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DESIGNING OF CLOSED-LOOP SUPPLY CHAIN ON DRY LAND-BASED CATFISH AQUABUSINESS IN GUNUNGKIDUL: A SYSTEM DYNAMICS APPROACH

RANCANG BANGUN RANTAI PASOK PUTARAN TERTUTUP PADA USAHA PERIKANAN LELE LAHAN KERING DI GUNUNGKIDUL: PENDEKATAN DINAMIKA SISTEM

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ABSTRACT

Dry land-based catfish fishery is one of the promising rural aquabusiness in Gunungkidul, Yogyakarta. There are several problems in this business, for example, supply-demand balancing, calculation accuracy of production capacity, and equitable profit distribution to each stakeholder. This research aimed to design a closed-loop supply chain of dry-land catfish industrial-fishery model by employing the system dynamics approach. Powesim Studio 7 coupled MINITAB 14 was applied to measure the robustness of the supply chain management system, to predict optimum production capacity, and to balance profit distribution. A financial analysis was also performed to determine business feasibility. Three scenarios of price were created by considering the predicted trend of catfish consumption and formulated three alternative prices by appraising the juvenile fish production, aquaculture practices, local feedstock manufactured by farmers, and fish-by products distributed by small-enterprises. Those consideration units were constructed of four observed models. The highest profit to stakeholder was obtained by scenario III that was directed to increase the juvenile fish price to Rp 240/fish, consumption-sized fish at the price of Rp 18,000/kg, fish-by product at the price of Rp 150,000/kg, and local feed at the price of Rp 9,000/kg. According to financial analysis, the four subsystems in dry land-based catfish aquabusiness were all feasible by BCR>1; PP was 5-9 years, NPV>0, PI>1, and IRR>15%/year. The implementation of the system required synergetic action among policymakers, farmer cooperative, and local innovation centers.

Keywords: system dynamics, closed-loop supply-chain, dry land-based catfish aquabusiness.

ABSTRAK

Perikanan lahan kering di perdesaan di Gunungkidul tergolong menjanjikan. Usaha ini mempunyai beberapa permasalahan operasional, seperti keseimbangan permintaan dan penawaran, ketepatan perhitungan kapasitas produksi, dan pemerataan distribusi keuntungan pada setiap pelaku usaha. Penelitian ini bertujuan merancang rantai pasok putaran tertutup pada model industri perikanan lele lahan kering dengan menggunakan pendekatan model dinamis. Powersim Studio 7 dan MINITAB 14 digunakan untuk mengukur kemantapan sistem manajemen rantai pasok, memprediski kapasitas produksi maksimum, dan keseimbangan distribusi keuntungan. Analisis finansial juga dilakukan untuk mengukur kelayakan usaha. Tiga jenis skenario harga dibuat berdasarkan prediksi pola konsumsi lele dan formulasi dari tiga alternatif harga dengan menilai produksi benih lele, praktik budidaya, produksi pakan ikan lokal, dan distribusi produk olahan ikan oleh UMKM. Unit-unit pertimbangan tersebut membentuk empat model terobservasi. Keuntungan tertinggi untuk pelaku usaha dihasilkan melalui skenario III dengan mengatur peningkatan harga benih menjadi Rp 240/fish, harga ikan lele konsumsi adalah Rp 18,000/kg, harga olahan ikan lele adalah Rp 150,000/kg, dan harga pakan ikan lokal adalah Rp 9,000/kg. Berdasarkan analisis finansial, empat subsistem dalam usaha perikanan lele lahan kering adalah layak dengan BCR>1, PP antara 5-9 tahun, NPV>0, PI>1, dan IRR>15%/tahun. Untuk menerapkan sistem ini perlu sinergi antara penentu kebijakan, koperasi petani, dan pusat inovasi lokal.

Kata kunci: sistem dinamik, rantai pasok putaran tertutup, usaha perikanan lele lahan kering

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INTRODUCTION

Gunungkidul specific fisheries center (*Minapolitan*) of Yogyakarta province was defined and assigned by the Ministry of Marine Affairs and Fisheries based on Decision Number 32 in 2010 and updated by Decision Number 35 in 2013 (KKP, 2010, 2013). It focused on dryland catfish aquabusiness, mainly located in Playen, Wonosari, and Patuk sub-district. These sub-districts have been supported by several other hinterlands such as Playen, Wonosari, Semanu, Paliyan, Karangmojo, Semin, and Ngawen sub-districts as the first priority areas. Subsequently, Tanjungsari, Nglipar, Ponjong, Gedangsari, Patuk, Girisubo, and Saptosari sub-districts as the second priority areas. Additionally, Rongkop, Saptosari, and Panggang sub-districts are arranged for water conservation areas to support other sub-districts. Those strategic plots are shaping the Gunungkidul *Minapolitan* landscape (DKP Gunungkidul, 2013; Septriani, 2015).

Previously, *Minapolitan* was modified from a specific agricultural excellence center well-known as *Agropolitan*, which admitted as a particular location that accommodates single or multiple growth centers in rural areas with a high-performance fisheries production basis (Abidin, Setiawan, Soemarno, Primyastanto, & Sulong, 2019). *Minapolitan* has unique management, pattern, and system of natural resources utilization articulated by a functional hub of social empowerment and settlement existing based on aquabusiness (Mawardati, 2018; Mawarsari, Dewanti, & Nurrahman, 2017). According to Gunungkidul Marine Affairs and Fisheries statistics in 2018, there was a significant increase in freshwater fisheries production by 7,200 tons in 2015 to 11,651 tons in 2017. The highest fishery production volume was catfish. It took account of 90.36 percent of total annual freshwater fisheries production in 2017 by 10,527.67 tons. This value has improved 33,49 percent compared to 2016 (**Table** 1). The catfish juveniles stock has significantly increased by 35.06 percent in the last three years (**Figure** 1) (DKP Gunungkidul, 2018).

Table 1. Total Annual Production by Fish Commodity in Gunungkidul 2011-2017

No	Commodities	Total Annual Production (Tons)						
		2011	2012	2013	2014	2015	2016	2017
1	Catfish	3.403,78	4.391,39	5.881,39	5.980,78	6.505,76	8.684,28	10.527,67
2	Tilapia	197,50	254,80	341,26	347,02	377,49	503,89	610,85
3	Pomfret	57,23	73,83	98,88	100,55	109,38	146,01	177,00
4	Gouramy	41,97	54,15	72,53	73,75	80,22	107,09	129,82
5	Silver Barb	20,00	25,81	34,56	35,15	38,23	51,04	61,871
6	Vannamei Shrimp	1,39	1,80	2,41	2,45	2,66	3,55	4,305
7	Goldfish	16,14	20,82	27,88	28,35	30,84	41,17	49,91
8	Other Fish	28,99	37,40	50,10	50,94	55,41	73,97	89,67

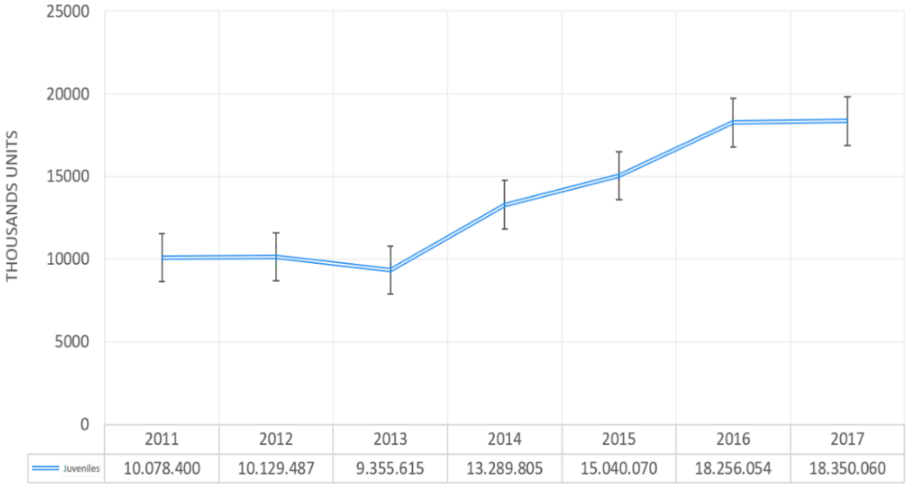

Figure 1. Total Annual Catfish Juveniles Stock Production in Gunungkidul 2011-2017

Based on a standard format designed by the Ministry of Marine Affairs and Fisheries, Gunungkidul *Minapolitan* has also set goals that cover multi-sectors and interests, mainly to promote regional economic development in terms of aquabusiness that jointly strengthened by government, research centers, private parties, and local peoples. It drives to achieve productive business activities, reducing poverty, provide more extensive employment opportunities, adaptive to fast global technological changing, facilitate effective communication channels, to open new market engagement, and to stabilize closed-loop supply chain in the aquabusiness system (Mawardati, 2018; Wulanningrum & Jayanti, 2016).

The closed-loop supply chain on dry land-based catfish aquabusiness investigated in this present research was a series of rural fishery enterprises from upstream to downstream, including fish juvenile stock production, routine aquaculture practices, local catfish feedstock manufactured by farmers, and fish-by products distributed by small-enterprises in Gunungkidul *Minapolitan*. Rural fishery management involves complex interactions among biological processes (Holland, 2010), varied social environments of users groups, conflicting management interest (Jiang, Min, Chang, & Ge, 2017), uncertainty of stock status (Bradley et al., 2019), and anthropogenic disturbance (Ward et al., 2016).

Considering the high potential of dry land-based catfish aquabusiness in Gunungkidul *minapolitan,* it technically needs to be supported by comprehensive planning to overcome complex problems, for example, supply-demand balance, the accuracy of production capacity calculation, market capacity prediction, and profit-sharing distribution for all stakeholders (Tedeschi, Nicholson, & Rich, 2011). The solution could be designed by closed-loop dynamics system modeling and simulation approach (Konkarikoski, Ritala, & Ihalainen, 2010; Sterman, 2000, 2006). The system dynamics method is frequently implemented to analyze the complex problems of social and economic interaction, as that condition changes rapidly because of various uncontrol and unforeseen factors. Sterman informed the steps of the system dynamics approach, as described below (**Figure** 2).

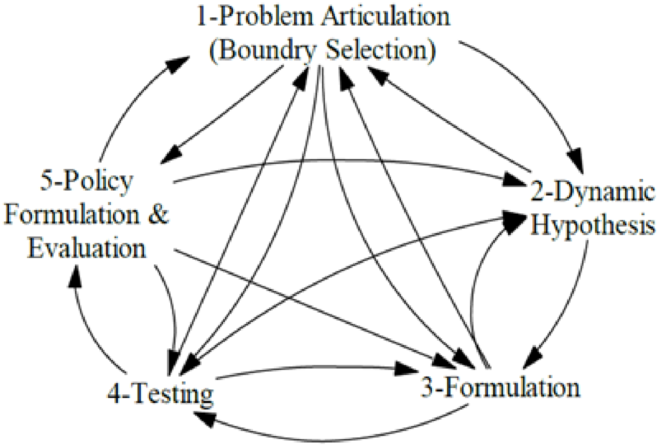

Figure 2. Feedback process of modeling a complex problem based on the system dynamics approach (Source: Sterman, 2000)

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According to Sterman, to solve the complex problem of the closed-loop dryland-based catfish supply chain in Gunungkidul *Minapolitan* by using the system dynamics approach, it needs to follow the essential procedures described below (Sterman, 2000):

a. Defining, classifying, and identifying the problems
b. Mapping closed-loop diagram of the supply chain to describe causes and effects
c. Generating the mathematical model by using stock and flow diagram
d. Computing and running the simulation and validation
e. Formulating the scenarios and evaluation
f. Selecting and implementing the most suitable solution

Complex problems could not be solved by using a simple method with a single cause. Thus, the system providing a basis to understand multiple causes of problems in a system framework is highly needed (Bastan, Sisi, & Nikoonezhad, 2016; Reinker & Gralla, 2018). However, the researchers have not investigated yet so far about the system dynamics in Gunungkidul *Minapolitan* based on its potential dryland catfish aquabusiness. Therefore, the work aims to design the closed-loop supply chain of the dry-land catfish industrial-fishery model by employing the system dynamics approach.

RESEARCH METHOD

In this research, a dynamics model based on general procedures of the System Dynamics method was designed to simulate several management scenarios both at tactic and strategic levels. This method was first introduced and formulated at MIT in the 1950s by J. W. Forrester. Afterward, it was improved and extended to be employed in many sectors of the industrial world (Bastan et al., 2016; Sterman, 2018). This approach could depict multiple problems in a complex system, analyze them by simulation, and describe either unexpected or unspecified outcomes in decision making (Ahmadvand, Bastan, & Mohammad, 2015; Farideh & Mahdi, 2014). Technically, it provides several alternatives and planning to predict the impacts of some scenarios to propose strategic decisions.

Materials

The research was carried out in Gunungkidul *Minapolitan* and its hinterlands. Data collection was performed by observation, interview, questionnaire, and focus group discussion. Purposive sampling was implemented for selecting the respondences, included one unit of local farmer cooperative and ten units of farmer group with at least eight individual farmers per each as samples.

Methods

a. Research design

The research was designed by analyzing primary, secondary, literature review, and expert acquisition data to identify the stakeholders' needs deeply, problem formulation, and existing system, then to design the fit model (**Figure** 3). Subsequently, the system approach was continuously implemented by following the iterative logic work-flow below (**Figure** 4). The conceptual framework of this research is shown in **Figure** 5. Henceforth, the model was computed, verified, and validated by Powersim Studio 10 software. The model was analyzed the sensitivity and stability by continuous trial-step running.

b. Data Processing Methods

All data components in the closed-loop supply chain model were measured and simulated by Powersim Studio 10 coupled MINITAB 14 software. The expense structure was processed to determinate the enterprise's performance by financial analysis method. Financial parameters of benefit/cost ratio (BCR), net present value (NPV), internal rate return (IRR), payback period (PP), profitability index, and break-even point (BEP) were calculated.

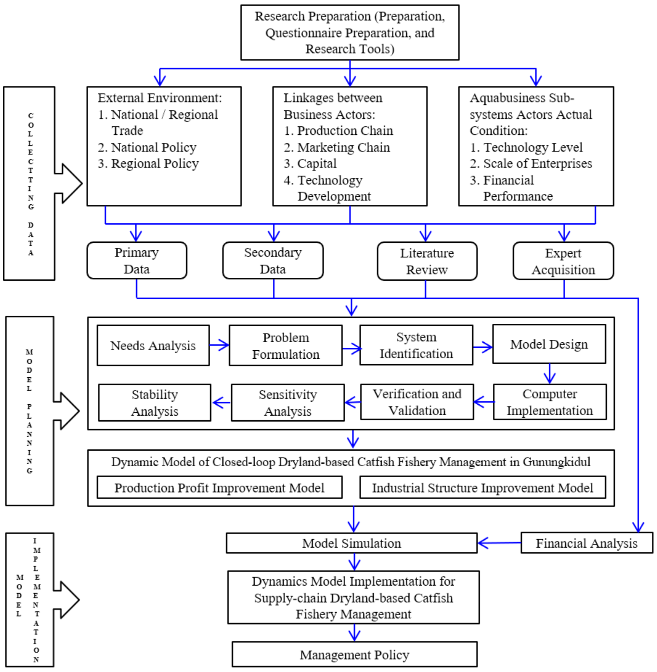

Figure 3. The research design of closed-loop supply chain dryland-based catfish aquabusiness

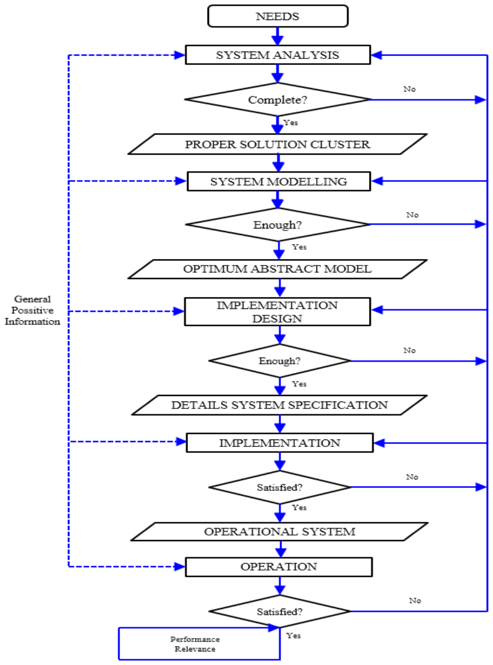

Figure 4. System approach of closed-loop supply chain dryland-based catfish aquabusiness

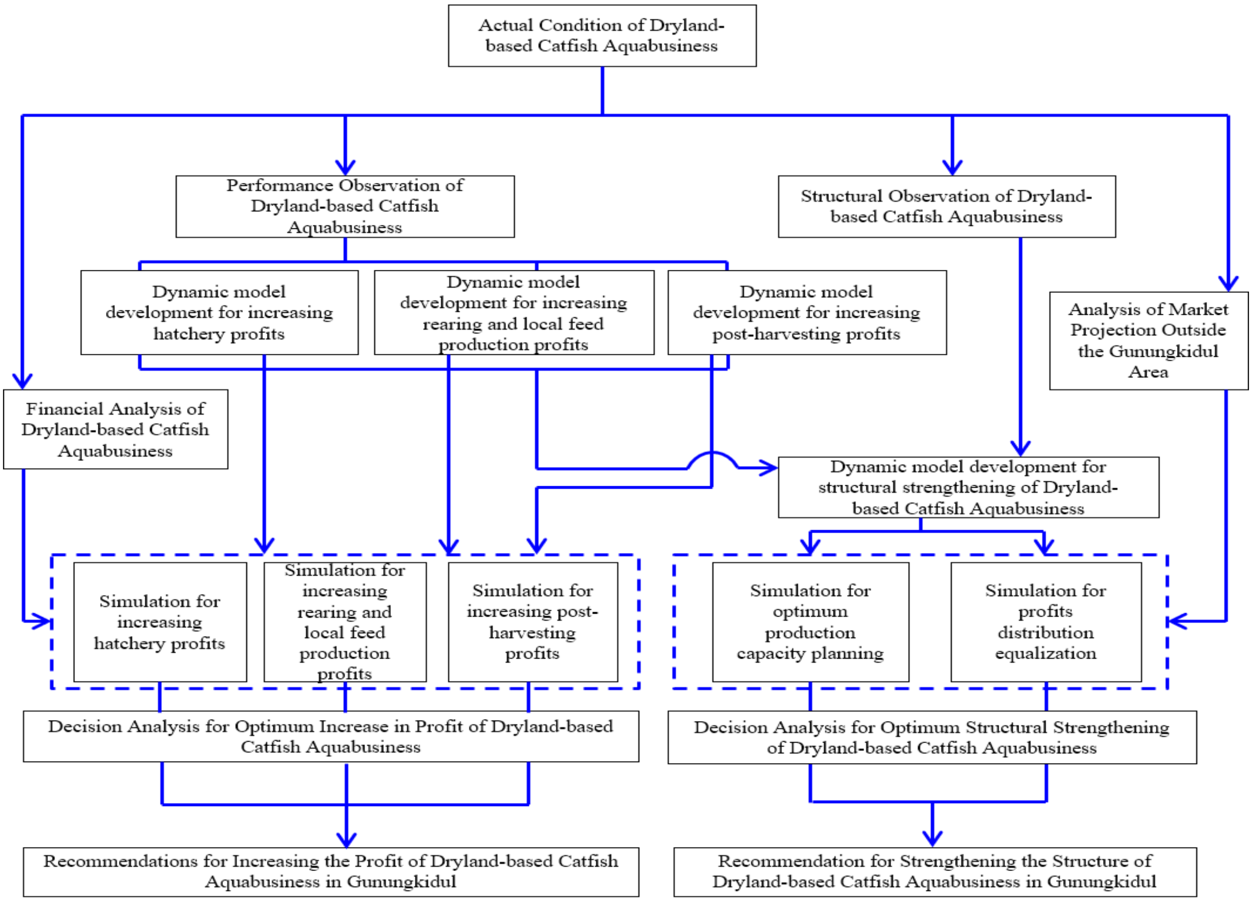

Figure 5. Conceptual framework of closed-loop supply chain dryland-based catfish aquabusiness

c. Validation Model

Validation is the last part of model development stages to verify whether the model's output accurately reflects the actual condition system and robust. It was carried out by observing internal consistency, correspondence, and representation of outputs. (Tsioptsias, Tako, & Robinson, 2016). Validation of each subsystem was conducted in consecutive tests as part of model improvement by quantitative comparing model behavior of the actual system by employing Mean Absolute Percentage Error (MAPE) (Puspitaningrum, 2019). MAPE is one of a relative parameter related to percentage error, to measure the compatibility of result forecast with actual data by aggregating the mean of over multiple in observation pairs prediction (Morley, 2016; Morley, Brito, & Welling, 2018). MAPE equation shown below:

$$MAPE = 100\%\ x\ \frac{1}{n}\sum_{i=1}^{n}\left|\frac{y_i - x_i}{x_i}\right| \quad (1)$$

$$= 100\%\ x\ \frac{1}{n}\sum_{i=1}^{n}\left|\eta_i\right| \quad (2)$$

Where, = simulation data result; = actual data; n = period/data number. Interpretations for model compatibility measured by MAPE, these are MAPE<5% is very accurate, 5%<MAPE<10% is accurate, and MAPE>10% is not accurate. The absolute percentage error value was calculated for every point of forecasting and divided by *n* and multiplying by 100%.

RESULTS AND DISCUSSION

Problem statements

This problem formulation was carried out to determine differences in interests due to the inequality of the desires of the components involved in the dynamics system as well as knowing the size of the impact caused by these differences in the system. The main problems that arise in the dryland-based catfish aquabusiness system are four crucial issues, including (1) the absence of supply-demand balance, (2) price fluctuations, (3) lack of market information, and (4) conflicts of interest between stakeholder. The four crucial problems caused instability in this aquabusiness system.

This instability causes farmers to lose money often and to start to leave this business. This supply-demand imbalance could be seen from the phenomenon of oversupply on the market, overstock in each business actor because there are still too many goods on the market, and also scarcity due to the absence of goods on the market. Furthermore, these price fluctuations occur at certain months at a time when there was much technical assistance from the local government (seeds, feed, and tarpaulins). Next, concurrent cultivation time also causes the same harvest.

This condition caused the price to drop dramatically. Then, during the year-end holidays and the beginning of the new year, demand usually increases, but there is no supply of goods so that the price of catfish could soar. These two things are the impact of the absence of valid and up-to-date market information about current trends and market dynamics. Besides, the occurrence of a conflict of interest is also an obstacle in the development of this aquabusiness system.

Input-output relation

The input-output diagram could be used as the investigation method on variables in the policy scenario and sustainability indicators of the aquabusiness system model. The input-output diagram could be employed to categorize input variables, output variables, and parameters determining system structure (Sadirsan, Siregar, Eriyatno, & Legowo, 2015). Dryland-based catfish aquaculture in Gunungkidul *Minapolitan* has controlled and uncontrolled input, controlled output, environmental input, and desired output. The input-output diagram of this system dynamics is shown in **Figure** 6.

Uncontrolled inputs include global warming, aquatic environmental health, pests and diseases of fish, natural disaster, consumer preference, changes in consumer desires, changes in the selling price and demand for catfish on the market, changes in the prices of inputs for production of hatchery, rearing, fish feed production, and postharvest, Rupiah exchange rate, interest rate, and inflation rate. Those uncontrolled inputs need to manage in order to create controlled outputs.

Controlled inputs include hatchery technology, fresh-water aquaculture technology, industrial manufacture technology for local feed production, industrial manufacture technology for fish-meal as the primary raw material of feed production, transportation system, information technology, and layout design of the local business area.

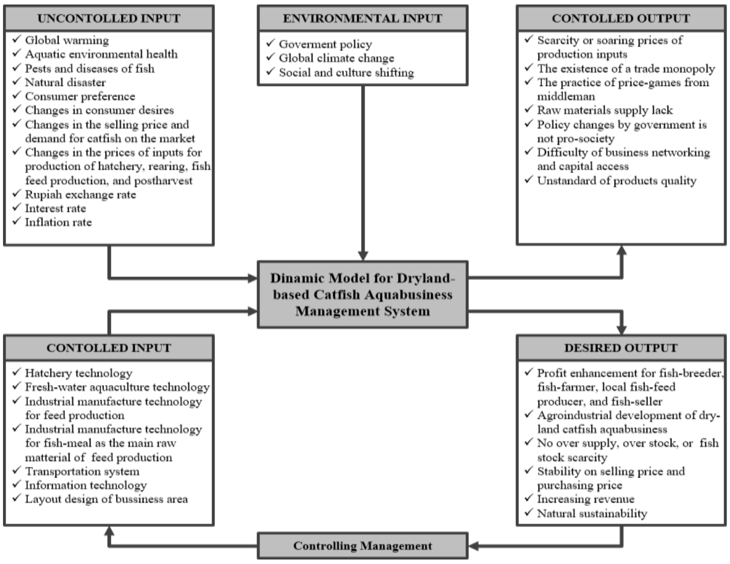

Fig. 6. Input-output diagram of closed-loop supply chain dryland-based catfish aquabusiness

Additionally, the desired outputs were obtained by processing controlled output in the aquabusiness system. It includes profit enhancement for fish-breeder, fish-farmer, local fish-feed producer, and fish-salesman, aquabusiness development of dry-land catfish fishery, no oversupply, overstock, or fish stock scarcity, stability on selling price and purchasing price in the catfish business, increasing revenue, and natural sustainability. The environmental input also has a direct influence on the system.

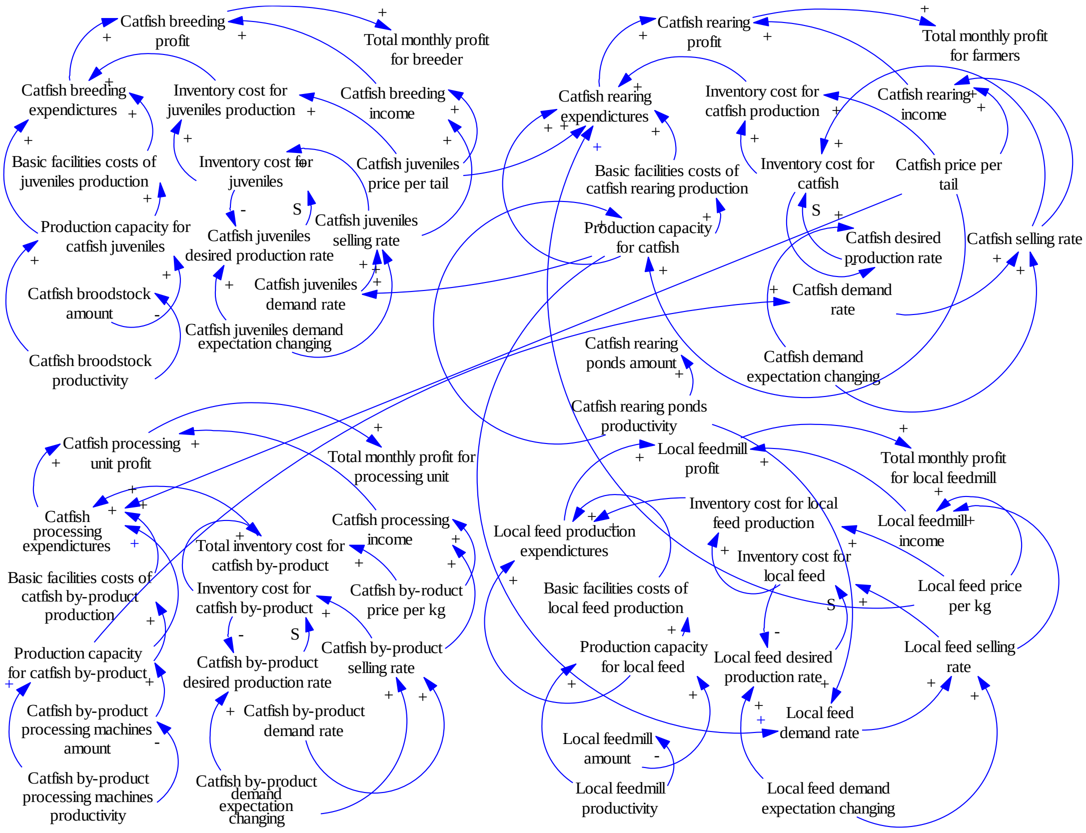

Figure 7. The closed-loop supply chain of dryland-based catfish aquabusiness in the causal-loop logic thinking

Closed-loop supply chain in the system dynamics model

The design of the models is comprehensively constructed as a reliable tool to simulate the level of profits obtained in the catfish aquabusiness subsystems by considering the variables involved in it. The four aquabusiness subsystems created in this study were the juvenile fish production, aquaculture practices, local catfish feedstock manufactured by farmers, and fish-by products distributed by small-enterprises. The closed-loop models are demonstrated in the causal-loop logic thinking, and system dynamics approach. These are elucidated in **Figure** 7. and **Figure** 8, respectively.

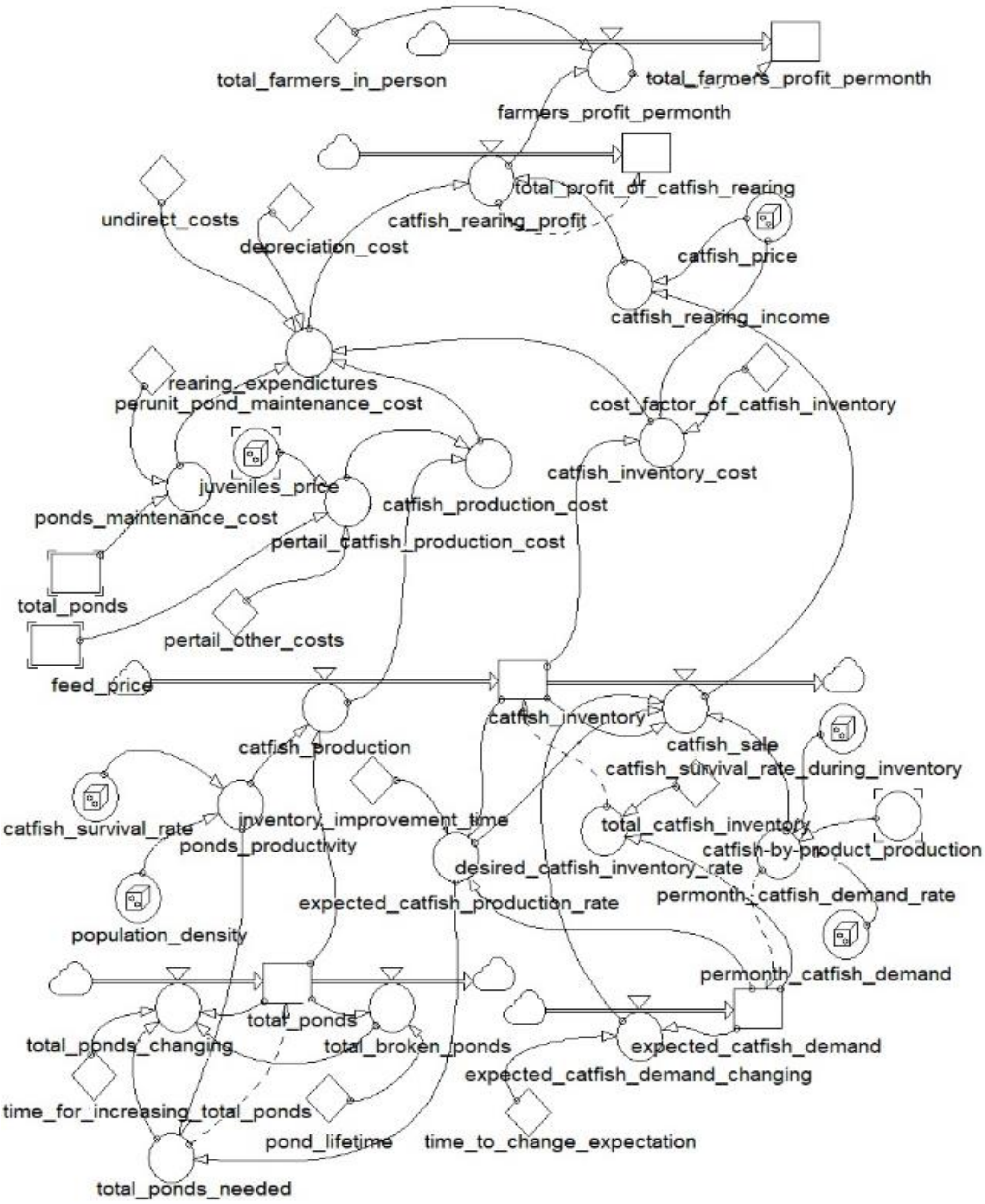

Figure 8. System dynamics model of dryland-based catfish aquabusiness (*particular for rearing subsystem*)

This closed-loop supply chain diagram is constructed with an arrangement of four subsystems. The four closed-loops are then assembled into one integrated unit, which is the supply chain relationship in this aquabusiness in Gunungkidul. Each supply-chain subsystem is arranged according to the structure and characteristics that occur in each business unit. In the supply chain relationship structure, there are some similarities due to the similarity of patterns and closeness of types of businesses in the fisheries sector. The construction of a causal relationship is done in stages, starting from the material flow to the financial flow. For example, for the dryland catfish hatchery subsystem, a causal diagram of material flow starts from the availability of healthy numbers of broodstock. The amount of availability of healthy broodstock determines how many seeds could be produced in a certain period.

Juveniles production capacity is very dependent on the productivity of broodstock owned. The juvenile production capacity determines inventory. The juvenile production capacity is also influenced by the number of sales and market demand. Furthermore, the large amount of seed inventory will determine how much juveniles must be produced, primarily related to the stock level. Next, a causal relationship to financial flows in the hatchery subsystem is formed from the conversion of material flows into its financial value.

The description and structure of the causal relationship of the juvenile fish production are quite similar to the closed-loop supply chain for aquaculture practices, local catfish feedstock manufactured by farmers, and fish-by products distributed by small-enterprises. Four subsystems were obtained MAPE<5%, which means the systems were very accurate and robust for performing the next simulation.

Simulation for increasing profit

Distribution of profits in closed-loop supply chain aquabusiness for all subsystems could be performed by simulating prices on each product line to get high profits. The alternative pricing decisions and the results of their simulations are as follows in **Table** 2.

Table 2. Scenarios for Increasing Profit Simulation

Parameters	**Scenario (Rp)**		
	1	**2**	**3**
Juveniles	200/tail	220/tail	240/tail
Catfish consumption size	16,000/kg	17,000/kg	18,000/kg
Catfish by-products	120,000/kg	130,000/kg	150,000/kg
Local feed	8,000/kg	8,500/kg	9,000/kg

By considering simulation results (**Fig.** 9, **Table** 3), it was known that price changes for all product lines in all subsystems have a significant influence on producing a higher average monthly profit. All alternative price decisions made must consider the ability of the consumer community to access these products. Price increases in one subsystem must be followed by price increases in other subsystems in a balanced pattern in order to obtain an even distribution of profits for all subsystems. This aquabusiness system will be balanced when all subsystems buy and sell each other in the system. If the circulation of money is carried out in a small area and business loop integrated into the cooperative system.

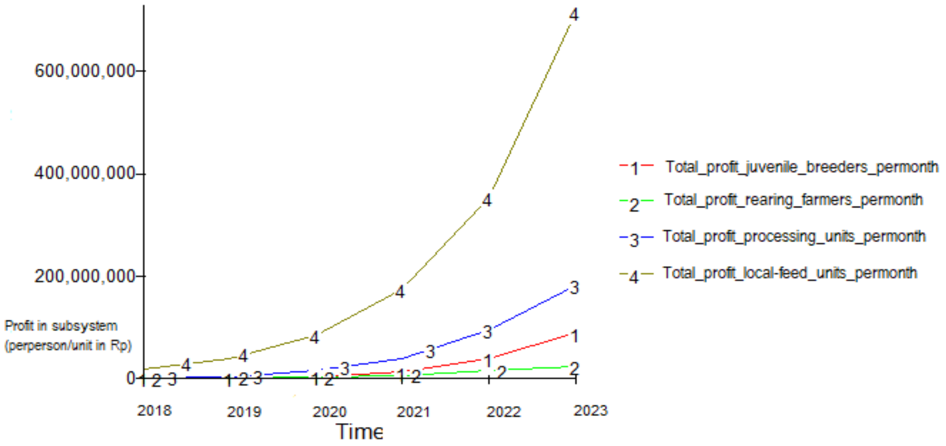

Figure 9. Simulation scenario I

Table 3. Profit Values of Simulation Scenario I

Year	Hatchery (Rp)	Rearing (Rp)	Processing (Rp)	Local Feedmill (Rp)
2018	6,003,421.01	4,866,545.84	16,542,353.12	86,450,947.70
2019	15,002,421.55	8,152,745.97	40,783,446.06	176,133,794.36
2020	42,065,193.73	15,753,940.08	96,897,965.65	356,287,824.25
2021	89,514,079.31	25,936,705.17	181,845,999.36	720,029,247.90

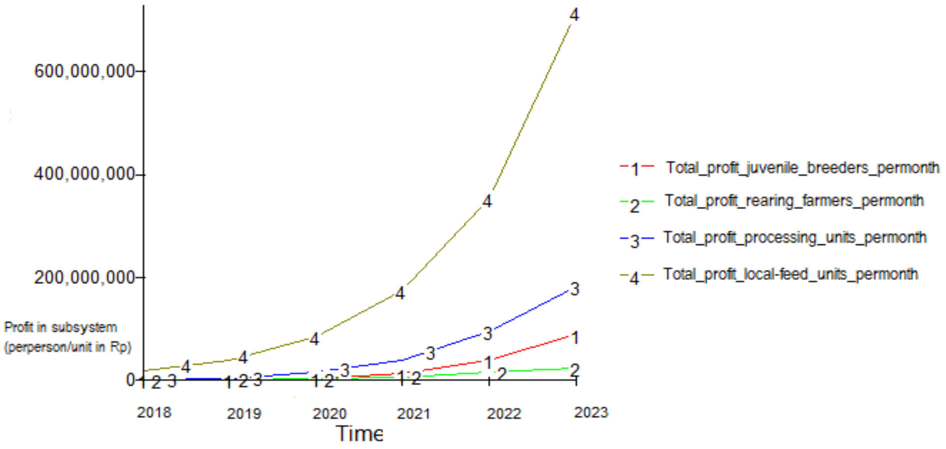

Figure 10. Simulation scenario II

Table 4. Profit Values of Simulation Scenario II

Year	Hatchery (Rp)	Rearing (Rp)	Processing (Rp)	Local Feedmill (Rp)
2018	7,932,326.11	5,478,882.97	21,108,282.68	101,177,568.56
2019	18,917,228.69	9,177,213.53	49,814,499.55	203,934,096.17
2020	51,707,327.28	17,729,973.28	116,001,272.54	408,348,953.83
2021	108,832,569.45	29,186,867.19	215,476,563.71	818,628,737.49

The three scenarios revealed a significant profit increase for four subsystems. Especially, the highest profit obtained by using scenario III, including the price of stocking seed size of 5-7 cm was raised to Rp 240/fish, the price of consumption catfish size of 8-10 fishes/kg was Rp 18,000/kg, the price of catfish by-product was Rp 150,000/kg, and the price of local feed for catfish rearing was Rp 9,000/kg. The results were that the profit of each subsystem by following the price decision scenario has significantly increased year-by-year (**Figure** 11, **Table** 5).

In 2019, by implementing this scenario III, closed-loop supply chain catfish aquabusiness in Gunungkidul *Minapolitan* is estimated to reach the monthly profit of Rp 18,917,228.69 for juveniles breeders in hatchery subsystem, Rp 9,177,213.53 for farmers in rearing subsystem, Rp 49,814,499.55 for catfish by-product processing in the small-enterprise subsystem, and Rp 203,934,096.17 for local catfish feedstock production subsystem.

They could reach this profit increasing by following technical requirements, including joining their private aquabusiness to collective business farmers cooperative hub, implementing good aquaculture practices, engaging angel investors to support their business management and finance, registered in the local in-line subsystem of aquabusiness group, professional and accountable in their business process, and creating collaboration with research institutes and innovation centers.

The farmers cooperative should also guide and strengthen their farmer's members in all subsystems to active for obtaining innovation, information, incubation, and financial support from many sources. Afterward, they must share their excellence or input to others. This relationship aims to accelerate their business in the group, nurturing local peoples, inspiring others, and enlarging their market share.

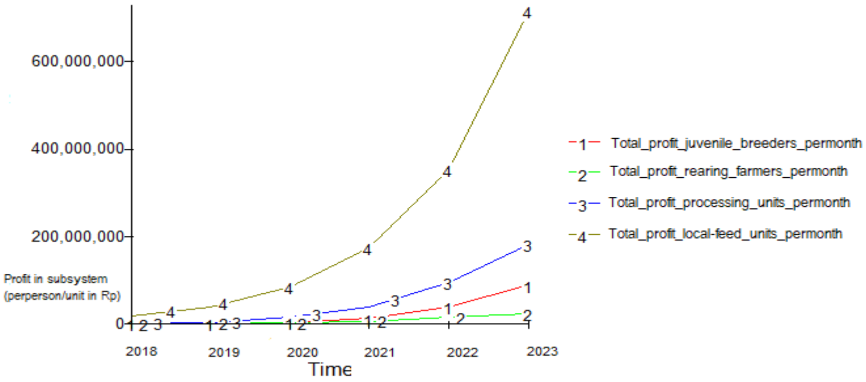

Figure 11. Simulation scenario III

Table 5. Profit Values of Simulation Scenario III

Year	Hatchery (Rp)	Rearing (Rp)	Processing (Rp)	Local Feedmill (Rp)
2018	6,967,873.56	5,172,714.40	18,825,317.90	94,111,258.13
2019	16,959,825.12	8,664,979.75	45,298,972.81	190,033,945.27
2020	46,886,260.50	16,741,956.68	106,449,619.09	382,318,389.04
2021	99,173,324.39	27,561,786.18	198,661,281.53	769,328,992.70

Financial Analysis

By considering the results of the financial analysis of all aquabusiness subsystems, it was demonstrated that the local feedstock production subsystem required the highest investment and operational costs. The highest amount of these costs generated the most feasible in financial performance, including the payback period was 5,08 years, the profitability index was 2.67%, and the internal rate return 53,03. Subsequently, its performance was followed by processing catfish by-product subsystem, juveniles production subsystem, and rearing subsystem as well (**Table** 6).

Table 6. Financial Analysis for Aquabusiness Subsystems by Implementing Scenario III

Financial parameters	Values in the subsystems			
Subsystems	**Juveniles production subsystem**	**Rearing subsystem**	**Processing by-product subsystem**	**Local feedstock production subsystem**
Period	Ten years	Ten years	Ten years	Ten years
Initial Capital	Rp 185,340,000	Rp 102,975,000	Rp 154,400,000	Rp 679,515,000
Break-Even Point (BEP) quantity	62,723 fishes per year	97.74 kg per month	229.50 kg per month	36.880 kg per month
Break-Even Point (BEP) selling	Rp 11,215,792 per year	Rp 1,645,563.42 per month	Rp 31,352,562.20 per month	Rp 75,928,777.01 per month
Benefit Cost Ratio (BCR)	2.64 (BCR > 1)	1.44 (BCR > 1)	1.47 (BCR > 1)	2,72 (BCR > 1)
Price per unit	Rp 240 (size 6-8 cm)	Rp 18,000,-/kg	Rp 150,000/kg (floss/*abon*)	Rp 9.000/kg
Payback Period (PP)	9.57 years	9.03 years	8,03 years	5,08 years
Net Present Value (NPV)	51,196,929,11 (NPV > 0)	2,834,813.42 (NPV > 0	153,180,405.44 (NPV > 0)	1.222.625.393,61 (NPV > 0)
Profitability Index	1.28% (PI > 1)	1.03% (PI > 1	1.99% (PI > 1)	2,67% (PI > 1)
Internal Rate Return (IRR)	37.22 (IRR > interest rate)	35.18 (IRR > interest rate)	56.52 (IRR > interest rate)	53,03 (IRR > interest rate)
Interest Rate	15%	15%	15%	15%

All four subsystems that are implementing scenario III were declared financially feasible. The financial performance of subsystems could be improved by following the technical recommendations aforementioned. This analysis was a continuation of previous work performed by Wardono and Prabakusuma (Wardono & Prabakusuma, 2017).

CONCLUSION

A system dynamics models of the closed-loop supply chain in catfish aquabusiness in Gunungkidul *Minapolitan* were as valid and robust with MAPE <5%. It could be employed to simulate three different scenarios to increase profit for all stakeholders in four subsystems. The highest profit to stakeholder was obtained by scenario III that was directed to increase the juvenile fish price to Rp 240/fish, consumption-sized fish at price of Rp 18,000/kg, fish-by product at price of Rp 150,000/kg, and local feed at price of Rp 9,000/kg. According to financial analysis, the four subsystems in dry land-based catfish aquabusiness were all feasible by BCR>1; PP was 5-9 years, NPV>0, PI>1, and IRR>15%/year. Finally, the implementation of the system required synergetic action among policymakers, farmer cooperative, and local innovation centers.

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