Modelling Stakeholders Collaboration in the Context of Food Security in Indonesia

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Abstract To create a comprehensive framework for stakeholder collaboration, this chapter integrates systems thinking, system dynamics, and Service-Dominant Logic (S-D Logic) to analyze Indonesia's food security issues. According to preliminary research, a lack of cooperation between ministries, local governments, operators, and communities has resulted in fragmented rules, unreliable data, pricing instability, and misaligned import decisions. In response, the government strengthened multi-sectoral food governance by establishing the National Food Agency (Bapanas) as a high-level regulator. Drawing on service science, this study conceptualizes food security as a value co-creation process that integrates knowledge, capabilities, and resources to achieve shared outcomes across various actors. System dynamics is applied to model stakeholder interactions through Causal Loop Diagrams (CLDs), which depict reinforcing and balancing feedback loops that influence willingness to collaborate, perceived benefits, institutional vision alignment, and conflicts of interest. This process leads to model affirmation to construct a causal loop diagram using system dynamic simulation. According to the Business-as-Usual scenario, the result shows a lower value co-creation score compared to the baseline, while the empowerment priority strategy can achieve the highest score, followed by strategies that focus on high and medium strategies. Nevertheless, if the orchestrator only prioritizes involvement and curation with minimal emphasis on empowerment, it will lead to even lower scores compared to BaU. Overall, this paper proposes a collaboration-oriented systemic model that positions Bapanas at a strategic point, enabling adaptive governance, specifically as a regulator of Indonesia's food ecosystem.

Keywords Service-Dominant Logic · Causal Loop Diagram · Food Security · Value Co-Creation · Collaboration

1. Background

Indonesia suffers from a lack of coordination among stakeholders. If left unchecked, this could significantly hinder efforts to strengthen national food security, potentially leading to issues such as uneven food distribution, rising food prices, uncoordinated food stock data, and import policies that are not aligned with harvest seasons, thereby harming farmers. Therefore, an integrated approach involving key stakeholders such as the government, ministries/agencies, local governments, communities, industry/businesses, and academic institutions is needed to improve policy development and effectively address these issues (Putro, 2016). However, academics and practitioners rarely discuss how shared value creation can function as a mechanism for sustainable development, the key factors that support it, and how to align it with sustainability goals (Luiz, França, Kruger, & Goyannes, 2018).

Furthermore, food policies in Indonesia still require integration and are often implemented in an ad hoc manner. This is because there is no dedicated agency to coordinate all food policies from upstream to downstream. BULOG, as the operator, faces various operational and financial challenges in carrying out its duties. Indonesia can learn from the effectiveness of food agencies in other countries, such as China, India, the Philippines, Malaysia, Thailand, Vietnam, Norway, and Denmark, which separate the roles of regulator and operator in implementing food policy. In this regard, the Indonesian government has established the National Food Agency (Bapanas) as a regulator reporting directly to the President, with BULOG acting as the operator.

The author argues that analyzing food security using a sustainability framework can broaden perspectives by exploring other related aspects, such as future supply-demand models, the environmental impacts of agricultural activities, community welfare, economic development, and public participation. This framework also encompasses the involvement of institutions, regulations, and stakeholders so that their capacity and participation align with the desired objectives.

The appointment of Bapanas as a multi-sectoral policy coordinating institution requires a robust method to develop a collaboration model. This study aims to explore the root of the problem and design solutions through stakeholder empowerment with a service science approach. As part of systemic thinking, service science enables the development of shared value creation. Service science defines *service* as an observable phenomenon in the form of a service system, with interactions creating shared value between entities (Maglio & Spohrer, 2008), involving a broad perspective where the entities of this system can be individuals, businesses, non-profit organizations, government agencies, or even cities.

The problem of food security in urban areas is not only an urban problem, but this problem is often influenced by regional or global conditions, thus requiring higher level of solutions to ensure sustainable food security (Hasyimi, Putro, Novani and Hendriadi, 2024). Cities play a role in the global market because their security depends on resources from other regions. Therefore, the analysis will only be adequate if it can identify the complex relationships between cities, including descriptions of the origin and destination of distribution, storage, processing, and variety of food. With the increasing urban population, high consumption needs to be anticipated and addressed.

This study highlights a gap in food security studies, which have traditionally relied on hard systems methodologies (e.g., laboratory studies, systems engineering, and spatial analysis) that focus on technical solutions such as increased production, new seeds, and supply chain efficiency. However, food security also involves complex socio-political, institutional, and sustainability issues. Therefore, this research requires a methodology capable of addressing stakeholder interactions and encompassing the causal relationships that arise within them.

This study employs a simulation model to apply the conceptual framework of service science and propose a novel strategy for promoting the creation of shared value. The use of this simulation model highlights gaps in collaborative strategies by analyzing stakeholder dynamics and the factors that influence them, thereby enriching academic perspectives and informing policy development. Furthermore, the use of this strategy is expected to provide actionable insights for key institutions, particularly the National Food Agency (Bapanas), a high-authority agency established by Presidential Decree No. 66 of 2021, which replaced the Food Security Agency under the Ministry of Agriculture.

The framework in this study aims to achieve sustainable food security by using a systems thinking approach to understand the entire food system and its complexities related to food security. In addition to focusing on addressing internal and external factors, this study also explores the potential for improving the food system. By fostering collaboration among stakeholders in the food security system through a service science approach, this study proposes a platform to support shared value creation.

Service science defines services as systems of interactions that create value between various entities, such as individuals, businesses, and institutions (Maglio & Spohrer, 2008). A concrete example is that food security issues in cities often mirror regional-scale challenges, underscoring the importance of addressing these issues through regional solutions. Because cities depend on resources from other regions, a holistic analysis is necessary to understand the complex relationships between cities in terms of food distribution, storage, and processing.

This study seeks to build a systemic thinking-based framework for sustainable food security, including analysis of internal and external factors and development of system improvement strategies through shared value creation, supply chain improvement, and crisis mitigation. The service science approach in this study also focuses on encouraging collaboration between stakeholders to strengthen shared value creation in food systems.

The main purpose of this study is to formulate strategy formulation process using system thinking and service science approach to promote sustainable food security in Indonesia. To formulate values can be co-created in food security using service science by considering various stakeholders' interest in Indonesia. To understand the interactions between stakeholders and recommend strategies to Bapanas as the orchestrator of the food security ecosystem to increase collaboration between stakeholders in realizing value co-creation.

2. Literature Review

2.1 System Dynamic

System dynamics is a mathematical modeling methodology and technique used to understand and solve complex problems. Developed by Jay Forester in the 1950s to help corporate managers understand industrial processes, system dynamics is now applied in the public and private sectors for policy analysis and design (Dunnett et al., 2018). System dynamics models overcome the problem of simultaneity by updating all variables simultaneously over small-time intervals through positive and negative feedback and time delays (Shen et al., 2009).

These models can predict the exponential growth of population and capital in a variety of growth scenarios with limited resources and perceptual delays. System dynamics, as a subset of systems theory, understands the dynamic behavior of complex systems by considering the circular structure and interactions among their components. Examples of applications include social dynamics, where the nature of the whole often cannot be explained by looking at behaviour of the parts (Pothukuchi, 2004; Schmitt Olabisi et al., 2018).

2.2 Service Dominant Logic

Service-dominant logic (S-D logic) examines how service value is co-created among entities in service systems, such as people, businesses, non-profit organizations, government agencies, and cities, to understand the exchange of social value (Barile, Lusch, Reynoso, Saviano, & Spohrer, 2016; Spohrer, Anderson, Pass, & Ager, 2009). The term ‘service’ in this context refers to the process of exchanging resources for the benefit of others.

S-D logic emphasizes the importance of intangibles in collaboration, thus offering a paradigm shift in understanding the fundamental exchanges that enable reciprocal value creation between institutions within a service ecosystem. Services can include the exchange of knowledge, skills, facilities, access, and financial resources (S. Vargo & Lusch, 2004).

Value co-creation is viewed as an active, creative, and social interaction involving collaboration between providers and customers. This collaborative creativity enhances the organization's knowledge acquisition process by engaging customers in the creation of meaning and value, often initiated by providers.

A service ecosystem is a self-sufficient and self-adaptive system of actors that integrate resources, share institutional logics, and create shared value through service exchange (S. L. Vargo & Lusch, 2016). This perspective suggests that all stakeholders interact and evolve within a value orchestration platform to dynamically create shared value, which can be implemented through processes of engagement, curation, and empowerment. This process involves four phases: shared experience, shared definition, shared improvement, and shared development, with each phase supporting joint value creation activities (Kijima & Arai, 2016).

The first phase, engagement, facilitates the exchange of information about preferences, capabilities, and expectations, enabling participants to collaboratively build and share internal models (based on shared experiences). During this collaborative process, participants may initially be unaware of each other's capabilities and expectations. The curation phase allows stakeholders to collectively redefine (shared definition) products, information, or services to meet their shared goals. Finally, the empowerment phase consists of the shared improvement and shared development phases. Co-improvement is a cyclical process characterized by fluctuations in partners' expectations and capabilities. Higher expectations lead to improved service quality and greater social value (driven by demand). In turn, the provision of high-quality services increases partners' expectations (driven by demand). Co-development focuses on joint innovation that emerges from simultaneous collaboration among multiple entities, achieved through continuous evaluation and assessment of partners' responses.

In a value orchestration platform, the platform focuses on methods for engaging the right customers and providers, and facilitating interactions between them (Figure 1). In real-world contexts, actors do not exist independently within a social framework (Novani & Kijima, 2012). Conceptual distinctions regarding institutions serve as the basis for the ongoing formation and reform of increasingly complex organizations.

Furthermore, institutions represent the relatively isolated roles of individuals (such as symbols, practices, norms, and laws) and interconnected communities that collectively form a coherent organization, facilitating the coordination of activities for shared value creation. Consideration of the important role of institutions in shared value creation from a Service-Dominant Logic perspective underscores an additional basic premise 11: Shared value creation is coordinated through institutions formed by actors and institutional arrangements (S. L. Vargo & Lusch, 2016).

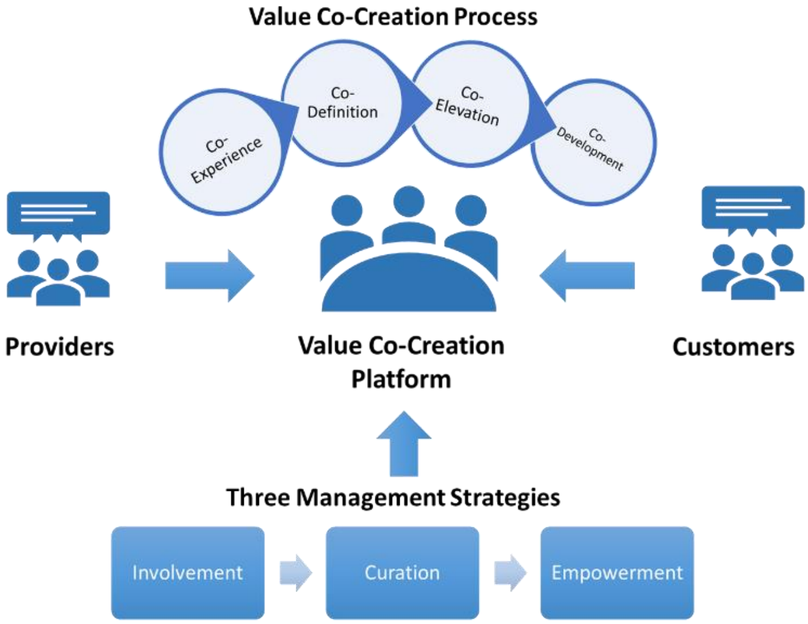


Fig. 1 Value Co-Creation Platform.
Adapted from Kijima & Arai (2016)

2.3 Institutional Context

Food security planning, implementation and monitoring in Indonesia involve many stakeholders, especially regulators and operators from various Ministries. It's well-known that the National Food Security Agency under the Ministry of Agriculture and Perum BULOG is a food operator and regulator at certain conditions that requires strong coordination with many Ministries/agencies. Nevertheless, in the practice, this condition usually creates overlapping roles which lead to conflict of interest and responsibilities due to lack of coordination and fragmentation in several Ministries/Agencies. So, it's important to see the overview of the assignments, roles, and constraints faced by each related stakeholder as an integrated food institution, especially in rice commodities. System thinking approach facilitates this purpose and provides methodologies to comprehend the complexity of stakeholders' interaction within food security.

Nowadays, the government is preparing the establishment of Bapanas to rebuild the system and institutions' interaction to achieve food security goals. The BAPANAS establishment is inspired from other countries which successfully implement their food security strategy, e.g. Thailand, Vietnam, Malaysia, China, India, Denmark and Norway. The most important lesson-learned from these countries is role separation between food regulators (direct report to president or prime minister) and food operators (responsible to an independent agency or ministry).

In this regard, some stakeholders perceived that Bapanas must be repositioned from Perum BULOG as the embryo of food operators in Indonesia. By considering the efficiency and effectiveness of the establishment process, Perum Bulog has benefitted by its former role to maintain food availability and stabilize several staple food commodities in terms of stock and price. Food stabilization requires a lot of time, resources and intensive coordination along the supply-chain. On the other hand, the government doesn't provide any funding to support the food procurement and distribution system for the Perum Bulog to do this task. The second perception is to establish the Bapanas from the ministry's organs as regulator while Perum BULOG as operator remains as a state-owned enterprise. Lastly, the Perum BULOG operates under the control of Bapanas supporting it to achieve every target.

The dynamic interactions between stakeholders come in the form of exchange activities and resource integrations among actors to pursue collective goal. Vargo & Lusch (2004) introduced serviced-dominant logic (S-D Logic) which focus on operant resources which perceives business process as a continuous learning process to constantly create a better value proposition by positioning intangibility, the process of exchange and relationship as crucial elements. Thus, collaboration amongst all stakeholders and being adaptive to the dynamic nature are important reasons that provide a suitable approach to this study. This approach also addresses resource exchange which can become a mutual benefit for each actor at the same time fulfilling their own purpose. By adopting PSMs and Service Science, collaboration among stakeholders could become one of key factors in addressing the wicked problem of food security and overcome it with reliable strategy and future cooperation.

The authors are applied three elements or activities of applied systems thinking by Edson (2008), namely synthesis, analysis, and inquiry. Synthesis means the researcher assesses the system as a whole and understands its position in its broader environment. Analysis refers to breaking down the component parts, their relationship, and behavior inside the system. Inquiry means formulating solutions through systemic investigation.

Regarding this context, the author investigates relevant stakeholders by considering their role significance within the food systems. The authors divide the institution involved into three categories. In the synthesis and analysis stage, the author defines main institutions who are responsible to pursue food security goal and its broader interactions with other relevant institutions. The primary actor is institutions who have direct authority as regulator or operator of food security development, namely Food Security Agency (Badan Ketahanan Pangan / BKP), Perum BULOG, and Provincial Government. The secondary category is considered for institutions who have a direct supporting role to support the regulator and operator in the coordination and implementation of food security development and monitoring, consisting of the Ministry of Social Affair, Ministry of Trade, Coordinating Ministry for Economic Affair, World Food Programme, and Consultant. Lastly, the tertiary category is institutions who help the primary and secondary categories with regulation supports, program collaboration and data integration, i.e. Ministry of Health, BNPB, Bappenas, Ministry of Agraria, Financial Institution and Academicians.

3. Conceptual Simulation Modelling of Value Co-Creation

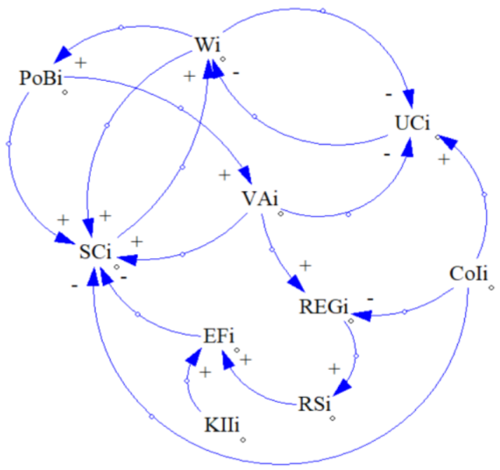
System dynamic usually is employed to address issues in Type C Structural Complexity (*unitary-complex*). However nowadays, the application of system dynamics can be a broader type of complexity. In this dissertation, the application is attempted to be applied in the pluralism-complex category with several reasons. First, pluralism accommodates multiple perspectives, values, and interests from various stakeholders. It requires methods that can express their understanding about the system adequate thus facilitating a shared understanding to achieve agreed structure. Therefore, it encourages participation among stakeholders so they can integrate their divergent multiple worldviews and pluralistic insights. Second, complex dimensions usually possess non-linear behavior, time delays, and emergent properties due to interaction among the system components. Causal Loop Diagram facilitates both reinforce and balancing feedback loop which is able to address unintended side effects from an intervention. This feature also can identify the significant component and system tipping point. Based on both reasons, system dynamics can be utilized to promote inclusivity by synthesizing divergent perspectives, promote shared understanding, and have the ability to anticipate unintended outcomes that may not be obvious from a static model.

4. Result

4.1 Causal Loop Diagram (CLD)

The CLD is proposed to depict a complete understanding of the dynamic changes in the various factors of food security development and their interrelationships. The interactions among stakeholders are dynamic, systemic and complex. Therefore, system dynamics offers advantages to understand these dynamic, multivariable and nonlinear processes and their intrinsic stochastic behavior.

Figure 2 illustrates the relationship between factors that encourage and inhibit the formation of collaboration by mimicking the mental model of each stakeholder. By understanding the interaction between these factors, it is hoped that this simulation can help formulate what strategies are capable of encouraging the formation of collaboration and how they impact each factor by looking at the level of significance of each factor.



Code	Interpretation
W_i	Willingness to Collaborate
SC_i	Suitability to collaborate
UC_i	Unsuitability to collaborate
PoB_i	Perceived of Benefit
VA_i	Vision Alignment
CoI_i	Conflict of Interest
REG_i	Regulation establishment
EF_i	Effort
RS_i	Resource Sharing
KII_i	Knowledge and Information Integration

Fig. 2 CLD for Value Co-Creation.
Source: Author's Analysis.

W_i is a variable that describes *the willingness to collaborate*. This variable is influenced by SC_i namely *fitness to collaborate* and UC_i namely *non-collaboration fitness*. The author also assumes that each stakeholder will evaluate the benefit, aligned institution vision, and conflict of interest before they join the collaboration, respectively using variables named *Perceived of Benefit* (PoB_i), *Vision alignment* (VA_i), and *Conflict of Interest* (CoI_i). Lastly, the *effort to collaborate* (EF_i) is measured by considering resource *sharing* (RS_i) and *knowledge and information integration* (KII_i).

Next, the author identifies the policy direction, strategy, and operation steps of Bapanas. This information will be used as a business-as-usual (BaU) strategy in the system dynamic simulation. The BaU strategy will be the basic strategy to see whether the simulation results show an increase or decrease in the Wi value. Next, the factors that influence the dynamics will be identified and then several strategies will be created with a combination of several factors.

4.2 Stock and Flow Diagram (SFD)

In this step, the author models the interaction among involved stakeholders using simple evolutionary game theory by giving stakeholders decision to collaborate and not to collaborate (Xu, Casasayas, & Huang, 2024). The behavior of involved stakeholders can be seen as the consequence of dynamic interaction within the environment. The interaction map for collaboration among the stakeholders is presented using Stock and Flow diagram (SFD) in Figure 3.

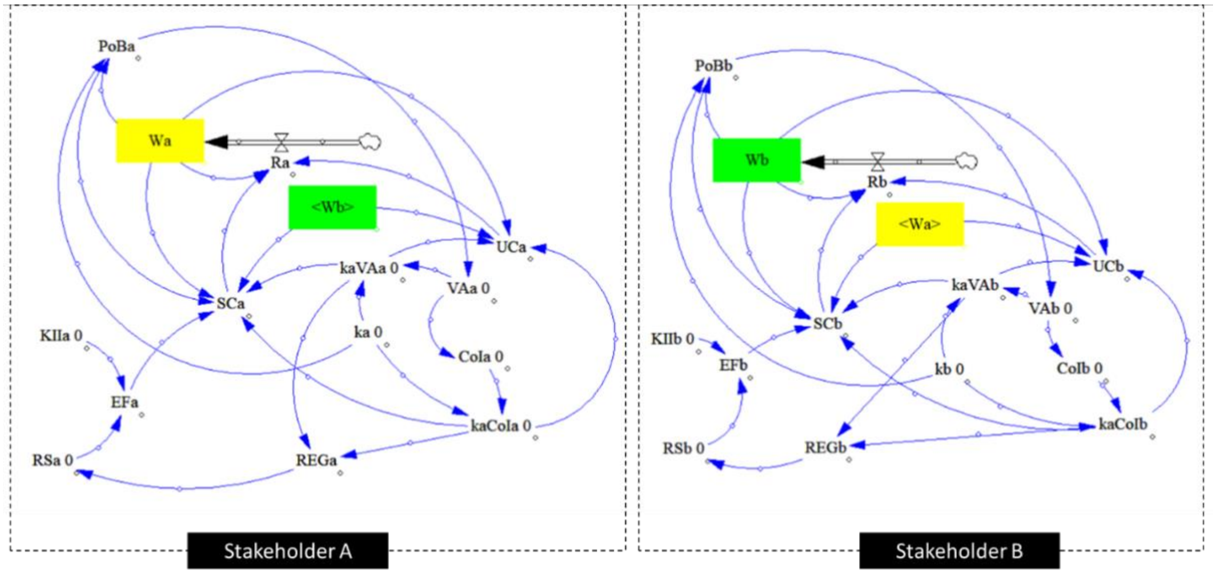


Fig. 3 Interaction map among stakeholders in SFD.
Source: Author's Analysis.

The model is employed to increase willingness to collaborate and minimizes collaboration effort, so the involved actor obtains benefits and reduces their hesitance to collaborate. Despite their varied characteristics, each role adheres to fundamental interaction rules. All stakeholders must consider interactions with other stakeholders. Beside influenced by their suitability to collaborate and unsuitability to collaborate, the willingness to collaborate is influenced by the level of willingness to collaborate from other stakeholders. This can be expressed in the following equation:

$$W_i = Init\ W_i + \int R_i \tag{1}$$

where W_i is willingness to collaborate, R_i refers to the change rate of W_i and $Init\ W_i$ indicates to the initial value of W_i. In the SFD, W_i is stock variable and R_i is flow rate. Therefore, if the value of R_i is positive, it will increase W_i which implies that the stakeholder is more interested in collaborating with others, and vice versa.

Next, R_i is influenced by their suitability to collaborate (SC_i) and unsuitability to collaborate (UC_i). It can be defined as the following equation:

$$R_i = W_i \times (1 - W_i) \times (SC_i - UC_i) \tag{2}$$

Next, stakeholder's SC_i leads to collaborate with other stakeholder within food security ecosystem which is determined by perceived of benefits (PoB_i), resource that stakeholder willing to share or stakeholder's effort (EF_i), vision alignment (VA_i), and conflict of interest (CoI_i). Each stakeholder also considers the average of willingness to collaborate of other stakeholders. Therefore, the stakeholder's suitability to collaborate can be calculated in the following equation:

$$SC_i = W_i \times (PoB_i - EF_i) + (1 - W_i) \times (k_i \times VA_i - k_i \times CoI_i) \times AVG(W_j + \cdots + W_n) \quad (3)$$

where k_i is perceived level of importance of the stakeholder within the collaboration.

Thus, to encourage collaboration, the stakeholder also considers what benefit they will get by participating in the collaboration. The calculation of perceived benefit can be seen in the following equation:

$$PoB_i = W_i \times INV + (1 - W_i) \times k_i \times InitPoB \quad (4)$$

where *INV* is the level of involvement strategy that is applied by the orchestrator.

On the other hand, stakeholder's unsuitability to collaborate leads to the decision not to collaborate which is determined by the same variables. It can be calculated by the following equation:

$$UC_i = W_i \times (k_i \times VA_i - k_i \times CoI_i) + (1 - W_i) \times (k_i \times VA_i - k_i \times CoI_i) \times AVG(W_j + \cdots + W_n) \quad (5)$$

Next, stakeholder's effort while deciding to join to collaborate is mean of two variables: knowledge and information integration (KII_i) and their willingness to share their resources (RS_i). The equation to calculate stakeholder's effort to collaborate following:

$$EF_i = (KII_i + RS_i)/2 \quad (6)$$

Collaboration in a food ecosystem occurs if every stakeholder in it is willing to collaborate in it. By using system dynamic simulation, the author tries to find the best strategy that can encourage the formation of collaboration represented by a high co-creation value. The author uses a scale of 0-1 for each variable, but not all variables have the same direction. In the variables W_i, VA_i, CoI_i, PoB_i and k_i, the author uses a score of 0 for the lowest value and a score of 1 for the highest score. Conversely, in the variables KII_i and RS_i, the author uses a score of 0 for the highest value indicating a smaller conflict or effort and a score of 1 to indicate a greater conflict or effort.

The initial value of each variable in each role is assumed based on the results of interviews and secondary data. To conduct the simulation, the author designs the value of each factor which can be seen in Table 1.

Table 1 Initial level for each variable in SFD simulation

Role	Init W	VA	CoI	KII	RS	PoB	k
Regulator	*Very High*	*Very High*	*Very Low*	*Very High*	*Very High*	*Very High*	*Very High*
Dominator	*Very Low*	*Very Low*	*Very High*	*Very Low*	*Very Low*	*Very Low*	*High*
Operator	*High*	*High*	*Low*	*Low*	*Low*	*Low*	*High*
Niche Player	*Low*	*Very Low*	*Low*	*Very Low*	*Very Low*	*High*	*Very Low*
Supporter	*Very Low*	*Very Low*	*High*	*Very Low*	*Very Low*	*Low*	*Low*

Source: Author's Analysis

Next, the value is changed from ordinal scale to numeric by changing the values: *very high* (0.8), *high* (0.6), *low* (0.4) and *very low* (0.2) in the variables *W, VA, CoI, PoB* and *k*. Contrarywise, for the variables *KII* and *RS* are changed to *very high* (0.2), *high* (0.4), *low* (0.6) and *very low* (0.8). The results of the value conversion can be seen in Table.

Table 2 Initial score for each variable in SFD

Role	Init W	VA	CoI	KII	RS	PoB	k
Regulator	0.8	0.8	0.2	0.2	0.2	0.8	0.8
Dominator	0.2	0.2	0.8	0.8	0.8	0.2	0.6
Operator	0.6	0.6	0.4	0.6	0.6	0.4	0.6
Niche Player	0.4	0.2	0.4	0.8	0.8	0.6	0.2
Supporter	0.2	0.2	0.6	0.8	0.8	0.4	0.4

Source: Author's Analysis

Each role has different values according to the assigned persona. In the variable, the author sets the initial value of the Willingness to Collaborate (WTC) of the Regulator role as the highest. The regulator consists of Bapanas (Orchestrator) and several Ministries that support it, given a score of 0.8 because as an orchestrator it has the largest WTC. Furthermore, the Operator, namely BULOG and ID FOOD, which are the implementers of food policies appointed by the regulator.

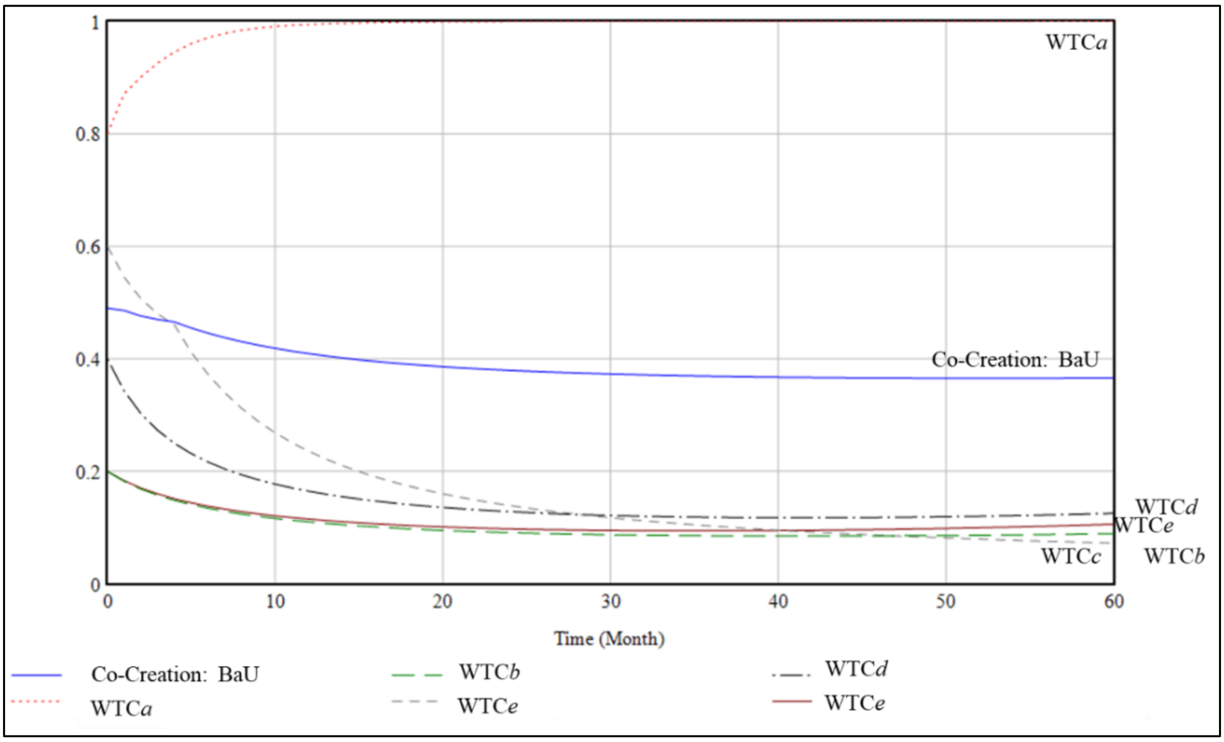


Fig. 4 Value co-creation and Willingness to collaborate score in BaU strategy. Source: Author's Analysis.

4.3 Strategy for collaboration

The author also designed an orchestrator strategy based on the service science framework, namely involvement, curation and empowerment.

Table 3 Assigned scores in each strategy

Strategy	Value			Delay		
	Involvement	Curation	Empowerment	Involvement	Curation	Empowerment
BaU	0.75	0.75	0.75	6	12	24
INV	1	0.5	0.5	6	12	24
CUR	0.5	1	0.5	6	12	24
EMP	0.5	0.5	1	6	12	24
LOW	0.75	0.75	0.75	6	12	18
MED	0.75	0.75	0.75	6	9	12

HIGH	0.75	0.75	0.75	3	6	9

Source: Author's Analysis.

The co-creation value is the result of the willingness to collaborate value of the five stakeholders involved in the food security ecosystem. We created a simulation with a 60-month timeline, adjusting the 5-year period of government in Indonesia. The simulation results can be seen in the following figure.

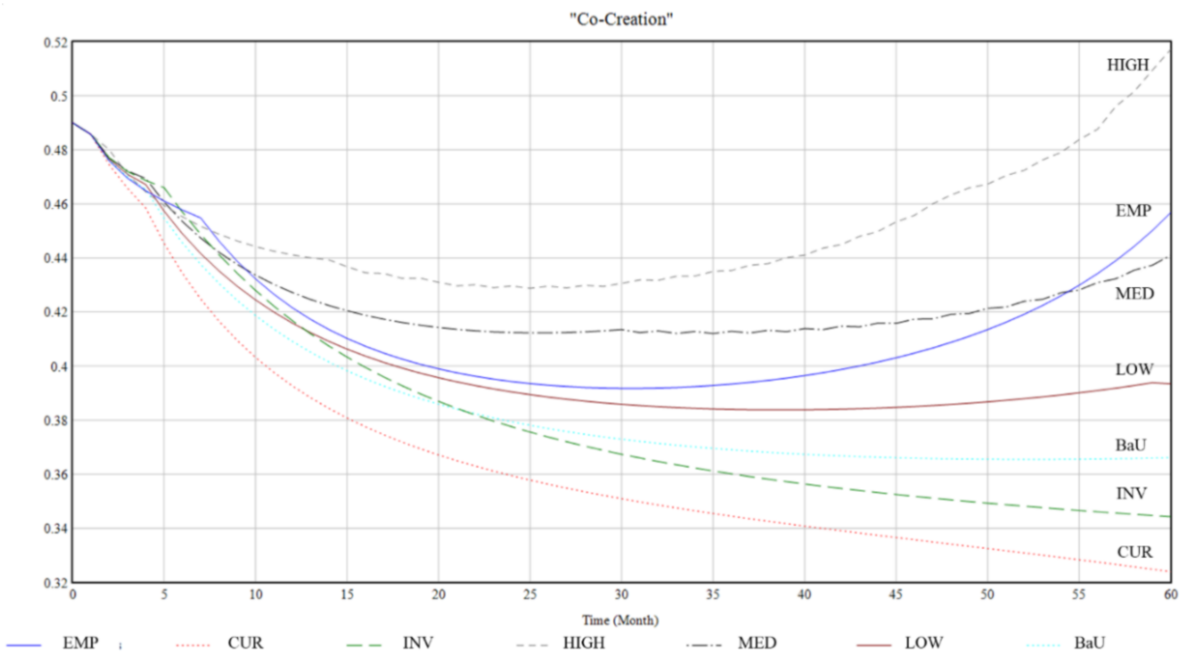


Fig. 5 Result of value co-creation score using various strategy.
Source: Author's Analysis.

Based on the simulation results, the BaU strategy showed a decrease in the co-creation value from 0.49 to 0.37 at the end of the term. The results of the analysis show that willingness to collaborate can decrease if the orchestrator is well maintained. In addition, in the INV and CUR strategies, the co-creation value results also decreased even below BaU. The author argues that these results show that if the initiation of collaboration is carried out only up to the involvement and curation stages, then the stakeholders involved in it feel that the development of food security is not carried out optimally until the empowerment stage, thus raising questions about the seriousness and continuation of the food security program. Furthermore, we can see that the HIGH strategy (0.52) shows the highest co-creation value, followed by the EMP strategy (0.46) and MED (0.44). These results show that the weight on efforts to carry out empowerment can increase the value of co-creation.

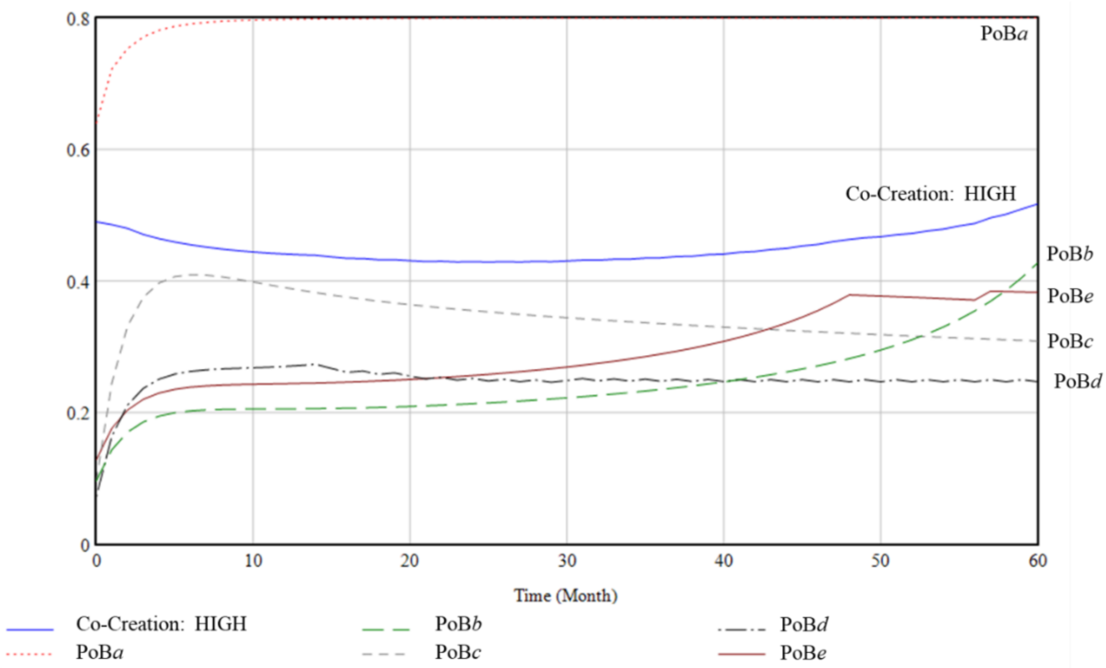


Fig. 6 Value co-creation and Perceived of Benefit Score in HIGH Strategy.
Source: Author's Analysis.

Based on the strategy with the highest output, which is HIGH, we can see that all stakeholders have an increase in Perceived Benefit (PoB). The score changes that occur are as follows:

- PoBa = 0.640 → 1.000
- PoBb = 0.096 → 0.427
- PoBc = 0.111 → 0.308
- PoBd = 0.072 → 0.247
- PoBe = 0.128 → 0.384

From these results, stakeholders from Regulators, Dominators and Supporters have an average upward trend. Meanwhile, Operators have a slight downward trend in the 7th month after increasing significantly at the beginning, and Niche Players are stagnant from month 18 to the end after also increasing significantly at the beginning.

These results show that innovation and novelty are needed in the strategy formulated by the orchestrator in redefining the value to be achieved by adjusting to the challenges faced and integrating resources and knowledge to create greater value.

Furthermore, the author sees how this simulation is able to describe the effort that must be expended by each stakeholder. From the results of the simulation, we can see that the Effort graph shows a downward trend, except for the Regulator. The changes in value in each stakeholder are as follows.

- PoBa = 0.10 → 0.25
- PoBb = 0.70 → 0.10
- PoBc = 0.50 → 0.25
- PoBd = 0.66 → 0.10
- PoBe = 0.66 → 0.39

Regulators and operators experienced an increase in Effort scores because both roles are responsible for ensuring collaboration in the food ecosystem. Furthermore, dominators and supporters have a trend that continues to decline, although supporters need to spend additional effort at the end of the collaboration period. Finally, niche players have a downward trend from the beginning, but since the 13th month have had a fluctuating trend but on average still show a downward trend.

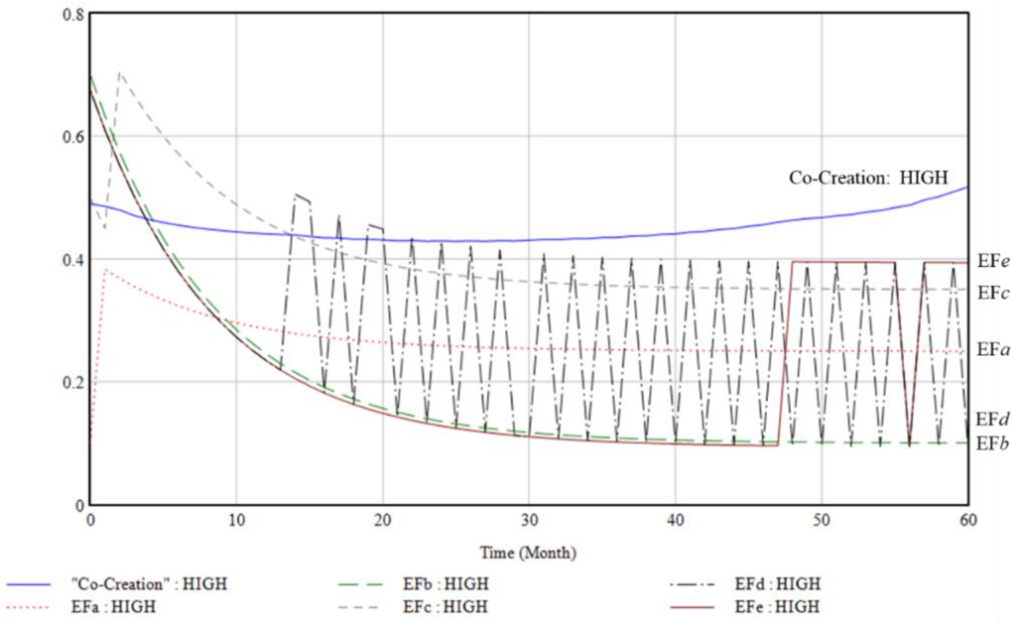


Fig. 7 Co-creation and Effort score in HIGH strategy.

Source: Author's Analysis.

4.4 Improvement Strategy

Different results are shown when the simulation is extended from 60 months to 100 months. The HIGH strategy, which initially produced the highest value co-creation score, shifted to the second highest, replaced by the EMP strategy.

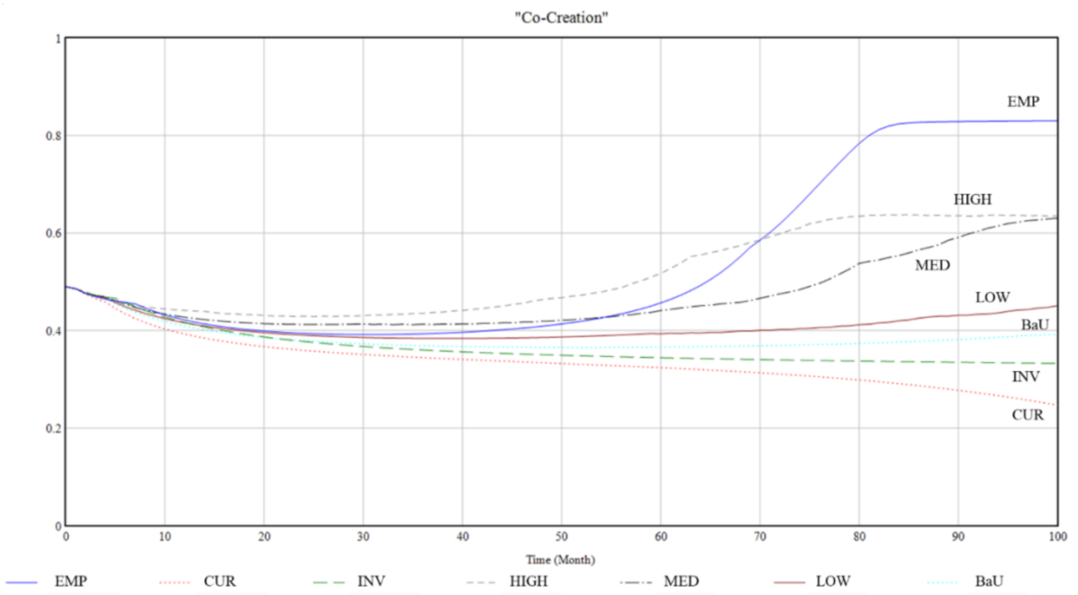


Fig. 8 Extended simulation timeline using various strategies.
Source: Author's Analysis

The author suspects that this dynamic indicates an opportunity for improvement so that the author can propose strategy recommendations to increase the value of value co-creation. One of the strategies that the author implemented in this simulation was to improve the importance level of stakeholder's role. The author increases the level of importance (k) value for Operator (0.6 → 0.8) and Niche Player (0.2 → 0.4).

The author also filters 3 strategies that produced the best co-creation values. The results shown proved to provide significant differences. This aims to see how significant the changes are by increasing the role of these two stakeholders in the food system in Indonesia.

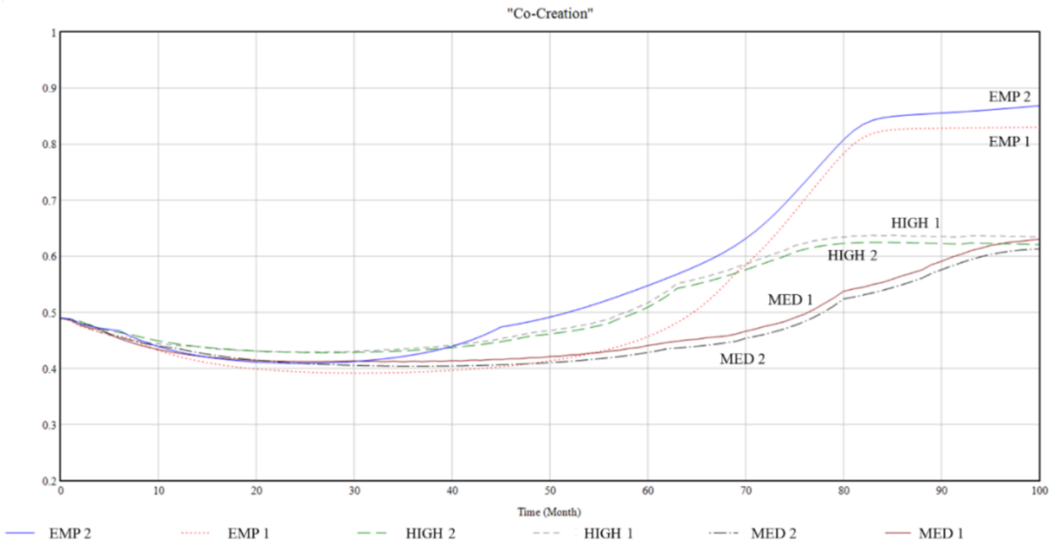


Fig. 9 Result of co-creation score using improvement of *k* variable toward EMP, HIGH and MED strategies. Source: Author's Analysis.

For the EMP 2 strategy, it remains the strategy that produces the largest co-creation value, and there was a significant increase in months 68-81 and began to decline slightly in months 82-100 with a final result of 0.83. Surprisingly, the EMP 1 strategy whose value was below HIGH 2 and HIGH 1 until the 60th month, namely 0.42, turned out to show a significant increase starting in the 61st month so that it had almost the same pattern results as the EMP 2 strategy in the 100th month with a score of 0.81. On the other hand, although the HIGH 1 and HIGH 2 strategies showed higher results than MED 2 and MED 1 until the 60th month, in the 100th month, both showed the same results, namely 0.63.

The model designed is a basic model that tries to simulate how the co-creation process can occur and what factors and strategies most influence it using the service science framework. From the simulation, we can see that there are short-term and long-term outputs that can be considered by stakeholders to realize value co-creation.

Based on the model simulation, we can see dynamic behavior due to the interaction between stakeholders. The strategies used produce various trends. Using the BaU scenario, the value co-creation score will produce a lower score compared to the initial one. On the other hand, we can see that the EMP strategy produces the highest value co-creation score, followed by HIGH and MED. On the other hand, if the value co-creation process only focuses on the INV and CUR strategies with little focus on EMP, the value co-creation process will produce a lower score compared to BaU.

In each strategy chosen, there is a cost in this case the effort that must be spent to produce co-creation value. Therefore, with the conflicting relationship between the two factors, the orchestrator needs to see the resource limitations they have to see what strategy needs to be chosen so that it is feasible to do. Certainly, this model is a basic model that is very open to being developed to get results that are more representative of the real world.

5. Conclusion

Indonesia's efforts to achieve sustainable food security require a paradigm shift from a fragmented, production-centric approach to a service-oriented and collaborative ecosystem. Food security is a complex concept that encompasses social, institutional, economic, and environmental dimensions, and it demands an integrated framework that recognizes the interdependence of various actors and resources.

In this context, the adoption of Service-Dominant Logic (S-D Logic) offers a transformative perspective, suggesting that food security is not merely the result of policy directives or market mechanisms, but rather the creation of sustainable shared value among stakeholders through the exchange of knowledge, competencies, and trust.

The establishment of the National Food Agency (Bapanas) is a crucial institutional innovation in realizing this new paradigm. Positioned as the regulator of Indonesia's food ecosystem, Bapanas bridges the gap between regulatory coordination and operational implementation. Its role extends beyond regulation to managing collaborative platforms, aligning institutional logics, and empowering actors across the food value chain. By enabling shared learning and resource integration, Bapanas can transform food governance into an adaptive system capable of responding to shocks, reducing inefficiencies, and improving welfare outcomes.

To operationalize this vision, systems thinking and system dynamics offer an analytical foundation for capturing the complexity of stakeholder interactions. The Causal Loop

Diagram (CLD) developed in this study visualizes the reinforcing and balancing feedback loops that shape collective behaviors, such as trust, willingness to collaborate, and perceptions of mutual benefit. Through this model, the mechanisms of shared value creation become transparent, enabling policymakers to identify leverage points to enhance collaboration, strengthen institutional alignment, and enhance policy coherence.

Ultimately, the integration of Service Dominant Logic, Bapanas orchestration, and system dynamics modeling provides a comprehensive pathway for reimagining Indonesia's food security system. This approach not only addresses immediate challenges related to availability, affordability, and stability but also fosters a long-term transformation toward a resilient, participatory, and innovation-driven food ecosystem, where shared value creation is the foundation of national food sovereignty and sustainability.

The conceptual model simulation highlights the dynamic interactions between stakeholders and their impact on strategy outcomes. The BaU scenario results in a lower value co-creation score compared to the baseline, while the EMP strategy achieves the highest score, followed by HIGH and MED. However, prioritizing INV and CUR strategies with minimal emphasis on EMP leads to even lower scores than BaU. The simulation also shows that increasing the level of importance of a stakeholder's role can increase the overall value co-creation score. By looking at these results, an orchestrator can provide a more intensive role and stronger involvement for each stakeholder to take part in the formulation, implementation and supervision of food policies.

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