The dynamic model analysis of production feasibility and market valuation of intensive shrimp culture business

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Abstract. The purpose of this research is to analyze the shrimp production feasibility and market valuation of shrimp farming activities per pond (which is the considered business unit), based on the dynamic systems analysis model. This research was conducted using a qualitative descriptive method with purposive sampling for data sampling. The results showed a harvested biomass of 12,730 kg, an FCR of 1.42, an investment cost of 50,567 USD, a total production cost of 31,825 USD and a business profit of 7.295 USD. The dynamic model analysis results suggest that cultivation feasibility can be increased by stocking density adjusting. For a pond, the cultivation production has a maximum value of 2,500 kg, with an estimated maximum cultivation profit value of 5,000 USD and the maximum present value of the business profit of 4,000 USD. The analysis results also indicated an estimated market valuation of 0 to >26,667 USD, suggesting that this type of business has growth opportunities, with high projected global market values. The conclusion of this study shows the intensive shrimp farming feasibility under an appropriate management of the stocking density systems. The shrimp farming's estimated market value will continue to increase along with the profit margin value and the present value of the profit.

Key Words: financial, investment, present value, profit, shrimp.

Introduction. Shrimp farming is an agribusiness activity mostly carried out in Indonesia's coastal areas (Ariadi & Mujtahidah 2022). The most widely cultivated species of shrimp include: vaname shrimp (*Litopeneus vannamei*), tiger prawns (*Penaeus monodon*), and giant prawns (*Macrobrachium rosenbergii*) (Akbar & Sukarta 2020). Shrimp farming activities can be carried out in several maintenance patterns, such as traditional, semi-intensive and intensive with the application of various technologies (Ariadi et al 2019). Shrimp farming is of great interest in Indonesia because of its high benefit value compared to other fishery commodities (Muqsith et al 2021). Although shrimp farming has gained a large popularity, it is still highly vulnerable to the failure risk (Ulhaq et al 2022). The disease prevalence and cultivation systems that are not environmentally friendly are the main causes of shrimp farming productivity decrease (Wafi et al 2021a). Several technologies have been applied as an anticipatory measure to prevent these risks, but they are still considered as not very effective (Khanjani et al 2023). Therefore, determining the cultivation feasibility status is needed as a way of analyzing the land carrying capacity (Ariadi & Wafi 2020).

The carrying capacity determination is related to the size of the shrimp culture, which is an indicator of the investment value of a business, to be compared to the investment products' prices and returns, on the market (Apriyanthi et al 2022). An economic valuation assessment is also based on several factors, other than financial, such as environment conditions, market opportunities, and global demand (Onofri & Nunes 2020). This economic valuation assessment is needed so that a business can carry out branding and improve its value on the investment markets (Nie et al 2021).

Based on the explanation, the purpose of this research was to analyze the shrimp production feasibility and market valuation of shrimp farming activities based on dynamic systems analysis model. The dynamic modeling system analysis was used to determine the correlation between shrimp culture business feasibility and the shrimp market valuation and thus to evaluate the business perspectives.

Material and Method

Description of the study sites and methodology. This research was conducted in the intensive shrimp farming ponds of Pondok Salafiyah Syafi'iyah Sukorejo, Situbondo Regency in December 2022-February 2023. The characteristics of pond locations for research sample data are similar to Ariadi et al (2019), namely: having an active shrimp culture cycle, a production profit margin >5,000 USD, a harvest production >15,000 kg ha^{-1}, and an investment level >250,000 USD. The research method used was descriptive and qualitative. The research data examined consisted of aquaculture production parameters, which included: stocking density, shrimp weight, growth rate, shrimp biomass, and feed conversion ratio (determined by measuring the harvested specimens, and operational data on the cultivation process, obtained from the shrimp farmers during the research. Biological data collection for shrimp is calculated based on the formula (Diatin et al 2021):

$$FCR = (F/(W_t+D-W_0))$$

$$RGR = ((W_t-W_0)/(W_0 \times t)) \times 100\%$$

$$Biomass = RGR \times SR$$

$$SR = (N_t/N_0) \times 100\%$$

Where:
FCR – feed conversion ratio;
F – weight of feed eaten (gr);
W_t – final shrimp biomass;
D – dead shrimp biomass;
W_0 – shrimp stocking biomass;
t – cultivation time;
RGR – relative growth rate;
SR – survival rate;
N_t – number of shrimp at harvest;
N_0 – number of shrimp at stocking time.

Other data observed in the current study are production costs, profits from harvested commodities' sales, and business investment costs. which were collected using purposive sampling of the interviewed cultivators, through questionnaires. The accumulated research data analysis was then carried out by dynamic modeling to determine the relationship pattern between the financial feasibility of shrimp culture businesses and the pond ecological feasibility.

Statistical analysis. The research data were analyzed using dynamic modeling system analysis with Stella ver 9.0.2 software. Dynamic model analysis is intended to determine predictively the relationship of the shrimp culture feasibility with the business economic feasibility.

Results. The production characteristics of intensive shrimp farming activities were presented in Table 1. For an intensive pattern shrimp culture with a long cycle, the production performance is reasonable. Optimum production levels will correlate with a better of shrimp farming financial feasibility (Ariadi et al 2019).

Table 1

Shrimp farming production data in this research

No.	*Indicators*	*Value*
1.	Stocking density (fry m^{-2})	125
2.	Shrimp weight (gr)	35
3.	Growth rate (gr day^{-1})	0.32
4.	Shrimp biomass (kg)	12.730
5.	Feed conversion ratio	1.42
6.	Paddle aerator (HP)	32
7.	Business investment cost (USD)	50.567
8.	Production cost (USD)	31.825
9.	Benefit cost (USD)	7.295

Shrimp growth rate models. The shrimp biological growth rate in ponds is largely determined by pond environment and shrimp metabolism condition (Gallaway et al 2020). Shrimp growth rate is also determined by the shrimp biomass density in the pond ecosystem. These dependencies are described in the causal loop model in Figure 1.

Based on the model illustration in Figure 1, it is illustrated that the shrimp biomass in ponds will continue to increase up to 2,000 kg. The shrimp biomass carrying capacity to support the shrimp growth is of 2,000 kg; beyond the carrying capacity, the shrimp growth will be hampered. Shrimp biomass will also have an influence on the shrimp pond productivity (Costa et al 2018). The biomass accumulation will increase the level of oxygen consumption in pond waters (Wafi et al 2021b).

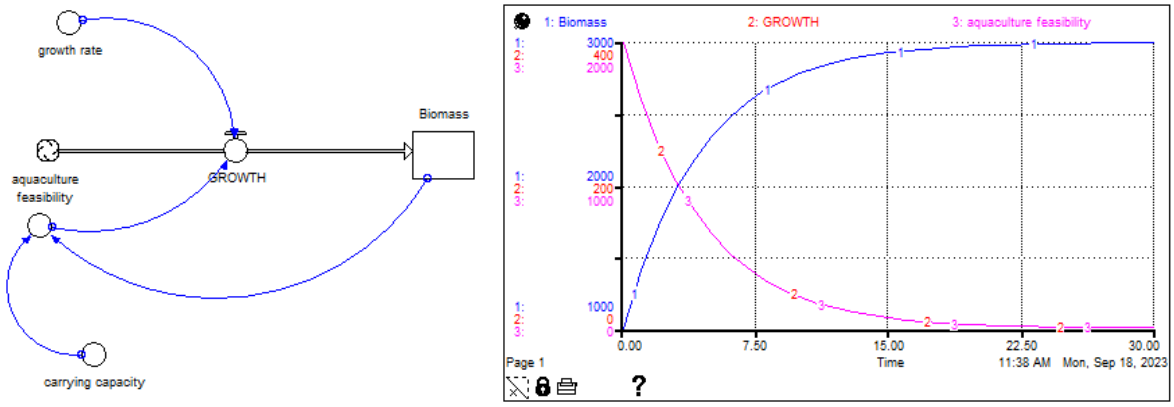

Figure 1. Model and simulation results of the shrimp biological growth rate.

The shrimp growth rate and aquaculture feasibility will decrease, as the shrimp reared biomass increases (Figure 1). The level of carrying capacity will decrease due to the increasing amount of pond waste (Ariadi et al 2022), while the growth rate of shrimp which continues to decline, due to unsuitable ecological conditions (Figure 1). This decrease of shrimp growth rate also correlates with the ponds productivity which is increasingly suboptimal (Syah et al 2014).

Stocking density and its influence on the shrimp culture feasibility. An option for managing the shrimp culture feasibility is to optimize the stocking density. Shrimp stocking density contributes to the population dynamics and the oxygen consumption rate by shrimp. In addition to the regulation of stocking density, it is also very important to consider the paddle wheel use, which affects the shrimp culture feasibility, since the paddle wheel use maintain a constant waters oxygenation (Wang et al 2021). The causal loop model illustration for controlling the amount of stocking density and its effect on the shrimp culture feasibility can be seen in Figure 2.

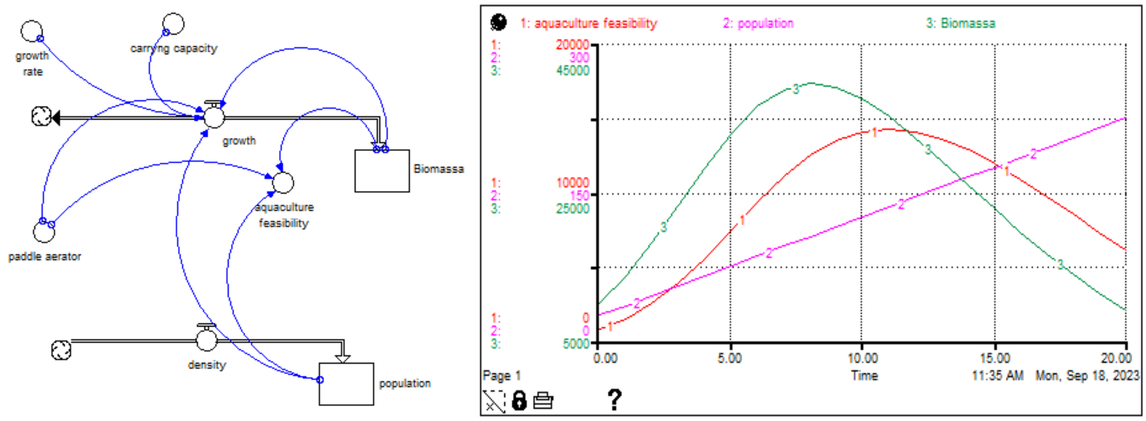

Figure 2. Model and simulation results of the shrimp culture feasibility model.

Based on the model illustration in Figure 2, adjusting the stocking density can change the ecological feasibility graph of shrimp farming from initially decreasing to slowly increasing over a certain period of time. A regular adjustment of the feed system also makes the shrimp farming cycle more productive (Madusari et al 2022). The increasing level of cultivation productivity is correlated with the estimated profit and feasibility status of shrimp culture (Gallaway et al 2020). The shrimp biomass will have an impact on the shrimp farming feasibility level in ponds. The carrying capacity is determined by the use of pond facilities and by the water environmental conditions (Lavoie et al 2022). The level of carrying capacity and the land feasibility status that can later determine the pond area's level of production (Junior et al 2021).

Aquaculture feasibility correlation model for business profits. The feasibility of aquaculture is correlated with the profit value of shrimp cultivation and the perceived value pricing (PVP), as suggested by the causal loop model. The business profit is obtained from the ratio of the infrastructure usage, feed and other operational costs to the value of the harvested commodity profits (Ariadi et al 2019). The causal loop model of the relationship between aquaculture production and business profits can be seen in Figure 3.

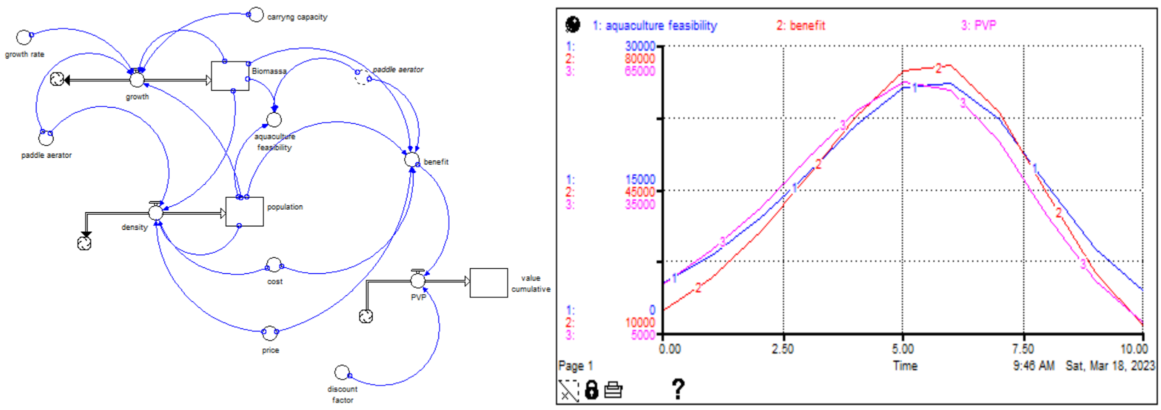

Figure 3. Model simulation of the relationship between business feasibility and profit.

Based on the results of the Figure 3. it is described that, when the feasibility level of shrimp culture production per pond continues to increase to a maximum limit of 2,500 kg it will have an impact on the benefit maximum production value of 5,000 USD. The latter will affect the net present value of the profit of 4,000 USD by unit of production (pond). The business present value is the business profits which describes the net income (Shin et al 2023).

From the business profit value and net present value, it can be observed that the intensive shrimp farming business would be very profitable. The business profit level determines the business financial feasibility on the long term (Diatin et al 2021). The net present value will also greatly determine the level of business re-investment in the global market (Pandyaswargo et al 2022). Several studies also found that the business profit will affect the business sensitivity and the maximum production capacity of a business unit, this means that a productive shrimp culture business will correlate with the level of sustainability of the operational cycle over a longer time period (Colpo et al 2022).

Market value model for intensive pattern shrimp culture business. The business profits and the business market value can be determined dynamically. The model and estimated market value of this intensive shrimp farming activity can be seen in Figure 4. This estimated market value will then have an impact on the business status continuity in the next few years (Astriani et al 2019).

Based on the dynamic model analysis in Figure 4, it is stated that fluctuations of profits and technical feasibility of shrimp culture have no impact on the business market valuations. The market valuation of the shrimp farming business is drawn to continue to increase, meaning that the level of investment acceptance in this business is very large. The estimated level of market valuation is described from 0 to >26,667 USD. A high and progressive market valuation makes it possible to form business unit stability in various economic conditions (Firtescu 2012).

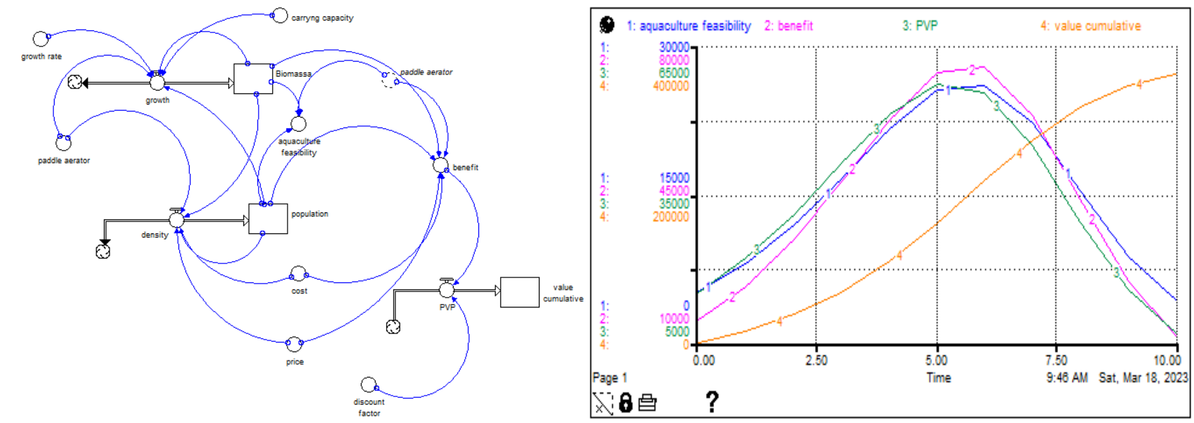

Figure 4. Model simulation of the shrimp farming's profit value and market valuation.

Overall, from the economic analysis it can be explained that the level of aquaculture production feasibility, which is described by the amount of cultivation production per cycle, can be increased by adjusting the stocking density of shrimp amount. A steady increase of the production amount will affect profit margins, the present value of business profits, and the value of business market valuations. The business impacts will empirically have an impact on the prediction profit margins in the long term (Mammadli 2017). Based on the analysis of production performance, shrimp farming activities are also described as quite ideal to be developed (Ariadi et al 2021).

Conclusions. This research, based on the dynamic modeling system analysis, shows that the feasibility of shrimp cultivation can be managed sustainably with an appropriate management system and the estimated market assessment of intensive shrimp cultivation activities will continue to increase along with the stability of shrimp cultivation. profit margin and present value profit points, so that from the results of this analysis a more progressive business development and investment pattern can be implemented.

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Conflict of interest. The authors declare no conflict of interest.

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