market Demand	MrktDmnd

Figure 2. Matrix Direct Influence (MDI) of Shrimp Farming Business Sustainability

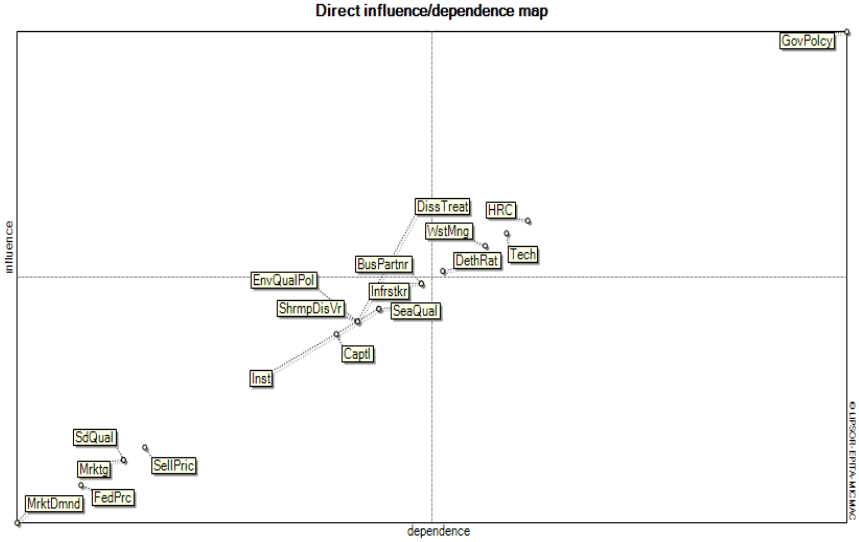
	1 : HRC	2 : Captl	3 : SeaQual	4 : Tech	5 : WstMng	6 : DissTreat	7 : Infrstkr	8 : DethRat	9 : BusPartnr	10 : FedPrc	11 : SellPric	12 : SdQual	13 : EnvQualPol	14 : Mrktg	15 : ShrmpDisVr	16 : GovPolcy	17 : Inst	18 : MrktDmnd
1 : HRC	0	1	3	3	3	3	3	3	2	1	1	1	1	1	1	3	3	1
2 : Captl	1	0	1	3	3	1	3	0	3	3	1	1	0	0	0	3	2	0
3 : SeaQual	3	1	0	3	3	1	3	3	0	0	0	0	3	0	3	3	1	0
4 : Tech	3	3	3	0	3	3	3	3	3	0	0	0	3	0	3	3	0	0
5 : WstMng	3	3	3	3	0	3	3	3	0	1	0	0	3	0	3	3	1	0
6 : DissTreat	3	1	1	3	3	0	2	3	0	0	0	0	3	0	3	3	1	0
7 : Infrstkr	3	3	3	3	3	2	0	2	3	0	0	0	2	0	1	3	1	0
8 : DethRat	3	0	3	3	3	3	2	0	0	0	0	3	3	0	3	3	1	0
9 : BusPartnr	2	3	0	3	0	0	3	0	0	3	3	3	0	3	0	3	3	0
10 : FedPrc	1	3	0	0	1	0	0	0	3	0	0	0	0	0	0	3	2	0
11 : SellPric	1	1	0	0	0	0	0	0	3	0	0	0	0	3	0	3	2	3
12 : SdQual	1	1	0	0	0	0	0	3	3	0	0	0	0	0	2	3	2	0
13 : EnvQualPol	1	0	3	3	3	3	2	3	0	0	0	0	0	0	3	3	2	0
14 : Mrktg	1	0	0	0	0	0	0	0	3	0	3	0	0	0	0	3	2	3
15 : ShrmpDisVr	1	0	3	3	3	3	1	3	0	0	0	2	3	0	0	3	1	0
16 : GovPolcy	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	0	2	2
17 : Inst	3	2	1	0	1	1	1	1	3	2	2	2	2	2	1	2	0	1
18 : MrktDmnd	1	0	0	0	0	0	0	0	0	0	3	0	0	3	0	2	1	0

The eighteen variables were classified into two, internal and external variables of shrimp farming. This finding corresponds to the previous works that elaborate on those variables in a different context of the study (Delphino et al., 2022; Elwin et al., 2020). The results of internal and external variables identification were input into the software MICMAC and evaluated for inter-variable influence in a matrix of 18 x 18 variables to be a Matrix Direct Influence (MDI), as may be observed in Figure 2. Influences range from 0 to 3, with the possibility to identify potential influences: 0: No influence; 1: Weak; 2: Moderate influence; 3: Strong influence.

Understanding Inter-Variable Relationship

After the 18 variables were identified using Matrix Direct Influence (MDI), a Direct Influence/dependence Map would be formed, as may be observed in Figure 3.

Figure 3. Sustainability Variables Map by Influence and Dependence



In Figure 3, it was apparent that the 18 variables were in quadrant II and quadrant IV. Quadrant II fell into the relay variables group, constituting the influencing variable but with high dependence, including Governance policy, Human Resource Capacity, Technology, Death rate, and Waste Management variables. These five variables were categorized into factors that reflect the instability of the *Vannamei* shrimp farming system. Previous studies also reveal similar results (Dong et al., 2023; Wang et al., 2022; Yang et al., 2020). Any change in any of the five variables may cause relatively serious consequences on the other variables. The remaining 13 variables were in quadrant IV, of which condition reflects the Excluded variables, commonly known as the "autonomous variables". The variables include Infrastructure, Seawater Quality, Business partner, Disease Treatment, Environmental Quality/Pollution, Shrimp Disease/Virus, Capital, Institutional, Feed Price, Selling price, Seed Quality, Marketing, and Market Demand. The fifteen variables had a small influence and also show small dependence and will not cause cessation of the system in the shrimp farming business. According to Godet in his book (Godet, 2006), based on the pattern formed from the inter-quadrant system as presented in figure 3, the system in the brackish water pond farming business activities is unstable since there is no clear difference between the influential variable and dependent variable.

Figure 4. Relationship of Inter-variable Direct Influence Relationship in Shrimp Farming Business Sustainability

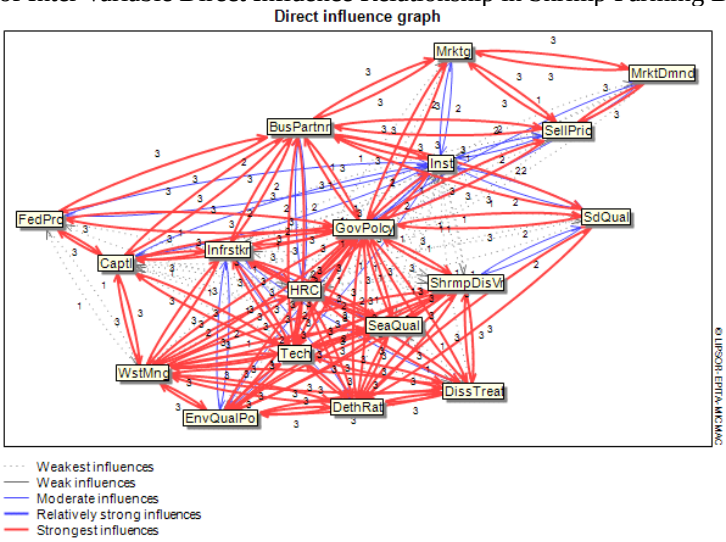


Figure 4 showed the network of direct influence between variables that determine success in the shrimp farming business in Kebumen. It was clear that there were very strong (thick red lines) influencing (outward arrow) and influenced (arrow towards the variable) variables. It was apparent that the Government policy strongly influenced the other variables. Death Rate was also a variable with a strong influence on the other variable, followed by the waste management variable, which also with strong influence on the other variables (Bontempi, 2021; Goolsbee & Syverson, 2021). Shrimp disease and Human resources capacity also strongly influenced the other variables (Rajeev et al., 2021).

Figure 5. Relationship of Indirect Influence between Variables of Sustainability

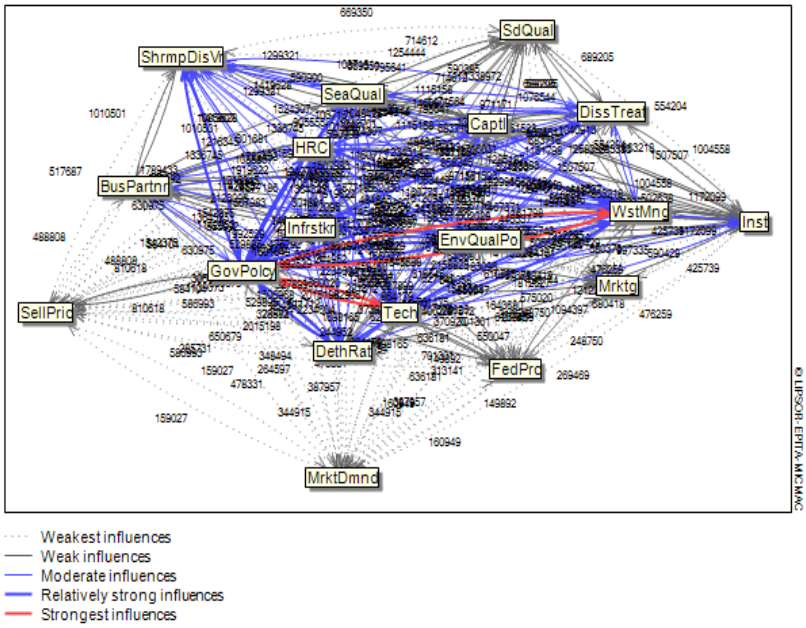
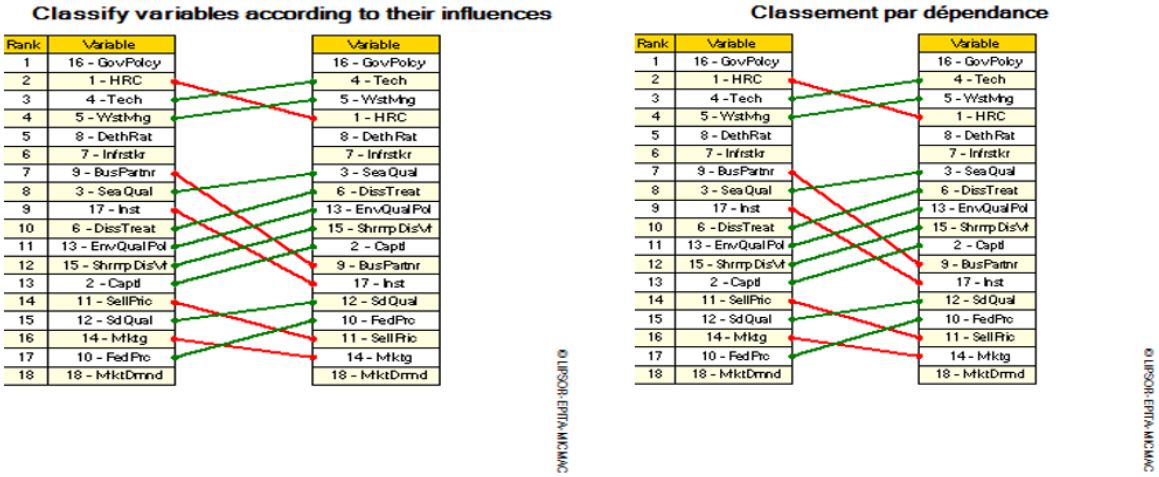


Figure 5 showed the inter-variable indirect influence on shrimp farming business sustainability. It was apparent that a strong indirect influence (red line) was shown by the external variable Government policy, internal variable Waste management, and external variable environmental quality/pollution with a strong influence on shrimp business sustainability (Murthy et al., 2022). Technology was also an internal variable that strongly influenced shrimp business sustainability. The indirect variables with weak influence (dotted line) included selling price, market demand, feed price, and seed quality. Variables with indirect, relatively strong influence on the other variables were shrimp disease/virus, human resources capacity, death rate, infrastructure, and waste management.

Figure 6. Ranking of Variables by Influence and Dependence



Rank	Variable	Variable
1	16 - GovPolcy	16 - GovPolcy
2	1 - HRC	4 - Tech
3	4 - Tech	5 - WstMng
4	5 - WstMng	1 - HRC
5	8 - DethRat	8 - DethRat
6	7 - Infrstkr	7 - Infrstkr
7	9 - BusPartnr	3 - Sea Qual
8	3 - Sea Qual	6 - DissTreat
9	17 - Inst	13 - EnvQualPol
10	6 - DissTreat	15 - Shrmp DisVt
11	13 - EnvQualPol	2 - Captl
12	15 - Shrmp DisVt	9 - BusPartnr
13	2 - Captl	17 - Inst
14	11 - SellPric	12 - Sd Qual
15	12 - Sd Qual	10 - FedPrc
16	14 - Mktg	11 - SellPric
17	10 - FedPrc	14 - Mktg
18	18 - MktDmnd	18 - MktDmnd

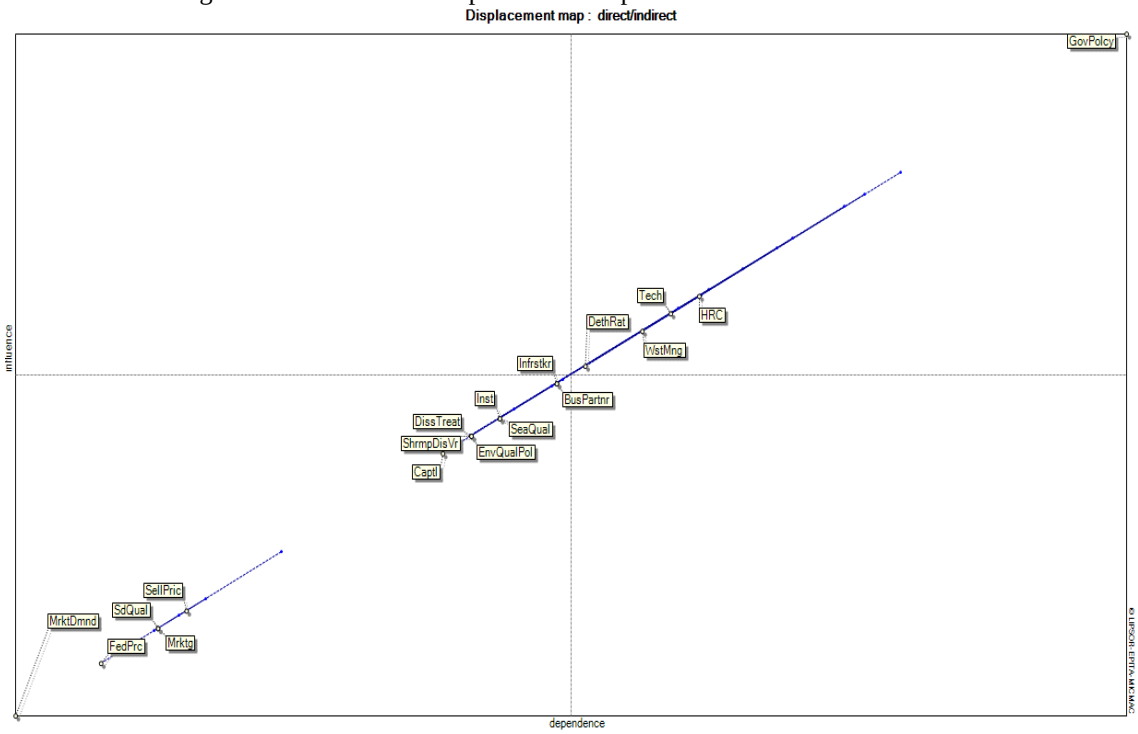
Rank	Variable	Variable
1	16 - GovPolcy	16 - GovPolcy
2	1 - HRC	4 - Tech
3	4 - Tech	5 - WstMng
4	5 - WstMng	1 - HRC
5	8 - DethRat	8 - DethRat
6	7 - Infrstkr	7 - Infrstkr
7	9 - BusPartnr	3 - Sea Qual
8	3 - Sea Qual	6 - DissTreat
9	17 - Inst	13 - EnvQualPol
10	6 - DissTreat	15 - Shrmp DisVt
11	13 - EnvQualPol	2 - Captl
12	15 - Shrmp DisVt	9 - BusPartnr
13	2 - Captl	17 - Inst
14	11 - SellPric	12 - Sd Qual
15	12 - Sd Qual	10 - FedPrc
16	14 - Mktg	11 - SellPric
17	10 - FedPrc	14 - Mktg
18	18 - MktDmnd	18 - MktDmnd

Figure 6 illustrated the comparison of ranking between variables by influence, such as the Government Policy variable that consistently ranked as the first influencing variable (Lee et al., 2022). Similarly, death rate, infrastructure, and market demand variables stayed consistently in their respective rank. The shift took place on the following variable: Human resources capacity in the MDI matrix initially ranked 2nd as the influencing variable, but after iteration by calculating indirect influence, it now ranks 4th. Likewise, the technology variable initially ranked 4th and now ranks 2nd. The waste management variable shifted from ranking 4th to 3rd. The business partner variable shifted from ranking 7th to 12th, followed by the institution variable from 9th to 13th. The disease treatment variable shifted from ranking 10th to 8th, Environmental Quality/Pollution variable from ranking 11th to 9th, and the shrimp disease/virus variable from ranking 12th to 10th influencing variable, similarly, the capital variable also shift from ranking 13th to 11th. Two variables ascend their ranking to be influencing variables, namely the seed quality variable to ranking 14th and the feed price variable from ranking 17 to

15th. Selling price and Marketing variables respectively descend from ranking 14th to 16th and from ranking 16th to 17th.

Figure 6 illustrated a comparison of variable ranking by dependence. 4 variables still consistently stayed in their ranking as dependence variables, namely government policy, death rate, infrastructure, and market demand, and the other variables shift their dependence ranking like the shift in the influencing variables, which meant that the variables influence depended on each other in the shrimp farming business system. In the comparison of ranking by influence and dependence, the government policy variable showed quite a significant role in business activity sustainability, followed by technology, waste management, and human resources capacity variables.

Figure 7. Inter-variable Displacement Map of direct and indirect influence



The shifts of the variables because of direct and indirect influence were observed in the inter-variable displacement map in figure 7. The dotted line shows a shift in variable position from the initial to the end position after accounting for indirect influence. All of the variables showed a shift of variable in the same quadrant and tend to be no shift except the market demand variable, which shifts but is still in quadrant IV (excluded variable) or autonomous variable, which meant only with small influence and dependence, only the shift illustrates changes in the magnitude of the variable. Government Policy still showed a strong position in influence and dependence on shrimp farming.

CONCLUSIONS AND RECOMMENDATIONS

Identifying the key factors in shrimp farming business sustainability is an important matter to solve and minimize the risk of uncertainty arising from external and internal interference and pressure in shrimp brackish water pond farming. Government policy serves as a variable with a strong and significant influence on shrimp farming business sustainability, in which good government policy will make the system in shrimp farming business able to reduce the pressure of and threat to sustainability. According to field facts, shrimp brackish water pond farming businesses on the coast of Kebumen Regency operates on their own with minimum attention, guidance, and policy of regulation on shrimp brackish water pond farming business operation. Minimum training in farming affects the capacity of the resources, only relying on their experience and practice, making them more susceptible to threats and problems causing a farming business vulnerability. This will also lead to bad farming management, such as good waste management, that, if no good management is applied, will threatens farming business sustainability and ecosystem sustainability. Local policy on guidance for and supervision over brackish water pond farming business is needed for them to continue and mitigate any risk of loss, either from the farming business community or risk of degraded environment or coastal ecosystem.

REFERENCES

Arthur, J. R., Phillips, M. J., Subasinghe, R. P., Reantaso, M. B., & MacRae, I. H. (2002). Primary aquatic animal health care in rural, small-scale, aquaculture development. *Asia Regional Scoping Workshop*.

Benjumea-Arias, M., Castañeda, L., & Valencia-Arias, A. (2016). Structural Analysis of Strategic Variables through MICMAC Use: Case Study. *Mediterranean Journal of Social Sciences*. https://doi.org/10.5901/mjss.2016.v7n4p11

Bontempi, E. (2021). Europe's second wave of COVID-19 infection and Italy's “strange” situation. *Environmental Research*, *193*, 110476. https://doi.org/10.1016/j.envres.2020.110476

Briggs, M., Funge Smith, S., Subasinghe, R. P., & Phillips, M. (2005). Introductions and movement of two penaeid shrimp species in Asia and the Pacific. In *FAO. Fisheries Technical Paper*.

Davis, R. P., Boyd, C. E., & Davis, D. A. (2021). Resource sharing and resource sparing, understanding the role of production intensity and farm practices in resource use in shrimp aquaculture. *Ocean & Coastal Management*, *207*, 105595. https://doi.org/10.1016/j.ocecoaman.2021.105595

Delphino, M. K. V. C., Laurin, E., Patanasatienkul, T., Rahardjo, R. B., Hakim, L., Zulfikar, W. G., Burnley, H., Hammell, K. L., & Thakur, K. (2022). Description of biosecurity practices

on shrimp farms in Java, Lampung, and Banyuwangi, Indonesia. *Aquaculture*, *556*, 738277. https://doi.org/10.1016/j.aquaculture.2022.738277

Ding, L., Liu, M., Yang, Y., & Ma, W. (2022). Understanding Chinese consumers' purchase intention towards traceable seafood using an extended Theory of Planned Behavior model. *Marine Policy*, *137*, 104973. https://doi.org/10.1016/j.marpol.2022.104973

Dong, P., Guo, H., Huang, L., Zhang, D., & Wang, K. (2023). Glucose addition improves the culture performance of Pacific white shrimp by regulating the assembly of Rhodobacteraceae taxa in the gut bacterial community. *Aquaculture*, *567*, 739254. https://doi.org/10.1016/j.aquaculture.2023.739254

Elwin, A., Jintana, V., & Feola, G. (2020). Characterizing shrimp-farm production intensity in Thailand: Beyond technical indices. *Ocean & Coastal Management*, *185*, 105019. https://doi.org/10.1016/j.ocecoaman.2019.105019

FAO/NACA/UNEP/WB/WWF. (2006). International Principles for Responsible Shrimp Farming. Network of Aquaculture Centres in Asia-Pacific (NACA). *Publicación de FAO/NACA/UNEP/WB/WWF*, *February*, 20.

Fauzi, A. (2019). *Teknik Analisis Keberlanjutan* (A. Fauzi, Ed.). Gramedia Pustaka Utama.

Godet, M. (2006). *Creating Futures: Scenario Planning as a Strategic Management Tool*. Economica.

Goolsbee, A., & Syverson, C. (2021). Fear, lockdown, and diversion: Comparing drivers of pandemic economic decline 2020. *Journal of Public Economics*, *193*, 104311. https://doi.org/10.1016/j.jpubeco.2020.104311

Hackett, Steven C., Moore, M. C. (2011). *Natural Resources Economics: Theory, Policy and the Sustainable Society* (3rd ed.). M.E. Sharpe, Inc.

Hák, T., Moldan, B., & Dahl, A. L. (2007). *Sustainability Indicators*.

Hempel, E., Winther, U., & Hambrey, J. (1998). *Shrimp Farming and the Environment – Can Shrimp Farming be Undertaken Sustainability?* World Bank.

Kumaran, M., Anand, P. R., Kumar, J. A., Ravisankar, T., Paul, J., vasagam, K. P. K., Vimala, D. D., & Raja, K. A. (2017). Is Pacific white shrimp (Penaeus vannamei) farming in India technically efficient? —A comprehensive study. *Aquaculture*, *468*, 262–270. https://doi.org/10.1016/j.aquaculture.2016.10.019

Kuzma, E., & Sehnem, S. (2021). Validation of the Measurement Scale for the Circular Economy: a proposal based on the precepts of innovation. *International Journal of Professional Business Review*, *7*(1), e0278. https://doi.org/10.26668/businessreview/2022.v7i1.278

Læss⃠e, J. (2010). Education for sustainable development, participation, and socio-cultural change. *Environmental Education Research*, *16*(1), 39–57. https://doi.org/10.1080/13504620903504016

Lebel, L., Mungkung, R., Gheewala, S. H., & Lebel, P. (2010). Innovation cycles, niches and sustainability in the shrimp aquaculture industry in Thailand. *Environmental Science and Policy*, *13*(4), 291–302. https://doi.org/10.1016/j.envsci.2010.03.005

Lee, C.-P., Hung, M.-J., & Chen, D.-Y. (2022). Factors affecting citizen satisfaction: Examining from the perspective of the expectancy disconfirmation theory and individual differences. *Asian Journal of Political Science*, *30*(1), 35–60. https://doi.org/10.1080/02185377.2022.2047081

Marirajan Murugan, & Natarajan, P. M. (2022). Agile Leader's Emotional Resilience and Their Digital Innovations and Business Transformations in a Workplace in Msme Sector (New Normal) to Mitigate COVID-19 & Its Successors. *International Journal of Professional Business Review*, *7*(4), e0755. https://doi.org/10.26668/businessreview/2022.v7i4.e755

Monsalve, E. R., & Quiroga, E. (2022). Farmed shrimp aquaculture in coastal wetlands of Latin America—A review of environmental issues. *Marine Pollution Bulletin*, *183*, 113956. https://doi.org/10.1016/j.marpolbul.2022.113956

Murthy, M. K., Khandayataray, P., Mohanty, C. S., & Pattanayak, R. (2022). A review on arsenic pollution, toxicity, health risks, and management strategies using nano remediation approaches. *Reviews on Environmental Health*, *0*(0). https://doi.org/10.1515/reveh-2022-0103

Paul, B. G., & Vogl, C. R. (2011). Impacts of shrimp farming in Bangladesh: Challenges and alternatives. *Ocean and Coastal Management*, *54*(3), 201–211. https://doi.org/10.1016/j.ocecoaman.2010.12.001

Paulus, C. A., & Fauzi, A. (2017). Factors Affecting Sustainability of Alternative Livelihood in Coastal Community of Nembrala Village East Nusa Tenggara: An Application of MICMAC Method. *Jurnal Ekonomi Pembangunan*, *18(2)*, 175–182.

Phornprapha, W. (2020). *Scholarship @ Claremont Shrimp Farming in Thailand: A pathway to Sustainability " Shrimp Farming in Thailand: A pathway to Sustainability " By: Warinyupa " Bebe " Phornprapha In partial fulfillment of a Bachelor of Arts Degree in Environmental Analysis*.

Pillay, T. V. R. (1997). Economic and social dimensions of aquaculture management. *Aquaculture Economics and Management*. https://doi.org/10.1080/13657309709380199

Rajeev, R., Adithya, K. K., Kiran, G. S., & Selvin, J. (2021). Healthy microbiome: A key to successful and sustainable shrimp aquaculture. *Reviews in Aquaculture*, *13*(1), 238–258. https://doi.org/10.1111/raq.12471

Rubel, H., Woods, W., Perez, D., Unnikrishnan, S., Felde, A. M. Zum, Zielcke, S., Lidy, C., & Lanfer, C. (2019). *A Strategic Approach to Sustainable Shrimp Production in Vietnam THE CASE FOR IMPROVED ECONOMICS AND*.

Sivaraman, I., Krishnan, M., & Radhakrishnan, K. (2019). Better Management Practices for sustainable small-scale shrimp farming. *Journal of Cleaner Production*, *214*, 559–572. https://doi.org/10.1016/j.jclepro.2018.12.172

St. Louis, T. J., Pedroza Filho, M. X., & Flores, R. M. V. (2022). Consumption frequencies, determinants, and habits of aquaculture species in Brazil. *Aquaculture International*, *30*(2), 919–936. https://doi.org/10.1007/s10499-022-00838-2

Sumarga, E., Syamsudin, T. S., Rahman, S. P., Kurnia Putri, A. R., Velia, Aldi, A. A., & Basyuni, M. (2022). Maintaining Carbon Storage Does Not Reduce Fish Production from Mangrove-Fish Pond System: A Case Study in Coastal Area of Subang District, West Java, Indonesia. *Forests*, *13*(8), 1308. https://doi.org/10.3390/f13081308

Venkatrayulu, C. (2019). *RESEARCH ARTICLE STUDIES ON SOCIO-ECONOMIC PROFILE, PROBLEMS, AND CONSTRAINTS OF SHRIMP FARMERS*.

Viederman, S. (1993). A dream of sustainability. *Ecological Economics*. https://doi.org/10.1016/0921-8009(93)90043-6

Wang, J., Che, B., & Sun, C. (2022). Spatiotemporal Variations in Shrimp Aquaculture in China and Their Influencing Factors. *Sustainability*, *14*(21), 13981. https://doi.org/10.3390/su142113981

WWF-Indonesia, T. P. (2014). *Better Management Practices Seri Panduan Perikanan Skala Kecil BUDIDAYA UDANG VANNAMEI Tambak Semi Intensif dengan Instalasi Pengolahan Air Limbah (IPAL)* (1 Desember). WWF-Indonesia.

Yang, W., Zhu, J., Zheng, C., Lukwambe, B., Nicholaus, R., Lu, K., & Zheng, Z. (2020). A succession of phytoplankton community during intensive shrimp (Litopenaeus vannamei) cultivation and its effects on cultivation systems. *Aquaculture*, *520*, 734733. https://doi.org/10.1016/j.aquaculture.2019.734733

Arthur, J. Richard et al. 2002. "Primary Aquatic Animal Health Care in Rural, Small-Scale, Aquaculture Development." In Asia Regional Scoping Workshop,

Benjumea-Arias, Martha, Leonel Castañeda, and Alejandro Valencia-Arias. 2016. "Structural Analysis of Strategic Variables through MICMAC Use: Case Study." Mediterranean Journal of Social Sciences. https://doi.org/10.5901/mjss.2016.v7n4p11

Briggs, Mathew, Simon Funge Smith, Rohana P. Subasinghe, and Michael Phillips. 2005. FAO. Fisheries Technical Paper Introductions and Movement of Two Penaeid Shrimp Species in Asia and the Pacific.

Dinas Kelautan Dan Perikanan Kabupaten Kebumen. 2018. No Title. Kebumen.

FAO/NACA/UNEP/WB/WWF. 2006. "International Principles for Responsible Shrimp Farming. Network of Aquaculture Centres in Asia-Pacific (NACA)." Publicación de FAO/NACA/UNEP/WB/WWF (February): 20.

FAO. 1997. "Aquaculture Development." FAO Technical Guidelines for Responsible Fisheries.

Fauzi, Akhmad. 2019. Teknik Analisis Keberlanjutan. ed. Akhmad Fauzi. Jakarta: Gramedia Pustaka Utama.

Godet, Michel. 2006. Creating Futures : Scenario Planning as a Strategic Management Tool. London: Economica.

Hackett, Steven C., Moore, Michael C. 2011. Natural Resources Economics: Theory, Policy, and the Sustainable Society. 3rd ed. London: M.E. Sharpe, Inc.

Hák, Tomás, Bedrich Moldan, and Arthur Lyon Dahl. 2007. Sustainability Indicators.

Hempel, Erik, Ulf Winther, and John Hambrey. 1998. Shrimp Farming and the Environment - Can Shrimp Farming Be Undertaken Sustainability? World Bank. http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:Shrimp+Farming+and+the+Environment#1%5Cnhttp://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:Inland+shrimp+farming+and+the+environment%230.

Kumaran, M. et al. 2017. "Is Pacific White Shrimp (Penaeus Vannamei) Farming in India Technically Efficient? - A Comprehensive Study." Aquaculture 468: 262-70. https://doi.org/10.1016/j.aquaculture.2016.10.019

Lebel, Louis, Rattanawan Mungkung, Shabbir H. Gheewala, and Phimphakan Lebel. 2010. "Innovation Cycles, Niches and Sustainability in the Shrimp Aquaculture Industry in Thailand." Environmental Science and Policy 13(4): 291-302. http://dx.doi.org/10.1016/j.envsci.2010.03.005. https://doi.org/10.1016/j.envsci.2010.03.005

Paul, Brojo Gopal, and Christian Reinhard Vogl. 2011. "Impacts of Shrimp Farming in Bangladesh: Challenges and Alternatives." Ocean and Coastal Management 54(3): 201-11. https://doi.org/10.1016/j.ocecoaman.2010.12.001

Paulus, C.A., and A. Fauzi. 2017. "Factors Affecting Sustainability of Alternative Livelihood in Coastal Community of Nembrala Village East Nusa Tenggara: An Application of MICMAC Method." Jurnal Ekonomi Pembangunan 18(2): 175-82. https://doi.org/10.23917/jep.v18i2.4397

Phornprapha, Warinyupa. 2020. "Scholarship @ Claremont Shrimp Farming in Thailand : A Pathway to Sustainability ' Shrimp Farming in Thailand : A Pathway to Sustainability ' By Warinyupa ' Bebe ' Phornprapha In Partial Fulfillment of a Bachelor of Arts Degree in Environmental Analysis."

Pillay, T. V.R. 1997. "Economic and Social Dimensions of Aquaculture Management." Aquaculture Economics and Management. https://doi.org/10.1080/13657309709380199

Rubel, Holger et al. 2019. A Strategic Approach to Sustainable Shrimp Production in Vietnam THE CASE FOR IMPROVED ECONOMICS AND.

Seafood Trading Intelligence Portal. "Members' Trade Data Analysis: Indonesia Q1 2020 Summary." https://seafood-tip.com/members-trade-data-analysis-indonesia-q1-2020-summary/ (October 8, 2020).

Sivaraman, Iyemperumal, M. Krishnan, and Kalidoss Radhakrishnan. 2019. "Better Management Practices for Sustainable Small-Scale Shrimp Farming." Journal of Cleaner Production 214: 559-72. https://doi.org/10.1016/j.jclepro.2018.12.172

Soebjakto, Slamet. 2019. "Kinerja Pembangunan Perikanan Budidaya." Kementerian Kelautan Dan Perikanan Republik Indonesia. https://kkp.go.id/an-component/media/upload-gambar-pendukung/kkp/DATA KKP/2019/Materi Konpers dan Halbil MKP/DJPB_pressconf (Kamis%2C 4 Juli 2019).pdf.

United Nations. 2020. "THE 17 GOALS | Sustainable Development." Department of Economic and Social Affairs.

Venkatrayulu, Ch. 2019. "RESEARCH ARTICLE STUDIES ON SOCIO-ECONOMIC PROFILE, PROBLEMS AND CONSTRAINTS OF SHRIMP FARMERS."

Viederman, Stephen. 1993. "A Dream of Sustainability." Ecological Economics. https://doi.org/10.1016/0921-8009(93)90043-6

Widowati, Hari. 2019. Indonesia Eksportir Udang Beku Terbesar Keempat Di Dunia 10 Negara Penguasa Ekspor Udang Beku Global Di 2018. https://databoks.katadata.co.id/datapublish/2019/06/12/indonesia-eksportir-udang-beku-terbesar-keempat-di-dunia#.

Wildan, Gayuh Zulfikar. 2020. "Kondisi Terkini Tambak Udang Indonesia: Trend Harga, Ekspor, Dan Efek Pandemi." : 1. https://app.jala.tech/kabar_udang/kondisi-terkini-tambak-udang-indonesia-trend-harga-ekspor-dan-efek-pandemi?redirect=https%3A%2F%2Fapp.jala.tech%2Fkabar_udang (October 10, 2020).

WWF-Indonesia, Tim Perikanan. 2014. Better Management Practices Seri Panduan Perikanan Skala Kecil BUDIDAYA UDANG VANNAMEI Tambak Semi Intensif Dengan Instalasi Pengolahan Air Limbah (IPAL). 1 Desember. Jakarta: WWF-Indonesia.