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Article

Promoting value co-creation in food security in Indonesia with the lens of service-dominant logic

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Abstract: Food security presents a complex challenge that spans multiple sectors and levels, involving diverse stakeholders. Such a challenge necessitates collaborative efforts and the creation of shared value among participants. Through the lens of service-dominant logic (S-D logic), food security can be redefined to achieve a more comprehensive understanding and sheds light on the dynamic interplay among stakeholders, enabling the realization of potential value co-creation. As a theoretical contribution, this research addresses the gap in explaining stakeholder interactions. This aspect is crucial for fostering collaboration, and the study accomplishes this by leveraging Social Network Analysis to identify clusters and assign them roles as sub-orchestrators to support the National Food Agency as the main orchestrator who responsible to implement co-creation management strategy (involvement, curation, and empowerment). The study also proposes stakeholder roles in the context of food security: regulator, operator, dominator, niche player, and supporter. Moreover, the practical significance of this research is highly relevant to the early stages of the National Food Agency (NFA) since its establishment in 2021. As the NFA seeks optimal structure, networks, and resources to enhance Indonesia's existing food system, the study offers valuable insights. This comprehensive study highlights key issues in developing food security in Indonesia and provides recommendations for overcoming future challenges.

Keywords: food security; national food agency; service-dominant logic; stakeholder analysis; value co-creation; social network analysis

1. Introduction

The 20th century global food security agenda branched into two overarching perspectives (Amiri et al., 2020). The first perspective claimed that the main food security problem is hunger and insufficient food production, thus encouraging society to increase production. In recent decades, however, production-oriented approaches have been questioned because they failed to solve broader hunger problems, such as food justice, affordability, nutrition intake, and climate change. A more comprehensive approach was needed, leading to an emerging second perspective, to recognize food security as interconnected dimensions: economy, social, ecological, and even political.

Responding to the second perspective, governments around the world are actively developing policies to support food security and add value to the food industry, thereby raising public expectations for agricultural services and performance to increase general welfare. Agriculture is not only expected to generate food to feed growing populations but also to maintain socio-economic stability and promote a healthy society and sustainable environment (Braun et al., 2020). Food and

Agriculture Organization (FAO) in the 1996 World Food Summit, defines food security as "when all people, at all times, have physical and economic access to sufficient safe and nutritious food to meet their dietary needs and food preferences for a healthy and active life" (FAO, 1996).

This target requires participation from various stakeholders, to cooperatively develop reliable, fair, and sustainable food systems for all (Putro, 2016). Using this perspective, we can categorize food security as multi-level (national, regional, local) and multi-sectoral (economy, social, environmental, and political). The complex and dynamic nature of a food system requires us to examine food security using a more holistic, dynamic, and practical perspective on interaction among food system elements.

In food security, we recognize many actors and their roles, such as farmers as producer, middleman and retail as distributor, food factory as food processor, and society as consumer. Studying food systems using engineering or hard approach will lead us to see the process as a conveyor belt, starting with the producer and ending with the consumer. This makes us consider the food system process to be mechanistic, thereby reducing appreciation of humanistic factors and interactions between actors in it, that each actor has interests, autonomy and welfare that need to be considered. Therefore, it will direct us to work in silos during the planning, policymaking, and implementation stages (Mamoriska et al., 2020). This approach makes it challenging to integrate multiple roles simultaneously, thus missing the potential of value co-creation as the essential outcome of collaboration.

Service-dominant logic (S-D logic) offers a framework for perceiving the emergence of value as the crucial consequence of the interconnection between actors and resources. S-D logic is the study of service value co-creation among service-system entities to understand social value exchange as the application of resources for the benefit of another actor and fostering mutual benefits within the entire service ecosystem (Barile et al., 2016; Spohrer et al., 2009). Maglio and Spohrer (2008) explain that the actors can be people, businesses, nonprofits, and governments. S-D logic enables us to evaluate and redesign the interaction among actors and resources (Vargo et al., 2020).

Value is subjective experience from each actor and can be defined as an emergent outcome of the resource integration that increases the well-being of a particular actor (Vargo and Lusch, 2019, p. 740). Resources can be operand which are usually tangible and static, for example office buildings, agriculture land, and farming equipment; and operant which is usually intangible and dynamic, for example knowledge, competence, and organization. The linkage between operand and operant creates *resourceness* which benefits the actors involved (Vargo and Lusch, 2014).

However, S-D Logic has yet to offer guidance to focus on interactions among stakeholders within the food security service ecosystem. By considering the extent of engagement among stakeholders, more targeted strategies and actions can then be formulated, establishing specialized working groups to foster more meaningful interactions. This research is designed as a study investigating the service ecosystem of food security and how S-D logic can promote collaboration among stakeholders and achieve food security goals.

The objectives of this research are (1) to obtain a more holistic and dynamic view of value co-creation of food security in Indonesia, using S-D logic, and (2) to develop a method for stakeholder identification to develop collaboration strategy by combining S-D Logic with social network analysis.

2. Literature review

2.1. The Indonesia food security problem

Indonesia has succeeded in diminishing its hunger problem, but long-term challenges remain (World Food Programme, 2020). Increasing food production has yet to catch up with increasing consumption, as exacerbated climate change leads to less arable land. Food loss and waste are still high as well. Price instability leads to inflation, so that high food prices in comparison to income remains a major challenge, particularly causing malnutrition in children due to lack of adequate healthy and safe food. In addition, food consumption for most Indonesians is dominated by carbohydrates, with insufficient consumption of protein, fiber, and vitamins (Limenta and Chandra, 2017).

Additionally, food security policies are designed and administered by various ministries and programs with different perspectives and goals, causing poor coordination, overlapping roles between institutions, and egocentric working culture due to differences in vision (Handayati et al., 2015). Data integration is still difficult to achieve due to the heterogeneity of available data between ministries but is imperative since planning and decision making require a reliable data source that is mutually agreed upon. Therefore, it is crucial to develop collaboration among institutions to prevent silo process during the policy formulation.

2.2. The National Food Agency of Indonesia

Table 1. Strategic objectives and key initiatives of NFA.

Strategic Objectives	**Key Initiatives**
Availability Maximizing national production and securing food sufficiency.	Policy for intensification and extensification of domestic production, exporting-importing, buffer stock management (Presidential Decree No. 66/2021*)*.
Affordability Maintaining stock and price stability to support affordability and increase the equitable distribution of food in all areas including the vulnerable and remote.	• Policy for government purchase price (HPP) and maximum retail price (HET) to control inflation and protect farmer incomes and consumer purchasing power. • Policy for food distribution, importing, and national and regional stocking.
Quality & Safety Promoting food quality to encourage a more diverse, nutritional, balanced and safe diet, including increasing protein consumption.	• Policy for stock disposal and stock refreshment delivered by BULOG and ID-Food (food aid and prevention of childhood stunting program) and policy for cutting inventory loss value. • Policy for monitoring safety, quality, and nutrition of import food and food in markets.
Sustainability Increasing environmental awareness of producers, consumers, and stakeholders.	• Public hearing and coordination regarding food policy together with local K/L and communities of producers and consumers in national and regional level. • Public hearing of consumption behavior shift, especially from fresh food to processed food.

To overcome those issues, the Government of Indonesia through Presidential Regulation of the Republic of Indonesia Number 66 of 2021 Regarding the National Food Agency, established the Badan Pangan Nasional/National Food Agency (NFA). The NFA established a vision: "The realization of a strong and sustainable National Food Security based on sovereignty and food self-sufficiency for a developed Indonesia that is sovereign, independent and has a personality based on cooperation" (President of the Republic of Indonesia, 2021).

To support its vision, the NFA established several responsibility and coordination mechanisms between ministries and other government agencies. The NFA furthermore established strategic objectives and key initiatives (**Table 1**).

According to NFA Action Plan For 2022 (National Food Agency, 2022a), the NFA has developed a three-year action plan to fix fundamentals, restructure institutions, and create a breakthrough (**Figure 1**). The final stage in this action plan is a breakthrough which means service innovation as the result of resource integration among institution after fixing the fundamentals and restructuring phases.

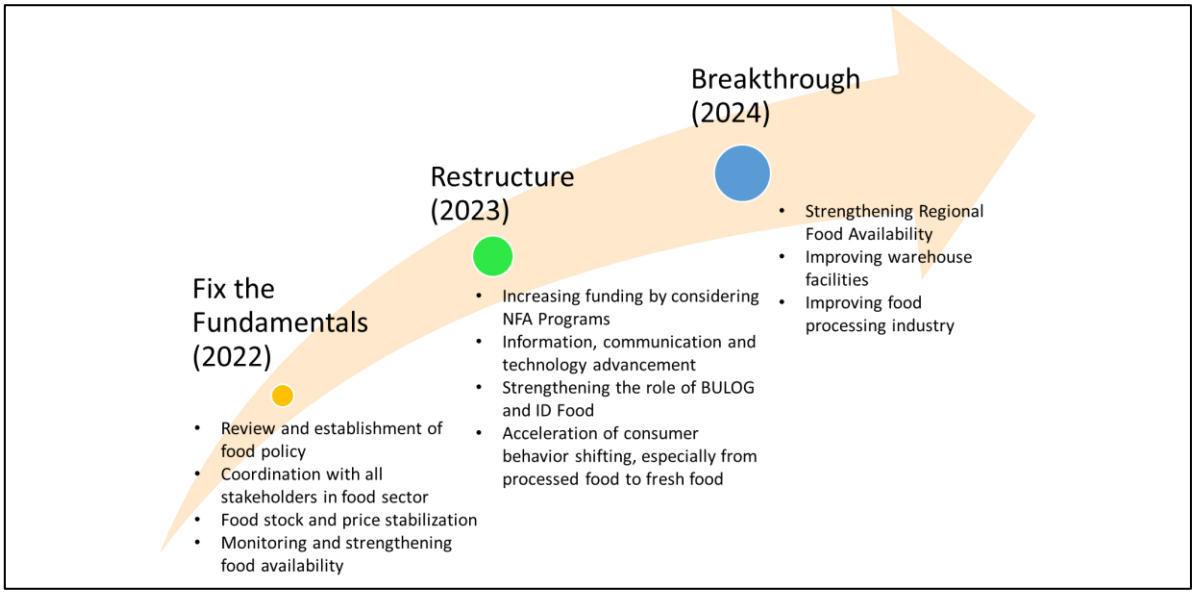

Figure 1. NFA action plan.

Source: National Food Agency (2022a).

In Indonesia food system, there are two distinct roles: regulator and operator. Additionally, the structure of food policy governance in Indonesia is shown in **Figure 2**. The NFA (Bapanas) is the regulator who takes role as institution who set the vision and target, create strategy, and establish regulation to ensure the achievement of food security development. President directly gives mandate to the regulator through Presidential Decree. However, in issuing regulation and policy, the NFA does not act alone and still has to coordinate with other Ministries, especially the Ministry of Stated-Owned Enterprises (BUMN), Ministry of Agriculture, Ministry of Trade, and Ministry of Social Affairs in implementing food security duties.

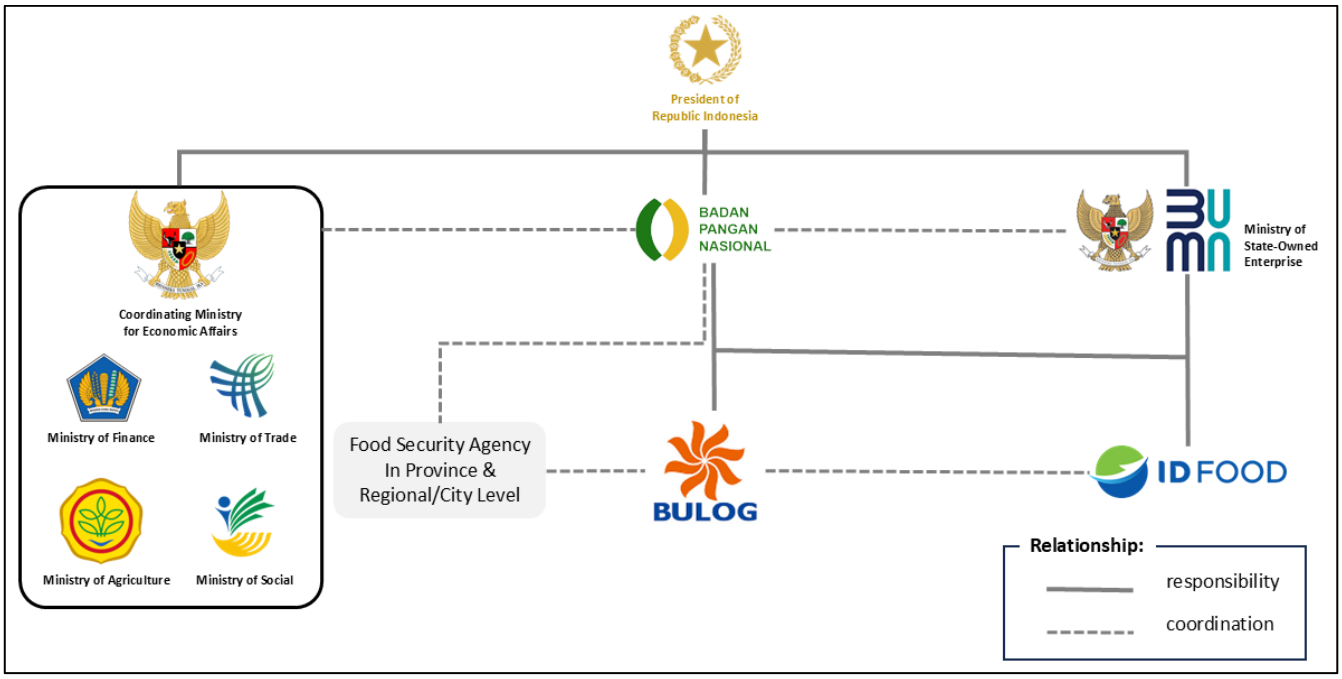

Figure 2. Food policy governance in Indonesia.
Source: National Food Agency (2022b, p. 29).

On the other hand, operators, which consists of BULOG and ID Food, are assigned to assist regulators in implementing the strategy that works under regulator instruction. As an operator, BULOG has the task of maintaining availability of nine food commodities (rice, corn, soybeans, sugar, onions, poultry eggs, beef, meat poultry and chili), and is also responsible for the Food Price Stability Reserves (Cadangan Stabilitas Harga Pangan) mechanism. On the other hand, ID Food is assigned to design commercial schemes, mostly business-to-business, and other non-commercial tasks. The Ministry of Trade takes a role in studying and making recommendations for food importing. The roles of the three institutions are supported by technical ministries such as the Ministry of Agriculture, the Ministry of Villages, the Ministry of Social Affairs, and the Food Security Agency at the regional and local levels.

We take the research opportunity presented by the establishment of the new NFA as the primary facilitator capable of instigating systemic transformation. The NFA holds a strategically vital role in enhancing the holistic advancement of the national food system.

2.3. Service-dominant logic

Service-dominant logic (S-D logic) is the study of value co-creation among service-system entities in order to understand social value exchange as the application of resources for the benefit of another actor (Barile et al., 2016; Spohrer et al., 2009). Maglio and Spohrer (2008) explain that interactions among entities can be analyzed from the S-D logic perspective by taking a bird's eye view in which service-system entities can be people, businesses, nonprofits, government agencies, and even cities. Service is not limited to the act of helping or fulfilling the counterpart's need, but can also come in many forms, such as exchange of knowledge, skill, facilities, access, and

finance resources. A service ecosystem is defined as a relatively self-contained, self-adjusting system of resource-integrating actors, shared institutional logics, and mutual value creation through the exchange of services (Lusch and Vargo, 2014).

We adopt that the value co-creation process is conducted by implementing co-creation management strategy: involvement, curation, and empowerment (Kijima and Arai, 2016). First, the involvement stage facilitates co-experience phase to exchange information about preferences, capabilities, and expectations, thereby enabling them to jointly build and share a shared internal model. When engaged in collaborative processes, involved actors may lack awareness of each other's capabilities and expectations. Next, the curation stage facilitates involved stakeholders collectively to redefine (co-definition) products, information, or services as their shared goal. Lastly, the empowerment stage consists of co-elevation and co-development phases. Co-elevation represents a spiral process characterized by fluctuations in partners' expectations and capabilities. Increased expectations result in higher service quality and increased social values (needs-pull). The provision of quality services then raises partner expectations (needs-push). Finally, co-development emphasizes joint innovation originating from simultaneous collaboration between various entities, achieved through continuous evaluation and assessment of partners' responses.

3. Methodology

3.1. Social network analysis

Social network analysis (SNA) is a set of techniques that studies the exchange of resources, such as information, among actors. Specifically, after identifying the important actors as a first step, SNA allows us to analyze their relational patterns and the overall process structure (Berkowitz, 1982; Wasserman and Faust, 1994).

SNA is particularly suitable for this research, as it is capable of grasping the structural patterns of actors involved (Adam and Kriesi, 2007). It potentially helps guide the application of S-D logic in promoting value co-creation by identifying relationships among stakeholders, which is relevant when assessing food security management that is only partly characterized by top-down, centralized decision making and implementation structures. Determining that different patterns of relational ties serve as structural characteristics of the networks can facilitate grasping their impact on enhancing knowledge transfer, resource mobilization, and consensus building. The fragmentation and multi-level arrangements of actor networks can be assessed, and the central importance of several key stakeholders outlined.

There are four indicators we examine in this research. All indicators range from 0 for low connectivity/centrality to 1 for a high connectivity/centrality toward other nodes. The first is the degree of centrality which represents the level of importance of a node by measuring the quantity of its direct connections in the network so that it has implications for the most important stakeholders who have the potential to become orchestrator. The second indicator is density level which represents the number of connections a node has, divided by the total potential connections a node has. The third indicator is Eigenvector which plays a role in pinpointing important nodes based on its connections to other important nodes. It is related to the potential for other stakeholders who can help in the role of orchestrator. The last indicator is Betweenness

centrality which plays an important role in shaping the flow of information or interactions between other nodes in the network. Essentially, it functions as a bridge or intermediary, aiding communication between different network segments.

We analyze current stakeholders' interaction using UCINET software and visualize it with Vos Viewer. The data source is presented in the Appendix, **Table A1** and **A2**.

3.2. Data collection

We used a Pentahelix model to understand and analyze stakeholders in complex ecosystems, particularly in the context of innovation, economic development, or sustainability. The penta-helix model highlights the importance of collaboration and communication among five key stakeholders: government entities, businesses, NGOs, media, and public or consumers (Patton and Willer, 1990).

- Government plays the lead role in providing comprehensive legislation and control of overall planning and implementation. This category is represented by the Food Security Agency, the Ministry of Agriculture, the Ministry of Villages, and BULOG.
- Academia plays a vital role in investigating, gathering information, carrying out research, and advancing the development of food systems. From the NGO, we interviewed a food bank that assists families in meeting their daily nutrition intake.
- Media is represented by Family Welfare Empowerment Organization, who distributes food aid, educates, and raises awareness of the prevalence of undernourishment to society, especially poor income families.
- Business enterprises create economically visible products, advice, and technical support in ensuring safety, efficacy, and marketability, and further provide market access in a broader scale. This category is represented by rice mill factories; food factory that processes raw food into frozen & precooked food; and Islamic boarding school which has a frozen food production business unit.
- Consumers should be addressed as the primary value definers of food policy. Planning should highlight the aspirations of consumers, from problem structuring to solution formulation. The public as food consumers is not a passive actor but should actively speak up in defining and being involved in implementing and monitoring policies. They must also shift towards more healthy and responsible consumption patterns that balance nutrition and reduce food waste.

We employed semi-structured interviews to obtain data from interviewees representing different sectors and institutions who play a prominent role in developing food security in Indonesia. The semi-structured interview technique was considered to be the appropriate method for this research because it allowed us to add new questions if we felt the need to discuss in detail of particular answers thus providing a deeper understanding of the context discussed during the interview session (Saunders and Lewis, 2017). Using snowball techniques, we obtained 19 interviewees representing five key stakeholders (**Table 2**).

Table 2. List of informants and interviewees.

Role	Institution	Number of interviewees
Government	National Food Agency of Indonesia	2
	Ministry of Villages	2
	BULOG	1
	Local Government	1
Business	Rice Mill Factory	3
	Food Manufacture	1
	Islamic Boarding School	2
Academician & NGO	NGO in social equity	1
	Research Institute	2
	Nutrition Expert	1
	Consultant in Agro-industry	1
	Food Bank	1
Media/Campaign	Family Welfare and Empowerment Organization	1

The questions contain the current food security situation, problems, and are followed by the ideal conditions expected from various points of view. Interviewees were also asked about their relationships with other stakeholders based on their role and responsibility, to support SNA.

Within S-D Logic, the orchestrator is the actor whose role is to orchestrate all involved stakeholders to co-create value. Iansiti and Levien (2004) categorize stakeholder interaction within business ecosystem into three major roles: keystones, dominators, and niche players.

Keystone has a role that creates ecosystem stability and diversity in the food security ecosystem. Therefore, by referring to Law no. 18 of 2012, there are two important roles, namely the regulator and the operator. A dominator is an entity that has the desire to dominate a portion of the market or food industry. Often, they have control over markets related to production, distribution, and fluctuations in food prices. Niche players is an entity that focuses on a specific area of expertise or specific market segmentation in the food ecosystem. They may not have a major influence on the food ecosystem as a whole, but they make an important contribution to enriching diversity and determining ecosystem characteristics. In addition, supporters are actors outside the food security ecosystem but play an essential role in empowering involved stakeholders.

So, in this research there are five roles: regulator, operator, dominator, niche player, and supporter (**Figure 3**). The description of each role is explained in **Table 3**.

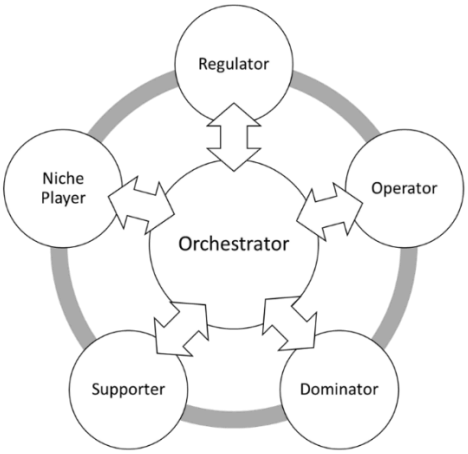

Figure 3. Redefining pentahelix stakeholder analysis within S-D Logic.
Source: Authors' analysis.

Table 3. Description of pentahelix stakeholder analysis within S-D Logic.

Role	Description
Regulator	Government entities who directly have authority to establish vision, plan, and policy/regulation.
Operator	Entities who are assigned by regulator to implement the plan and policy.
Dominator	Entities who have dominant resources and usually have desire to dominate a portion of the food ecosystem.
Niche Player	Their interests should be mainly addressed, because they define the value that should be delivered by other actors as the core of the ecosystem.
Supporter	Outside of the food security system, tend to take neutral positions but have potential to connect with and empower other stakeholders.

4. Results

4.1. Defining the value of co-creation in food security in Indonesia using the lens of S-D logic lens

S-D logic encourages the formation of a platform as the foundation for collaboration, which can be in the form of a working group of actors from various levels and sectors. According to the interviews referred to NFA's objectives, the expected value co-created by stakeholders are:

- Fulfillment food demand anytime for all,
- Maintaining stabilization of food supply and prices,
- Eradicating food insecurity and nutrition deficiency,
- Guaranteeing safety and quality of fresh food,
- Increasing the quality of food consumption,
- Developing reliable integrated food data,
- Establishing an effective and efficient National Food Agency bureaucracy that is oriented towards excellent service.

To respond, several strategies can be proposed for the NFA as orchestrator to promote collaboration to pursue food security through the lens of service science, and to help orchestrators in value co-creation. Five strategies have the potential, using S-D logic, to promote value co-creation:

1) Develop a shorter and sustainable food supply chain

An important indicator of food security is the stability of food supply and prices through an efficient supply chain (Chen et al., 2023). Therefore, information integration of supply and demand is important. The biggest cost element in the supply chain is usually in distribution and storage, which are prone to food waste.

The role of the NFA in food chains is to collaborate with Local Government and FSA R&C (the dominator), creating a platform that also engages food producers, distributors, and consumers. NGOs and the media become a control function for policy implementation. It is necessary to create a communication platform, such as the Regional Food Council, that invites all stakeholders to routinely discuss the planning and implementation of food chain policy. If this goes well, it is not impossible that in the future the Food Council will be able to provide direction regarding what food commodities, and how much, should be planted to meet local food needs.

2) Price fairness and stability

Two factors that make food security difficult to realize are guaranteeing farmer welfare and price fluctuating at the consumer level (Schupp et al., 2021). The NFA as a regulator has a very important role in ensuring that the purchase price of grain and other commodities favors farmers. BULOG was established as the operator in carrying out this task. Although there are many challenges, it is hoped that a good synergy can be created between BULOG and the Ministry of Finance to determine a satisfactory purchase price for farmers.

The government has a responsibility to control price stability which has an impact on multi-sectoral problems. Food price inflation has an impact on poor purchasing power which leads to low food accessibility especially in rural areas and nutritional imbalances because people predominantly consume carbohydrates, lacking fiber and vitamins. Finally, an increase in food prices can cause inflation to the general price level of goods and services. The government has formulated several related policies: (1) providing compensation to protect farmers as producers from low selling prices during the main harvesting period; (2) building a social safety net, particularly to protect low-income consumers from price fluctuations, (3) creating more stable macroeconomic conditions so as to encourage investment and economic growth (Mamoriska et al., 2020).

At the consumer level, an unstable supply chain contributes to fluctuations in commodity that make consumers vulnerable. It is hoped that the NFA in collaboration with Ministry of Trade (MoT) and Food Task Force (Satuan Tugas Pangan/SP) will be able to carry out market operations efficiently and eradicate the food mafia which often hoards food. Hoarding and corruption hinder the realization of shared value creation in food security.

3) Adequate diet and nutrition intake

In addition to accessibility factors, education about healthy food and monitoring food quality and safety are important for reducing malnutrition. Several stakeholders have roles directly involved in these tasks, including the Ministry of Health and local government with assistance from NGOs for food education program (Sitaker et al., 2021). Nevertheless, education on food diversification has not been adequately promoted; people still predominantly consume carbohydrates and need to be more aware of the value of protein and vitamins.

4) Developing reliable national food data

Production and consumption data are not well integrated. For example, there are different policies for determining purchase prices. Reliable data is necessary to create an integrated platform that can be accessed by all parties in real-time for policy formulation. Integrated food data is also an important resource for determining food adequacy at the regional and national levels. Unreliable data creates misinterpretation in decisions, for example food import that causing farmers' buying prices to fall (Cameron and Connell, 2021).

5) Establishing an effective and efficient National Food Agency bureaucracy that is oriented towards excellent service

Several institutional issues should be addressed. Policy formulation is still a project-based shopping list process. Policy integration between agencies is necessary, to create planning synergies with clear directions (Han et al., 2024). A former NFA civil servant stated:

> *The development of our food security is still conducted sporadically and there is no integrated planning between agencies. This creates overlapping plans leading to resource inefficiencies and unsustainable implementation.*

As there was no institution capable of coordinating between ministries/institutions, efforts to achieve food security are inefficient. An institution having authority over ministries/institutions is needed, an orchestrator with power to coordinate between ministries/institutions related to food security and a key figure in managing the planning and implementation of policies in a food security ecosystem. Nowadays, NFA has been established and become an orchestrator in the development of food security in Indonesia.

4.2. Value co-creation strategy

In the interviews we focused on obtaining information about interviewee perceptions, interactions, and personal experiences in the service ecosystem. Based on interviews with several stakeholders, we adopt co-creation management strategies by Kijima and Arai (2016), following involvement, curation, and empowerment, to promote improved food security.

By combining SNA with SD-logic, stakeholder mapping can be depicted with a new value co-creation strategy. Several clusters are formed, and each has cluster core which usually has role as regulator or dominator, responsible to lead each cluster in value co-creation process in each cluster's function: availability, accessibility, utility, and stability. Each cluster also has various roles that support each other in creating food policy plans and implementation by considering the cluster's goal. This strategy can be adopted as a reference for the Action Plan of NFA; we will adapt it to the co-creation strategy by involving stakeholders to collaborate on the co-creation platform. Involvement and Mapping stages can be used to develop a strategy for the "fixing the fundamentals" and "restructuring" phases from NFA action plan 2022–2023 by facilitating them through involvement and mapping strategy. Then the Curation and Empowerment strategies are suitable for developing strategies for the "breakthrough phase" from NFA action plan 2024.

The analysis of current stakeholders' interaction yields three clusters: production, policy & regulation, and stability (**Figure 4**). Members of each cluster are presented in **Table 4**. In each cluster, the domination of stakeholders has a larger bubble size compared to other stakeholders. Current stakeholders' interaction does not yield a good score: degree of centrality (0.43), density (0.49), eigenvector (0.22) and betweenness (0.21) which implies that collaboration among stakeholders has not fully formed.

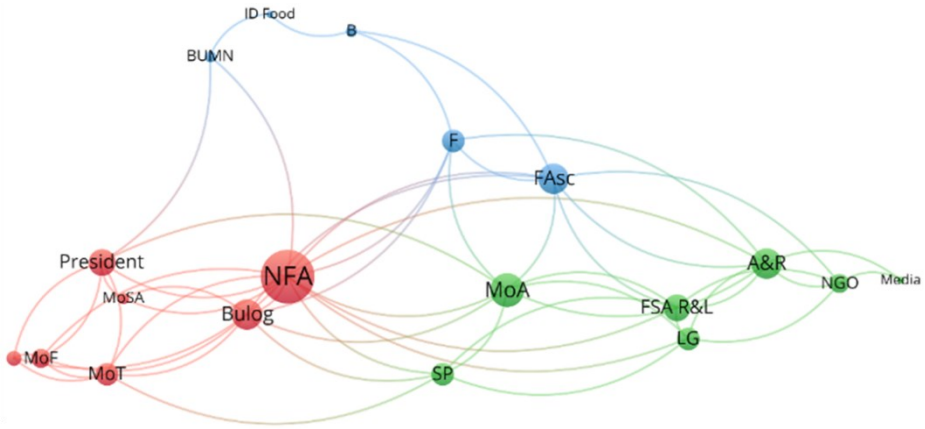

Figure 4. Social Network Analysis (SNA) of current condition of food security stakeholders in Indonesia.

President (P), National Food Agency (NFA), Ministry of Agriculture (MoA), Ministry of Trade (MoT), Ministry of Finance (MoF), Ministry of Village (MoV), BULOG, Coordinator Ministry of Economy (CMEcon), Ministry of Social Affair (MoSA), Ministry of State Owned Enterprise (BUMN), Ministry of Health (MoH), Statistics of Indonesia (BPS) Local Government (LG), Food Security Agency in Regional and Local Level (FSA R&L), Satuan Tugas Pangan (SP), and ID Food, Farmers (F), Farmers Group/Association (FAsc), Business (B), Non-Governmental Organization (NGO), Academicians & Consultants (A&C), Media, and Consumers (C).

Table 4. Clusters result from stakeholder analysis at current condition.

Cluster	Stakeholder	Role	Cluster	Stakeholder	Role
Cluster 1 (Production)	MSOE/BUMN	Regulator	Cluster 3 (Stability)	MoA	Regulator
	ID Food	Operator		FSA R&L	Regulator
	B	Dominator		LG	Regulator
	FAsc	Niche Player		A&C	Supporter
	F	Niche Player		NGO	Supporter
				Media	Supporter
				SP	Supporter
Cluster 2 (Policy & Regulation)	NFA	Regulator			
	Bulog	Operator			
	MoT	Regulator			
	President	Supporter			
	MoF	Regulator			
	CMEcon	Regulator			

Cluster 1 (blue) is dominated by stakeholders who act as producers. The Farmer Association has an important role in this cluster as liaison to connect farmers to other stakeholders by referring it to its connections, for example MOA, FSA, NFA and A&C. This strategic role is expected to encourage farmer welfare to improve through multi-stakeholder collaboration. Cluster 2 (red) consists of stakeholders who have a role as food regulators. The NFA is the core in this cluster and acts as a regulator, assisted by BULOG which has a close relationship as a food operator. Cluster 3 (green) consists

of stakeholders with role categorized in stability. Three actors have a regulator role: Ministry of Agriculture (MOA), Food Security Agency in Regional and Local Level (FSA R&L), and Local Government (LG). Other stakeholders assigned with supporter role, following Academicians & Consultant (A&C), Non-Government Organization (NGO), Media, and Food task force (SP).

Using value co-creation management strategy, NFA must develop strategy to improve collaboration and involve other relevant stakeholders, for example Ministry of Health, Ministry of Social Affair, and Consumers.

4.2.1. Involvement

Although the President of Indonesia has established working groups for food security development consisting of multiple ministries and institutions, disharmony among those stakeholders is often found during policy planning and implementation process. The diversity of interests between stakeholders is difficult to unite because the group members are too varied. We suggest several sub-working groups with a sub-orchestrator based on specific tasks which will allow dialogue and joint learning to create shared values that lead to collaboration among agents (Ruankaew et al., 2010; Ulibarri, 2015).

The orchestrator and sub-orchestrator will go on to proactively invite, map, and integrate resources and stakeholders to align their perceptions and co-create value (Choi and Robertson, 2013; Feo et al., 2022). The orchestrator should be an entity who can engage stakeholders to collaborate, organize tasks, and monitor the progress of food security development and may be separated from the regulator role. Therefore, to develop collaborative governance in food security, an orchestrator should be supported with a clear mandate from the central government. A BULOG official explains:

> *The NFA as orchestrator should have a direct mandate by the president. This is necessary because of its function to coordinate inter-ministerial policies. With strong authority, the NFA has more power to invite the relevant stakeholders into the working group.*

Collaboration involves multiple stakeholders who usually face many barriers, especially coordination at different levels of authority (Andoko and Doretha, 2020). Our data indicates that the local level has more authority to control over operand and operant resources, and thus can be considered the dominator later.

In the mapping process, the authors focus on actors who are committed to joining the service ecosystem. Mapping process integrates actors' interaction and their potential resources from various backgrounds and levels of authority.

4.2.2. Curation

In the Curation stage, stakeholders work together to develop new meanings in the service ecosystem. For example, the presence of middlemen usually causes food prices on the market to rise too high. This requires a supply chain model that can produce fair prices for farmers and affordable prices for customers. The government can develop an online marketplace to enable farmers to sell their products directly to consumers, so that prices from producers to consumers do not rise too high due to many middlemen.

4.2.3. Empowerment

Empowerment stage encourages stakeholders to jointly increase capacity by continuously seeking new opportunities and potential value that can be co-creation through the collaboration. The final stage of this shared value creation strategy represents a major shift regarding stakeholders' interaction in the food ecosystem in Indonesia (**Figure 5**). Members of each cluster are presented in **Table 5**. After conducting the three co-creation management strategies, the degree of centrality has increased to 0.54, and the density level to 0.38.

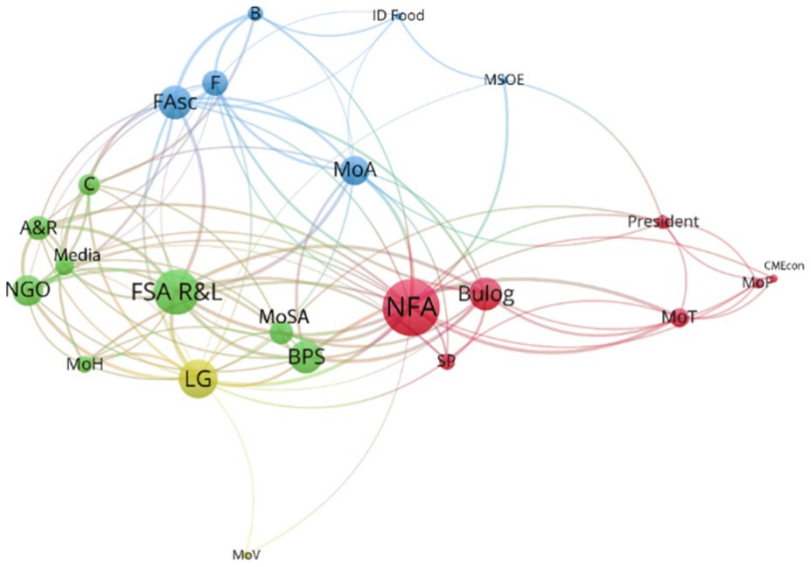

Figure 5. Social Network Analysis (SNA) in the curation and empowerment stages.

President (P), National Food Agency (NFA), Ministry of Agriculture (MoA), Ministry of Trade (MoT), Ministry of Finance (MoF), Ministry of Village (MoV), BULOG, Coordinator Ministry of Economy (CMEcon), Ministry of Social Affair (MoSA), Ministry of State Owned Enterprise (BUMN), Ministry of Health (MoH), Statistics of Indonesia (BPS) Local Government (LG), Food Security Agency in Regional and Local Level (FSA R&L), Satuan Tugas Pangan (SP), and ID Food, Farmers (F), Farmers Group/Association (FAsc), Business (B), Non-Governmental Organization (NGO), Academicians & Consultants (A&C), Media, and Consumers (C).

Table 5. Clusters result from stakeholder analysis after applying value co-creation strategy.

Cluster	Stakeholder	Role	Cluster	Stakeholder	Role
Cluster 1 (Availability)	MoA	Regulator	**Cluster 3 (Utility)**	FSA R&L	Dominator
	MSOE/BUMN	Dominator		MoSA	Regulator
	ID Food	Operator		MoH	Regulator
	B	Dominator		BPS	Supporter
	FAsc	Dominator		NGO	Supporter
	F	Niche Player		A&C	Niche Player
				Media	Supporter
				C	Niche Player
Cluster 2 (Accessibility)	NFA	Orchestrator	**Cluster 4 (Stability)**	LG	Dominator
	Bulog	Operator		MoV	Supporter
	MoT	Regulator			
	SP	Operator			
	President	Supporter			
	MoF	Supporter			
	CMEcon	Supporter			

Cluster 1 (blue) is dominated by actors who have role in food production, consisting of Ministry of Agriculture (MoA) as regulator who can be sub-orchestrator

to maintain food production and MSOE as dominator with ID Food as operator. Business (B) has role as dominator because they own major resource and dominate the market related to food production and distribution. Farmer Association (FAsc) and Farmer (F) have role as niche player because they have specific capability in cultivating crops, raising livestock, and producing food for human consumption. Specifically, farmer associations have a strategic role in empowering farmers by connecting them with other stakeholders, such as BULOG, ID Food, business, and local government. They play an important role in meeting the dietary needs of communities and nations. In the availability cluster, MoA (blue) appears to be becoming a regulator that plays a role in orchestrating food production due to its high eigenvector score.

In Cluster 2 (red), based on the SNA, stakeholders who have role accessibility are gathered. NFA has central role as Orchestrator by the mandate of President of Indonesia. Ministry of Trade (MoT) is the regulator and can be sub-orchestrator to maintain accessibility which keeps food price stable with the help of Bulog and Satuan Tugas Pangan (SP). Thus, President, Coordinator Ministry of Economy (CMECon), and Ministry of Finance (MoF) have role as supporter which supporting assigned stakeholders who have direct task to develop food security.

Cluster 3 (green) consists of stakeholders who have roles in utility dimension. Ministry of Social Affair (MOSA) and Ministry of Health (MoH) presenting the ministry who have the task of assisting the President in carrying out some government affairs in the Social and Health sector. A&C and C are niche players which their interest should be accommodated by the orchestrators and the regulators. A&C has the skill to add value by independently conducting research and studies about food security that can be an important information for orchestrator and regulators to evaluate and formulating development plan. Consumers can actively demand that their aspirations be acknowledged by business and government because safe and healthy food quality to create a healthy generation. BPS, NGO and Media play role as supporter who have role to empower stakeholders and promote connectivity among stakeholders identified by its high betweenness score among others. In the Utility cluster, Regional & Local FSA become sub-orchestrators, supported by MoH, MoSA, NGO, and A&C. By looking at betweenness score, Media and BPS clusters in Utility can serve as information and data centers with monitoring roles.

Cluster 4 (yellow) represents stability dimensions which consists of Local Government (LG) as dominator and Ministry of Village (MoV) as supporter. Local Government as the owner of regional resources has the power to take control of the development of food security in its region both from the dimensions of availability, accessibility and utility. According to the eigenvector value, we conclude that Local Government is capable of serving as an intermediary for stakeholders thus becoming a synergistic partner for other agencies in realizing food security at the local level. Interview data reinforce this, as many technical policies require the role of the Local Government for their implementation. Local Government has authority, understands the situation well, and provides a network for inviting stakeholders to collaborate. On the other hand, the Ministry of Villages has the task of developing villages which are generally centers of agriculture and food production from the aspect of increasing the capacity of village organizations and human resources.

In summary, the changes in roles experienced by each stakeholder are as follows (**Table 6**).

Table 6. Changes in stakeholder roles before and after implementing the co-creation management strategy.

Stakeholders	Before	After
President (P)	Regulator	Supporter
National Food Agency (NFA)	Regulator (Orchestrator)	Regulator (Main Orchestrator)
Ministry of Agriculture (MoA)	Regulator	Regulator (sub-orchestrator)
Ministry of Trade (MoT)	Regulator	Regulator (sub-orchestrator)
Ministry of Finance (MoF)	Regulator	Supporter
Ministry of Village (MoV)	-	Supporter
BULOG	Operator	Operator
Coordinator Ministry of Economy (CMEcon)	Regulator	Supporter
Ministry of Social Affair (MoSA)	-	Regulator (sub-orchestrator)
Ministry of State-Owned Enterprise (BUMN)	Regulator	Dominator
Ministry of Health (MoH)	-	Regulator
Statistics of Indonesia (BPS)	-	Supporter
Local Government (LG)	Regulator	Dominator
Food Security Agency in Regional and Local Level (FSA R&L)	Regulator	Dominator
Food task force/Satuan Tugas Pangan (SP)	Operator	Operator
ID Food	Operator	Operator
Farmers (F)	Niche Player	Niche Player
Farmers Group/Association (FAsc)	Niche Player	Dominator
Business (B)	Dominator	Dominator
Non-Governmental Organization (NGO),	Supporter	Supporter
Academicians & Consultants (A&C)	Supporter	Niche Player
Media	Supporter	Supporter
Consumers (C)	-	Niche Player

5. Conclusions and recommendations

The scope of food security development is very complex because it involves many sectors and actors. Viewing food security development within the lens of S-D logic that focuses on the interactions between stakeholders and the potential value co-created, shows that institutions can support the role of other institution with assistance of the orchestrator and/or sub-orchestrators, with assigned roles that follow specific tasks or objectives.

While Indonesia has made progress developing food security, the lens of S-D logic indicates some issues that clearly need to be resolved. Unsustainable agricultural technologies practices (e.g., excess fertilizer and pesticide use) are still important issues which lead to desertification, erosion, soil degradation, water and soil pollution, and increased pests and diseases. This condition is exacerbated with poor knowledge and skills among farmers and poor coordination among institutions in the food sector. An institution that has adequate authority to establish plan and policies from various stakeholders in the food sector is needed.

In this study, the NFA is the main orchestrator supported by three sub-orchestrators: the Ministry of Agriculture, Ministry of Trade, and Food Security Agency in Regional and Local Level. The Ministry of Agriculture is responsible for availability dimension. On the other hand, the Ministry of Trade together with the Food Security Agency at the Regional & Local level, can work together in promoting value co-creation the dimensions of accessibility, utility and stability in their respective regions. This proposed model is expected to improve current stakeholders' interaction, which previously relied on National Food Agency as a single orchestrator.

The practical contribution of this study is very relevant to current situation because the National Food Agency (NFA) of Indonesia, established in 2021, is still in its early stages and seeking the most suitable organization structure, networks, and resources to fulfil its role in redeveloping Indonesia's food security ecosystem. With SNA, we fill the theoretical gap of the value co-creation process by mapping the interaction among actors, showing that relationships between stakeholders are an essential aspect of building collaboration. We propose new roles in defining stakeholder roles in food security: regulator, operator, dominator, niche player, and supporter. Based on analysis that highlights the NFA as the main orchestrator, we indicate sub-orchestrators: the Ministry of Agriculture, Ministry of Trade, and the Food Security Agency at the Regional & Local level.

Future research can investigate the application of SNA at the regional or local level because each region has a diversity of cultures, institutions, planning, and policies. Furthermore, research can be followed with computerized simulations to describe the dynamic interactions between agents in micro-level interactions using agent-based modeling. The analysis result of SNA can be taken as input and a series of procedures in conducting the simulation.

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Appendix: Dyadic value of social network analysis per actors

Table A1. Matrix of stakeholder interaction at current condition (before the implementation of value co-creation management strategy).

	President	**NFA**	**MoA**	**CMEcon**	**MoF**	**MoSA**	**MoT**	**Bulog**	**BUMN**	**MoV**	**MoH**	**BPS**	**ID Food**	**SP**	**FSA R&L**	**A&C**	**LG**	**Media**	**NGO**	**FAsc**	**F**	**B**	**C**
President	0	1	1	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NFA	1	0	1	1	1	1	1	1	1	0	0	0	0	1	1	1	1	0	0	1	1	0	0
MoA	1	1	0	0	0	0	0	1	0	0	0	0	0	1	1	1	1	0	0	1	1	0	0
CMEcon	1	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MoF	1	1	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MoSA	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MoT	1	1	0	1	1	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Bulog	0	1	1	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0
BUMN	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
MoV	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MoH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BPS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ID Food	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0
SP	0	1	1	0	0	0	1	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0
FSA R&L	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	1	1	0	0	0
A&C	0	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1	1	0	0
LG	0	1	1	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	1	0	0	0	0
Media	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0
NGO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	1	0	0	0
FAsc	0	1	1	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0	1	0	1	1	0
F	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	1	0	1	0
B	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0
C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

0 = weak, 1 = moderate, 2 = strong.

Table A2. Matrix of stakeholder interaction after the implementation of value co-creation management strategy.

	President	**NFA**	**MoA**	**CMEcon**	**MoF**	**MoSA**	**MoT**	**Bulog**	**BUMN**	**MoV**	**MoH**	**BPS**	**ID Food**	**SP**	**FSA R&L**	**A&C**	**LG**	**Media**	**NGO**	**FAsc**	**F**	**B**	**C**
President	0	1	1	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NFA	1	0	2	1	1	2	2	2	2	1	1	1	0	2	2	2	2	1	1	1	1	1	0
MoA	1	2	0	0	0	0	0	1	0	0	0	1	1	1	2	1	1	0	0	2	2	1	0
CMEcon	1	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MoF	1	1	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MoSA	1	2	0	0	0	0	0	2	0	0	1	2	0	0	2	0	0	0	2	0	0	0	1
MoT	1	2	0	1	1	0	0	2	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0
Bulog	0	2	1	0	1	1	1	0	0	0	0	2	0	2	2	0	0	0	0	2	2	0	0
BUMN	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
MoV	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MoH	0	2	0	0	0	1	0	0	0	0	0	2	0	0	2	0	2	0	2	0	0	0	2
BPS	0	2	2	0	0	1	2	2	0	0	0	0	0	0	2	1	2	1	1	0	0	0	0
ID Food	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1	1	0
SP	0	1	1	0	0	0	1	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0
FSA R&L	0	2	2	0	0	0	0	2	0	0	0	2	0	2	0	2	2	1	1	2	1	0	1
A&C	0	1	1	0	0	0	0	0	0	0	0	1	0	0	2	0	1	1	2	1	1	0	0
LG	0	2	1	0	0	2	0	1	1	1	1	1	0	1	2	1	0	1	2	1	1	0	2
Media	0	1	0	0	0	0	0	0	0	0	0	1	0	1	2	2	0	0	2	2	1	0	1
NGO	0	1	0	0	0	1	0	0	0	0	0	1	0	0	2	2	2	1	0	2	1	0	2
FAsc	0	1	1	0	0	0	0	1	0	0	0	0	0	0	2	1	2	0	1	0	2	2	1
F	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0	0	2	0	1	1
B	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	2	2	0	2
C	0	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0	1	0	1	1	1	1	0

0 = weak, 1 = moderate, 2 = strong.