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Strengthening institutional capacity for fresh food safety governance: Evidence from Indonesia's Regional Food Safety Authorities

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Abstract

Institutional capacity is a critical factor in ensuring safe and sustainable local food systems, particularly for fresh foods that are highly perishable and often traded through traditional markets. As an agrarian country and one of the world's major food producers, Indonesia manages a wide range of fresh, plant-based food commodities that require effective food safety oversight. In this context, strengthening fresh food safety governance supports local producers by promoting safer production standards and practices, while reinforcing traditional markets as trusted channels for fresh food distribution. It also contributes to regional food system resilience by ensuring the availability of fresh foods that are safe in both quantity and

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Disclosures

The authors declare no conflict of interest.

Data Availability Statement

The data used in this study were obtained through an institutional survey conducted among officials of the Regional Food Safety Competent Authority (RFSCA) in Indonesia. All participants provided informed consent to participation, and no personal or confidential information was collected or disclosed. Due to privacy agreements with participating institutions, the whole dataset is not publicly available.

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quality. Within Indonesia's decentralized governance structure, Regional Food Safety Competent Authorities (RFSCA) serve as key institutional actors responsible for safeguarding the safety of fresh foods at the subnational level. As of 2025, a total of 34 provincial food affairs agencies have been formally verified as RFSCA. However, the institutional performance of around 60% of these authorities remains uneven and, in several cases, suboptimal. This study examines the institutional drivers influencing RFSCA performance and develops strategies to strengthen their operational capacity using Interpretive Structural Modelling (ISM) and Best–Worst Method (BWM). Data was collected from 34 provinces through structured surveys and expert assessments. The findings indicate that adequate budget allocation and standardized institutional mandates function as fundamental drivers of institutional performance. Approximately 80% of RFSCA operate with insufficient budgetary support, while core functions such as monitoring, evaluation, and capacity-building activities are largely dependent on these foundational institutional conditions. The proposed framework offers actionable guidance for regional authorities and policymakers to enhance coordination, accountability, and resilience in fresh food safety governance—ultimately supporting safer and more resilient local food systems.

Keywords
Best–Worst Method (BWM), fresh food safety, Indonesia, institutional strengthening, Interpretive Structural Modelling (ISM), regional food governance, system-based analysis

Introduction and Literature Review

Food safety governance plays a critical role in protecting public health and sustaining consumer confidence, particularly in developing countries where institutional capacity constraints continue to hinder effective implementation. In decentralized governance systems, regulatory authority is often distributed across multiple agencies at national and subnational levels, including entities with enforcement and delegated oversight responsibilities. While such arrangements may facilitate coordination and information exchange, they frequently lack clear mechanisms for accountability, performance monitoring, and resource alignment. As a result, fragmented institutional mandates and uneven capacity across regions can weaken food safety control effectiveness (Food and Agriculture Organization of the United Nations [FAO], 2019). Weak institutional capacity can constrain food safety assurance and oversight, increasing consumer exposure to unsafe foods, undermining the reliability of local markets, and weakening regional food system resilience (Cheruiyot et al., 2024). These challenges are particularly evident in decentralized governance systems, where responsibilities are distributed across subnational authorities with differing levels of institutional capacity (Kimanya, 2024). Therefore, strengthening regional food safety institutions should be understood not merely as a regulatory obligation but as a strategic component of food system–based community development (Doustmohammadian et al., 2022). In Indonesia, the decentralization framework established under Law No. 23/2014 delegated substantial authority to provincial governments without distributing substantial resources. Multi-agency and multi-institutional food safety control requires coordination among diverse government entities and stakeholders to ensure coherent regulation, inspection, and enforcement (Al Busaidi et al., 2025). Previous research has emphasized national-level regulatory frameworks, risk communication, and surveillance mechanisms (Geng et al., 2021). Even so, limited attention has been given to the institutional capacity of regional authorities, despite their central role in policy implementation and compliance assurance.

Within Indonesia, responsibility for fresh, plant-based food safety is shared between central and local governments. The National Food Agency sets national regulations and standards and oversees the safety of imported fresh foods, while local governments—through Regional Food Affairs Offices serving as food safety authorities—implement inspection, monitoring, and enforcement for domestically produced fresh foods at the regional level (Hermansyah et al., 2025). This institutional arrangement is grounded in Indonesia Food Law No. 18/2012 along with Presidential Regulation No. 66/2021, which established the National Food

Agency and delineated fresh food safety responsibilities, and Government Regulation No. 86/2019 on Food Safety. Despite formally defined mandates, the current governance structure faces systemic challenges such as overlapping agency functions, inconsistent policy enforcement, limited technical expertise, and weak stakeholder coordination (Liu et al., 2019). These systemic constraints reflect the coordination and enforcement challenges observed in other decentralized systems, undermining the effectiveness of food control, increasing contamination risks in fresh produce, and eroding public confidence in regulatory performance. These challenges underscore the need for targeted institutional strengthening to ensure effective and sustainable food safety system performance (Chen et al., 2021). Without targeted reforms—such as enhancing human resources, improving infrastructure, and ensuring adequate financial and regulatory support—institutions will likely remain fragmented and ineffective (Mayett-Moreno & Oglesby, 2018).

Although existing studies provide valuable insights into food safety governance, they have focused mainly on regulatory design, risk communication, or technical interventions. They offer a limited understanding of how institutional elements interact to influence governance performance at the regional level (Unnevehr, 2022). In this study, institutional elements refer to organizational structures, human resource capacity, operational procedures, infrastructure, and budgeting support that collectively shape regulatory performance at the regional level. Furthermore, most analyses rely on descriptive or qualitative approaches and lack systematic methods to prioritize strategic interventions or model the complex interdependencies among institutional drivers. This creates a significant research gap in identifying which institutional factors exert the greatest influence on food safety governance and how they should be strengthened in a decentralized context. Therefore, this study aims to: (a) identify key institutional drivers influencing the performance of Regional Food Safety Competent Authorities (RFSCA); (b) analyze the structural interrelationships among these drivers using Interpretive Structural Modelling (ISM); and (c) prioritize institutional strengthening strategies through the Best–Worst Method (BWM). ISM structures complex interdependencies among institutional factors, while BWM quantifies expert judgment to prioritize strategic actions. The integration of these methods offers both diagnostic and decision-supporting structural insights for institutional governance while encouraging decision-support capabilities that enable the formulation of actionable strategies to strengthen regional food safety system development. This study addresses these gaps by developing a systems-based analytical framework to examine and strengthen the institutional performance of Regional Food Safety Competent Authorities (RFSCA), while ultimately revealing budget allocation and standardized mandates as foundational enablers of institutional performance.

Food Safety Governance

Food safety governance is increasingly conceptualized as a multi-actor, multi-level process that requires alignment of policy, regulatory institutions, and operational capacities across scales (Shen et al., 2021). Food safety governance encompasses the frameworks and mechanisms through which government agencies coordinate to ensure and monitor food safety. It relies on adequate regulatory support, financial resources, established guidelines, and the professional competence of institutions mandated to manage food safety (L. Wu et al., 2023). However, disparities in institutional capacity across regions frequently compromise the efficacy of governance. Although institutional responsibilities have been formally defined, the current governance structure faces several systemic challenges. These include inconsistent policy enforcement, limited technical capacity, unstandardized procedures and services, and weak stakeholder coordination (Termeer et al., 2018). In decentralized settings, these challenges call for institutional strengthening that enables food safety systems to operate consistently across jurisdictions and over time (Abdollahzadeh, 2021).

Institutional Performance and Capacity in Food Safety

Institutional capacity—including clear mandates, stable financing, human resources, logistics, and

data systems—is widely recognized as a primary determinant of effective food-safety control. Empirical studies report that without reliable funding and standardized duties and functions, investments in technical capacity, inspection coverage, and risk communication are difficult to sustain at the subnational level (Kraak & Niewolny, 2024). Therefore, when assessing food-system governance, it is crucial to analyze the formal institutional structures and the practical capabilities required for effective action and ongoing improvement (Karan et al., 2023). Accordingly, this study focuses on identifying and analyzing the key institutional elements that determine the performance of RFSCA across provinces.

Empirical Applications for Food Safety Institutional Strengthening

Food safety supervisory agencies face several challenges, including limited staff capacity, insufficient facilities, and weak monitoring activities (Shuangshuang et al., 2018). Institutional strengthening is therefore crucial for improving food safety governance. It emphasizes a comprehensive framework, clear institutional responsibilities, adequate supervision, and regular risk monitoring to enhance governance performance (Wang et al., 2025). Systems methods are being increasingly applied to food safety governance problems to map causal relationships and identify leverage points. Empirical applications for strengthening food safety institutions could combine mapping and prioritization tools to translate complex diagnostic findings into actionable strategies. Interpretive Structural Modelling (ISM) is a well-established technique for structuring complex, interdependent factors into hierarchies and revealing driving versus dependent variables in organizational systems (Sreenivasan et al., 2023). The Best–Worst Method (BWM) has gained popularity because it requires fewer pairwise comparisons and often yields higher consistency in expert judgments than older AHP-type approaches (Pamučar et al., 2020).

Applied Research Methods

This study employed a systems-based analytical approach to examine institutional conditions and identify strategic priorities for strengthening regional food safety governance in Indonesia. The methodological framework integrated Interpretive Structural Modeling (ISM) and the Best–Worst Method (BWM), enabling the study to explore structural dependencies while also prioritizing actionable institutional strengthening strategies.

Collecting Data and Respondents

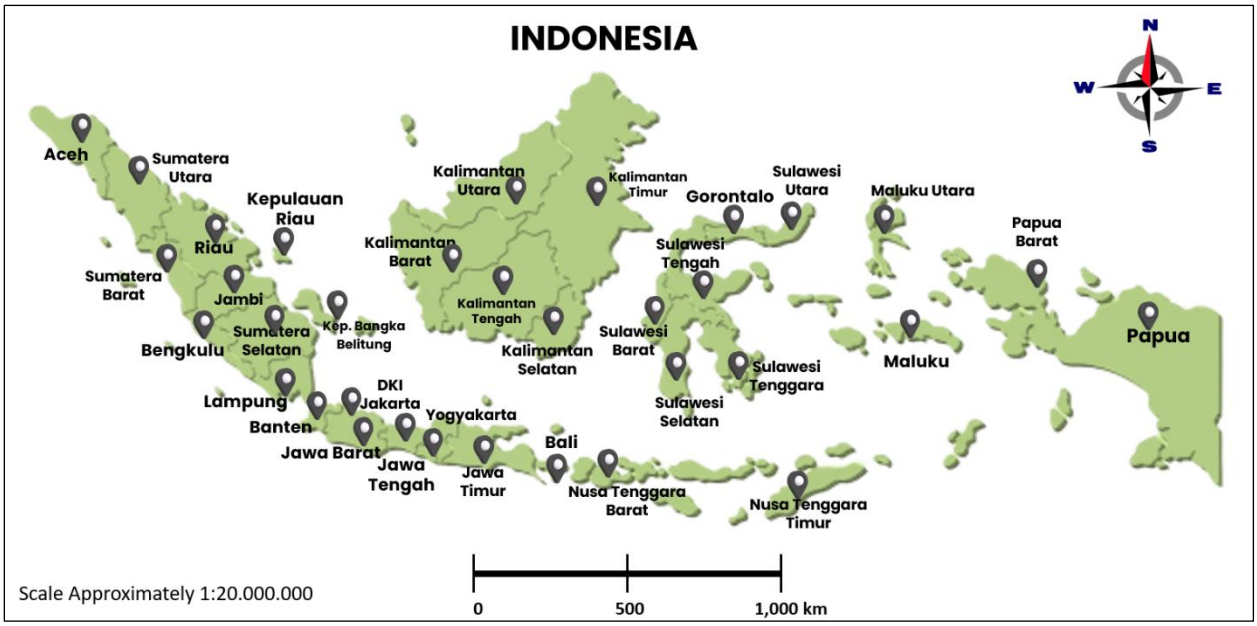
Data for this study was collected from November 2024 to March 2025 through a structured survey of the RFSCAs across all 34 provinces in Indonesia (as shown in Figure 1). Each province was represented by a leader of a competent authority agency or one senior official directly responsible for food safety supervision, purposively selected based on their decision-making role and operational knowledge. The survey aimed to assess the institutional conditions of these authorities through seven key dimensions. These dimensions were identified and based on National Food Agency Regulation No. 12/2023, as crucial for institutional strengthening: organizational structure, human resources, food safety assurance, inspection and supervision, guidance and outreach, supporting facilities, and budget allocation.

Five experts were purposively selected to complement the survey data, provide in-depth insights into the relationships among these dimensions, and help formulate and prioritize institutional strengthening strategies. These experts were selected based on their professional experience and at least five years of direct involvement in food safety agency governance, regulatory policy, or institutional management at the national or regional level. The expert panel comprised two senior representatives from regional authorities, two senior representatives from central authorities, and one academic expert.

Interpretive Structural Modelling (ISM)

The ISM technique was used to explore the interrelationships among the institutional dimensions identified in the survey. This method was chosen because it helps visualize how institutional factors interact hierarchically—from foundational enablers to outcome variables—thereby revealing leverage points for institutional improvement. Once the variables were identified, the relationships among

Figure 1. Location of Regional Food Safety Authorities in Indonesia



Source: Author's compilation based on National Food Agency data (2025).

the variables identified by experts were assessed using a structural self-interaction matrix (SSIM; Nega et al., 2024). In an SSIM, expert judgments about the pairwise relationships are recorded using standard ISM symbols:

- V: if element *i* influences element *j*, but not vice versa
- A: if element *j* influences element *i*, but not vice versa
- X: if elements *i* and *j* influence each other
- O: if there is no relationship between them

For example, experts agreed that budget allocation (E12) directly influences human resource capacity (E2), as funding determines recruitment, training, and retention. The SSIM was then converted into a binary reachability matrix, applying the standard ISM rules and verifying transitivity to ensure logical consistency (Alawamleh et al., 2023). The binary reachability matrix (*RM*) can be mathematically defined as:

$$RM(i,j) = \begin{cases} 1\,, if\ element\ i\ influence\ j \\ 0\,, otherwise \end{cases}$$

Once the initial binary matrix is formed, a transitivity check is performed to ensure that if element *i* leads to *j*, and *j* leads to *k*, then element *i* should also lead to *k*. Mathematically, transitivity implies:

$$\text{If } RM\ (i,j)\ = 1 \text{ and } RM\ (j,k) = 1, \text{then ensure } RM\ (i,k) = 1$$

If any transitive links are missing, they are added to complete the matrix. After transitivity closure, the reachability matrix is used to determine the reachability set and antecedent set for each element. The next step is level partitioning, which involves grouping elements based on their relationships in the reachability matrix. For each element, a reachability set (all elements it can reach), an antecedent set (all elements that can reach it), and their intersection set are identified (Meher & Mishra, 2019). An element is placed at a specific level when its reachability set matches the intersection set. This process is repeated until all elements are assigned a level. After that, a conical matrix is created to examine the system's structure by calculating each element's driving power and dependence power. The final output of the ISM process is a hierarchical model (Ahmad & Qahmash, 2021) that

maps the causal structure of institutional performance in regional food safety governance. All ISM and Cross-Impact Matrix Multiplication Applied to Classification (MICMAC) computations were performed using Microsoft Excel.

Best–Worst Method (BWM)

After identifying the key drivers through ISM, the BWM was applied to determine the priority order of prioritize strategic actions for institutional strengthening. BWM was selected because it allows for consistent expert judgments and requires fewer comparisons than traditional multi-criteria methods, making it more practical for decision-making in a policy context (Wankhede & Vinodh, 2021). It is used to determine the relative weights of several available strategies based on expert judgments by comparing the most and least preferred (best and worst) strategies with the others. The BWM analysis process is conducted through the following steps (Rezaei, 2015):

Step 1: Criteria Identification. The strategies formulated based on the ISM analysis were evaluated in terms of their priority, as weighted by expert respondents.

Step 2: Determination of the Best and Worst Criteria. Each expert was asked to identify one strategy considered the most important (*Best*) and one considered the least important (*Worst*).

Step 3: Best-to-Others Assessment (B → j). Experts were asked to assign preference values indicating how much more important the Best strategy is compared to each of the other strategies, using a scale from 1 to 9. This forms the Best-to-Others preference vector: $A_B = (a_{B1}, a_{B2}, \ldots, a_{Bn})$.

Step 4: Others-to-Worst Assessment (j → W). Experts were also asked to rate the relative importance of each strategy compared to the Worst strategy, using the same 1–9 scale:

$A_W = (a_{1W}, a_{2W}, \ldots, a_{nW})$.

Step 5: Optimal Weight. The optimal weights $w_1, w_2, \ldots w_n$ are obtained by solving a linear optimization problem subject to the following constraints:

$\left|\frac{w_B}{w_j} - a_{Bj}\right| \leq \xi, \left|\frac{w_j}{w_W} - a_{jW}\right| \leq \xi$ subject to:

$\sum_{j=1}^{n} w_j = 1, w_j \geq 0$

Step 6: Consistency Ratio Calculation. To assess the consistency of expert judgments, a consistency ratio (CR) was calculated. The CR is defined as the ratio between the optimal deviation value ξ^* obtained from the optimization model and the maximum allowable deviation $\xi_{\max}$, which is determined based on the scale used for preference values in the assessment (Q. Wu et al., 2024).

This hybrid method (ISM–BWM) integrates structural analysis with quantitative prioritization, enabling both causal mapping of institutional interdependencies and strategic decision support. This approach represents a relevant and novel methodological contribution to food safety governance research in decentralized systems.

Results

The results of this study provide an overview of the institutional conditions of Regional Food Safety Competent Authorities (RFSCAs) across Indonesia and highlight the key factors influencing their performance. The findings are organized into three parts: survey-based institutional condition, structural analysis using ISM, and strategic prioritization using the BWM approach.

Institutional Condition: Survey Findings

Out of the 34 RFSCAs surveyed, the majority operate within a formally established regulatory framework at the provincial level. Specifically, 94% of provinces have formalized the legal status, organizational structure, functions, and work procedures of their RFSCA through decrees issued by regional heads, while the remaining 6% rely on administrative decisions by local food agency leaders. This pattern indicates relatively high levels of formal institutional compliance yet also reveals variation in the degree of institutionalization across provinces, particularly in terms of administrative authority. These findings reflect common challenges in decentralized governance systems in

Indonesia, where policy attention and institutional formalization are closely linked to political commitment and fiscal capacity at the regional level. Most RFSCAs are structured under one or two functional units, typically comprising a food safety division and, in some cases, a technical implementation unit such as a food safety and quality control laboratory.

The adequacy and competence of human resources strongly influence institutional performance. The survey reveals that 71% of RFSCAs fall short of the minimum staffing requirements relative to their operational workload. Nearly 44% employ only five to 10 personnel, 15% have fewer than five, and only 9% report more than 20 staff members. This significant shortage of qualified personnel constrains the effectiveness of food safety control activities. Regarding staff competency, 56% of RFSCAs reported that more than three quarters of their personnel are certified in relevant roles such as food safety inspectors, sample collectors, or auditors. The remaining 44%, however, have yet to meet this competency threshold, indicating uneven regional capacity development.

Operational standardization through standard operating procedures (SOPs) is essential for consistency and accountability in food safety assurance. Survey results show that only 41% of RFSCAs possess complete SOPs, while 56% have partial versions and 3% have none. This gap reflects the limited availability of detailed national technical guidance, combined with uneven regional institutional capacity to translate general regulatory requirements into operational procedures. Even among agencies with established SOPs, only 47% report consistent implementation, with limited understanding, insufficient training, and weak internal commitment cited as key barriers. These findings indicate that institutional weaknesses lie not only in the availability of formal procedures but also in their operationalization, reflecting gaps in national technical guidance, regional capacity for procedural development, and sustained organizational commitment to implementation.

Despite these structural and procedural gaps, 94% of RFSCAs have developed post-market surveillance plans, demonstrating strong awareness of the importance of risk-based monitoring. Execution, however, remains inconsistent: Surveillance data is often collected but rarely used for corrective or preventive actions. Approximately 62% of RFSCAs identified limited budgets, personnel, and infrastructure as barriers to follow-up, while 38% cited the absence of a clearly defined feedback mechanism. These challenges suggest both procedural and institutional weaknesses that may compromise the effectiveness of local food safety surveillance systems (Barinda & Ayuningtyas, 2022).

Adequate facilities and infrastructure are fundamental to effective food safety supervision. While most RFSCAs have access to office space—dedicated or shared within local food agencies—only 47% are equipped with a complete set of inspection tools, including sampling kits and rapid test devices for field assessments. Moreover, just 38% of agencies have access to operational vehicles, which limits mobility for inspection, monitoring, and outreach. These basic equipment and logistics limitations significantly reduce the agencies' ability to perform timely and reliable food safety interventions.

Budgetary constraints remain one of the most significant institutional challenges. Although funding sources include regional and national budgets, only 20% of RFSCAs reported receiving adequate financial support. Alarmingly, three agencies operate with no regional budget allocation, as recorded in the 2023 institutional review by the National Food Agency (Badan Pangan Nasional, 2023). Insufficient budgets limit the scope of essential activities such as routine inspections, laboratory analysis, staff training, and maintenance of facilities, ultimately weakening the sustainability and responsiveness of regional food safety governance (Bi et al., 2025).

These findings highlight the structural, operational, and financial disparities among RFSCAs across Indonesia. Building on the survey findings, several key factors were identified as constraints or enablers that affect institutional performance, as shown in Table 1. To further understand how these institutional factors interact and influence one another, the ISM method was applied as described in the next section.

ISM and MICMAC Analysis: Structural Drivers of Institutional Performance

Based on the survey results and expert consultation, 12 institutional elements were identified for ISM analysis. With 12 institutional elements, there are 66 possible pairwise relationships, and the final reachability matrix contains 48 validated directed relationships (excluding self-loops), representing approximately 36% of all possible interelement linkages. This level of connectivity indicates a moderately structured institutional system, allowing key driving and dependent elements to be identified without excessive model complexity. The final reachability matrix revealed an eight-level hierarchical structure, as shown in Figure 2. Budget allocation (E12) and standardization of tasks and functions (E1) emerged as the strongest foundational drivers. Essential operational supports — including human resources (E2, E3), equipment (E10), and vehicles (E11)—form the foundational capacity required for effective

Figure 2. Hierarchical Structure of Institutional Drivers Derived from Interpretive Structural Modelling (ISM) Analysis

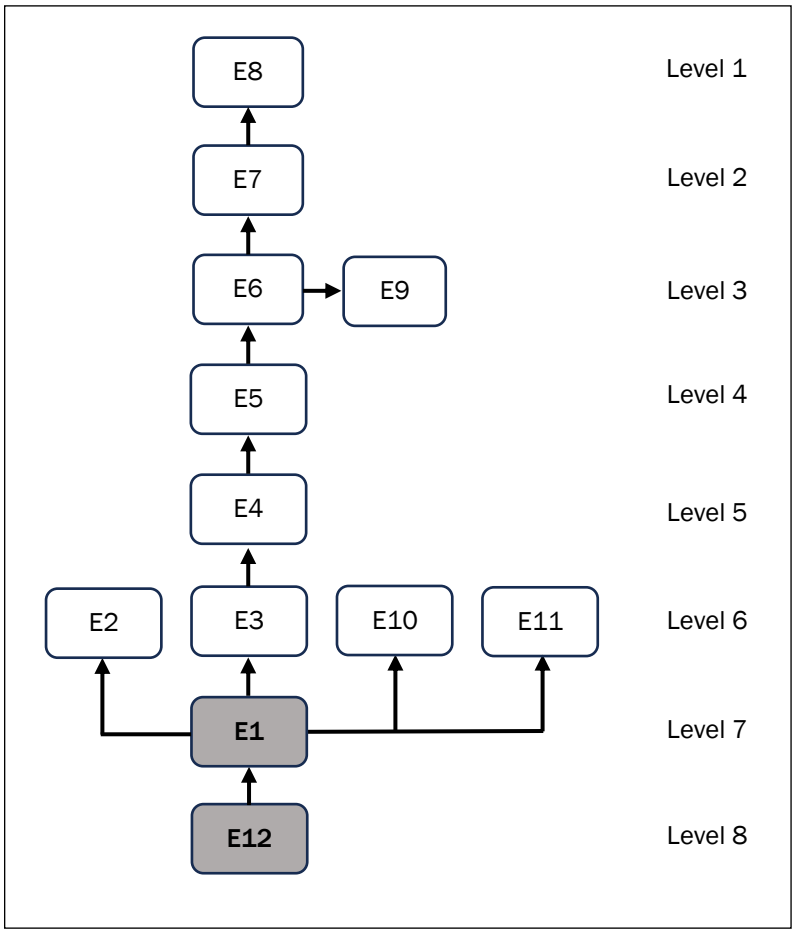


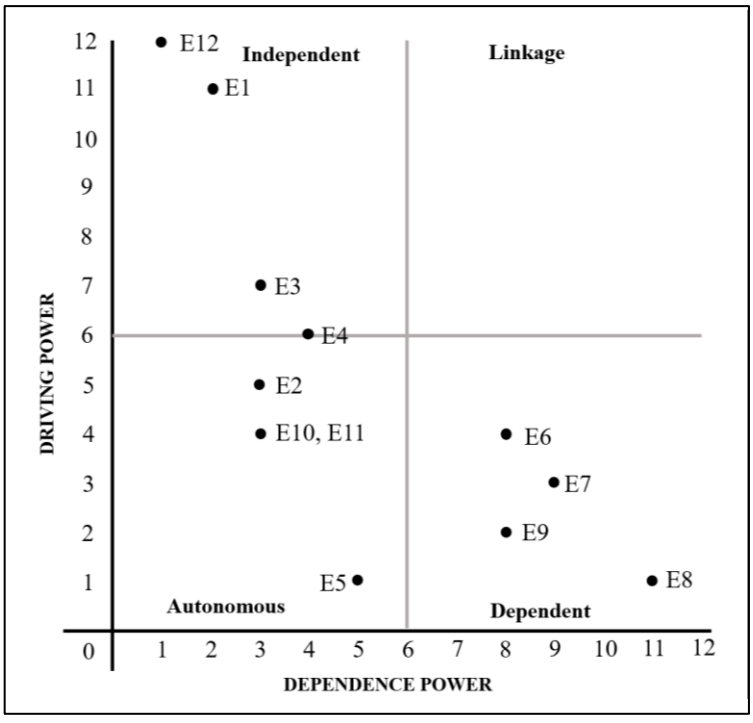
Table 1. Identification of Elements Influencing RFSCA Performance

Aspect	Code	Elements
Institutional	E1	Implementation of standardized duties and functions
Human Resources (HR)	E2	Number of human resources staff
	E3	Human resources competency
Food Safety Assurance Services	E4	Food safety assurance service standards
	E5	Accessibility of food safety information
Food Safety Supervision	E6	Sampling and testing
	E7	Follow-up actions on supervision results
Food Safety Capacity Building	E8	Food safety capacity-building activities
	E9	Evaluation of capacity-building activity effectiveness
Supporting Facilities	E10	Availability of food safety supervision equipment
	E11	Operational vehicles for food safety
Budget Support	E12	Amount of budget for food safety programs

implementation. Service quality (E4) is directly shaped by staff competency (E3), underscoring the critical role of human resources in determining operational standards. Information management (E5) facilitates transparency and informed decision-making. The interaction of sampling and testing (E6) influences the effectiveness of food safety coaching programs (E9). Level 2 is represented by follow-up actions based on supervision results (E7), emphasizing responsiveness within the system. At the highest level, sustained capacity-building activities such as training and coaching (E8) reflect the cumulative output of the institutional system. This finding suggests that operational factors depend heavily on institutional and budgetary readiness, confirming hierarchical interdependence within Indonesia's decentralized food safety governance system.

The MICMAC analysis (Figure 3) identifies budget allocation (E12) and standardized institutional mandate (E1) as dominant driving elements with high driving power and low dependence. This finding aligns with prior studies on food safety governance in decentralized systems, which emphasize fiscal capacity and legal clarity as foundational enablers of regulatory performance (Martins et al., 2024; Nayak & Jespersen, 2022). Strengthening these base-level drivers would have a cascading effect on human resource development, operational consistency, and ultimately, food safety assurance. Elements classified as dependent variables—such as E6, E7, E9, and E8—exhibit limited driving power but high dependence, indicating that they are outcomes of broader institutional arrangements. In the autonomous quadrant, there are four elements—namely number of human resources staff (E2), accessibility of food safety information (E5), availability of food safety monitoring equipment (E10), and food safety operational vehicles (E11). These elements have low driving and dependence values, indicating that they have little influence on the system as a whole and are also not significantly influenced by other elements. Nevertheless, the existence of autonomous elements is still necessary to support the operationalization of the system, and strengthening them should be a low priority. Interestingly, no elements were found to be in the linkage quadrant, which describes elements that have both high driving and dependence values. This indicates that the institutional system structure is relatively stable and there are no elements that are in a vulnerable (leverage-sensitive) position.

Figure 3. Summary of Driving and Dependence Power for Institutional Factors (Cross-Impact Matrix Multiplication Applied to Classification—MICMAC) Classification



Formulation of Institutional Strengthening Strategies

Based on the results of the ISM hierarchy diagram and MICMAC diagram mapping, the formulation of institutional strengthening strategies was carried out through a functional structural approach. An ISM hierarchy diagram provides an overview of the causal and hierarchical structure of the system elements. At the same time, MICMAC can be used to identify the strength of influence and interdependence between elements (P. Wu et al., 2023). The

combination of these two analyses enables the identification of key elements that function as primary drivers, operational supporters, and system output elements. These elements can then be grouped based on institutional functions, as shown in Table 2.

Based on the clustering and interrelationships of these elements, the institutional strengthening strategy was then formulated in a series of steps to represent clusters of interrelated institutional functions. These strategies represent actionable responses to the main driving elements identified in the model, particularly related to budget allocation, mandate standardization, and institutional coordination. The strategies are as follows:

1. Increasing budget allocation and regulations
2. Consolidating resources and infrastructure
3. Standardizating food safety assurance and monitoring services
4. Optimizing technical and evaluative functions
5. Building capacity for sustainable food safety

These strategies served as the basis for subsequent prioritization using BWM, determining the strategies' relative importance and urgency. Thus, the following analytical step quantifies the relative importance of these strategies to guide practical implementation priorities.

Strategy Prioritization Using the Best–Worst Method

Following the ISM analysis, the BWM was applied to prioritize strategies for institutional strengthening. The BWM analysis involved five expert respondents drawn from national regulators, including regional food safety authorities, and academic specialists, all of whom met predefined criteria of experience and institutional knowledge. Experts were asked to evaluate the strategies according to five criteria: regulatory and policy support (Zhang et al., 2022), resource availability (Phulkerd et al., 2016), impact on institutional performance (Maiberger & Sunmola, 2022), ease of implementation (Ibrahim & Baqutayan, 2024), and stakeholder involvement (Phulkerd et al., 2016). The resulting consistency ratio (CR) values for all expert judgments were below the acceptable threshold ($CR < 0.1$), indicating a high level of internal consistency in the pairwise comparisons. The results show that the impact on institutional performance and regulatory support received the highest weights, whereas ease of implementation and stakeholder involvement were rated lower. The complete results are shown in Table 3.

Building on the criteria weighting results, the five institutional strengthening strategies were evaluated against these criteria to identify their relative priority. As shown in Table 4, among the strategies evaluated, standardizing food safety assurance and monitoring services ranked as the top priority, followed by enhancement of budget allocation and regulatory, and sustainable food safety capacity-building programs. This demonstrates the role of standardization as a key factor that is aligned with regulatory support and has a direct impact on institutional performance. This strategy provides an essential foundation for ensuring the consistency, credibility, and effectiveness of food safety governance across the region. The consistency ratio ($CR < 0.1$) indicated reliable expert judgments. These findings suggest that institutional performance improvement relies on regulatory coherence and structured resource management.

Table 2. Clustering of Functions Based on Hierarchy and Cross-Impact Matrix Multiplication Applied to Classification (MICMAC) Analysis

Cluster	Function	Element
Structural	Main drivers of the system	E12, E1
Operational capacity	Operational enablers	E2, E3, E10, E11
Service process	System connectors	E4, E5
Technical and control	Control/evaluation mechanisms	E6, E7, E9
Outcome	System end goals	E8

Discussion

The findings reveal that institutional performance of RFSCA is shaped not only by resource availability but also by how governance functions are organized, standardized, and implemented across provinces. The discussion focuses on interpreting the structural relationships identified through the ISM and BWM analyses, particularly the roles of budget support, regulatory clarity, and service standardization in strengthening regional food safety governance in Indonesia's decentralized system.

Practical Implications of Institutional Drivers

Although the ISM–MICMAC results identified budget allocation and standardization of duties and functions as the most influential structural drivers, the BWM analysis prioritized the standardization of food safety assurance and supervision services as the top strategic action. This study emphasized that budget enhancement and regulatory reform, although crucial, require long-term political commitment and fiscal negotiations often beyond the direct authority of regional food safety agencies. In contrast, service standardization offers a practical and immediate pathway for improving institutional performance. Previous studies on food safety governance indicate that standardized inspection and supervision procedures help reduce implementation gaps across regions by improving consistency, accountability, and coordination, particularly in decentralized systems with uneven institutional capacity (Oñederra-Aramendi et al., 2023).

Through standardized inspection procedures, reporting templates, and risk-based supervision protocols, RFSCAs can transform existing resources—however limited—into more consistent and accountable operations. Standardization effectively converts structural readiness into functional performance by creating a shared operational language across provinces and facilitates better coordination on the national level.

This approach also enhances efficiency in resource use and strengthens the evidence base for future policy and budget advocacy. In this sense, service standardization is a systemic catalyst, bridging the gap between foundational drivers (funding and mandates) and operational outcomes (inspection, monitoring, and assurance). Empirical studies in decentralized contexts have highlighted that inconsistent implementation and standards undermine effectiveness and accountability, underscoring the value of service standardization as an actiona-

Table 3. Criteria Weights Based on Expert Judgments Using Best–Worst Method (BWM)

	Weight					
Criteria	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Average
1. Regulatory and policy support	0.26	0.34	0.48	0.44	0.15	**0.33**
2. Availability/capacity of resources	0.18	0.22	0.11	0.13	0.12	0.15
3. Impact on institutional performance	0.43	0.22	0.29	0.27	0.56	**0.35**
4. Ease of implementation	0.05	0.08	0.08	0.05	0.11	0.07
5. Stakeholder involvement and collaboration	0.07	0.15	0.04	0,11	0.05	0.08
Consistency Ratio (CR)	0.03	0.06	0.02	0.03	0.05	0.04

Table 4. Ranking of Institutional Strengthening Strategies Based on Best–Worst Method (BWM) Results

	Criteria Number					
Strategy	1	2	3	4	5	Total
1. Standardization of food safety assurance and monitoring services	2.67	0.77	2.90	0.46	0.34	7.14
2. Enhancement of budget allocation and regulatory	2.40	0.65	2.90	0.21	0.27	6.43
3. Sustainable food safety capacity-building programs	2.13	0.74	2.34	0.43	0.60	6.23
4. Optimizing technical and evaluative functions	2.26	0.80	2.20	0.47	0.32	6.06
5. Consolidating resources and infrastructure	1.99	0.65	2.41	0.31	0.29	5.65

ble mechanism to enhance institutional performance (Kang et al., 2022). By prioritizing standardization, regional agencies can deliver measurable governance outcomes for food safety while progressively building the institutional momentum needed for deeper regulatory and financial reforms.

Beyond their institutional implications, the identified structural drivers also carry significant community-level consequences. Weak budget support and unstandardized mandates not only limit the operational capacity of regional food safety authorities but also undermine the reliability of public food safety services on which local producers, traditional markets, and consumers depend. Conversely, strengthening these foundational elements can enhance the legitimacy of local institutions, improve trust in food safety oversight, and support more inclusive and resilient fresh food systems, particularly for small-scale actors and vulnerable communities that rely heavily on locally distributed fresh foods.

Practice Implementation of Strategies

Translating institutional strengthening strategies into practice requires a stepwise approach that aligns with the diverse capacities of regional food safety authorities. While the ISM–BWM analysis provides a structured understanding of strategic priorities, successful implementation depends on how these strategies are applied in daily practice.

The five priority strategies analyzed in this study do require a practical implementation roadmap that translates strategic intent into operational action. The implementation actions outlined in Table 5 were selected based on their practical feasibility, scalability across provinces, and potential to strengthen accountability within Indonesia's decentralized food safety governance system. The framework prioritizes measures that can be operationalized by regional food safety authorities using existing institutional arrangements, while also enabling coordination with

Table 5. Practical Implementation Framework for Institutional Strengthening Strategies

Strategy	Implementation Actions
Standardizing food safety assurance and monitoring services	• Develop and adopt template inspection SOPs and checklists across all provinces. • Establish a national reference guideline for risk-based inspection and sample collection. • Conduct inter-provincial peer reviews to ensure consistent interpretation of standards.
Enhancing budget allocation and regulations	• Define minimum budget thresholds for food safety programs in provincial planning documents. • Strengthen coordination with the National Food Agency for joint funding schemes. • Promote financial transparency through annual public reporting.
Building capacity for sustainable food safety programs	• Develop a structured training roadmap for inspectors, laboratory analysts, and educators. • Collaborate with universities, vocational institutions, and professional associations to deliver specialized modules. • Institutionalize mentoring and peer-learning initiatives between well-performing and developing regions.
Optimizing technical and evaluative functions	• Strengthen laboratory testing networks and ensure minimum testing capacity in every region. • Develop standardized inspection checklists and evaluation criteria for post-market surveillance. • Improve data management systems to enable evidence-based corrective and preventive measures.
Consolidating resources and infrastructure	• Develop shared-use laboratory facilities and mobile testing units for interregional access. • Optimize logistics, transportation, and communication equipment to support on-site inspections. • Encourage cross-sectoral resource sharing among food, agriculture, and health agencies.

national agencies and providing a clear basis for performance monitoring and evaluation.

In addition, these implementation actions are expected to improve the consistency, effectiveness, and accountability of food safety governance at the regional level. Standardized service procedures will enhance operational coherence across provinces, while strengthened budgetary coordination and capacity-building programs will support sustained institutional performance. Collectively, these measures will help translate foundational institutional drivers—such as mandates and funding—and can develop measurable governance outcomes, including more reliable inspections, improved monitoring, and stronger food safety assurance within a decentralized system. By adopting these steps, regional authorities can enhance accountability and resource efficiency in service delivery, risk management, and public trust. Building on these governance implications, the following section synthesizes the study's key conclusions and highlights its contributions to institutional food safety governance.

Conclusions

The analysis revealed that budget allocation (E12), regulatory mandate and standardization of duties and functions (E1), and institutional capacity–related elements constitute the fundamental structural drivers shaping the performance of regional food safety governance. Through a systems-based analytical approach integrating ISM and the BWM, this research identified five interrelated strategies that can be utilized to strengthen institutional performance. Among these, the standardization of food safety assurance and monitoring services was ranked as the highest priority, reflecting its role as an operational lever that enables regional authorities to translate formal mandates and limited resources into more consistent and risk-based supervision. In decentralized governance settings, service standardization provides an actionable mechanism to reduce implementation variability across jurisdictions, strengthen coordination between national and regional institutions, and enhance accountability—an observation consistent with findings from comparable food safety governance studies (Al Busaidi et al., 2025). Overall, this study offers a practical and transferable framework to inform policy design and institutional reform aimed at strengthening coherent, equitable, and resilient food safety governance in decentralized systems.

From a global perspective, strengthening institutional capacity for fresh food safety governance contributes directly to the achievement of Sustainable Development Goals, particularly SDG 2 (Zero Hunger) through safer food systems and SDG 3 (Good Health and Well-Being) by reducing foodborne risks (Department of Economic and Social Affairs, 2016). The Indonesian case offers transferable insights for other developing countries seeking to operationalize decentralized food safety governance while maintaining coherence, accountability, and system resilience.

This study places food safety governance within the broader functioning of local food systems, showing how institutional capacity shapes interactions among producers, markets, and public authorities. The findings help policymakers and food system actors align food safety strengthening efforts more closely with community-level priorities, including reliable fresh food distribution, trust in local markets, and locally grounded public service delivery. From this perspective, food safety governance operates as an enabling element of inclusive and resilient community food systems, rather than a stand-alone regulatory intervention.

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