Opsi
Vol. 19, No. 1, June 2026
p-ISSN 1693-2102
e-ISSN 2686-2352

Sustainable strategy development for organic waste management supply chain in Bekasi Regency

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Article history:
Received: 12 September 2025
Revised: 16 December 2025
Accepted: 29 July 2026
Published: 30 July 2026

Keywords:
Analytical hierarchy process
Interpretive structural modelling
Organic waste
Supply chain
Waste management

ABSTRACT
The rapid population growth and urbanization in Bekasi Regency have led to a significant increase in organic waste, creating a serious challenge in waste management. This study aims to identify and prioritize strategies to improve the performance of the organic waste management supply chain by applying Interpretive Structural Modeling (ISM) and Analytical Hierarchy Process (AHP). Data were collected from six experts in waste management, government institutions, and academia. ISM results revealed that the most fundamental elements driving system performance are land availability, infrastructure readiness, and institutional support. Meanwhile, AHP analysis indicated that the top strategic priority is provision of land and supporting infrastructure (48.6%), followed by technological enhancement (32.3%), and human resource capacity building (19.1%). The findings highlight that limited land availability is the most critical issue in Bekasi, while technology and human resources serve as supporting enablers. This study provides managerial insights for local governments and stakeholders in designing sustainable and context-specific strategies for organic waste management.

DOI:
https://doi.org/10.31315/opsi.v19i1.15570

1. INTRODUCTION

Based on data from the National Waste Management Information System (SIPSN), waste generation in Bekasi Regency in 2024 totaled 821,379 tons, with organic waste accounting for 60.4% of the total, or approximately 496,176 tons. Of this amount, only a small portion is managed through composting or TPS3R methods, while the majority still ends up in the Burangkeng Landfill, which is currently experiencing overcapacity. This suboptimal management triggers leachate pollution and greenhouse gas emissions [1]–[3]. Therefore, the urgency of improving the organic waste supply chain management system is crucial to maintaining environmental sustainability and public health [4],[5]. Information compiled from the National Waste Management Information System (SIPSN) shows that Bekasi Regency has generated waste over the past three years, as shown in Figure 1.

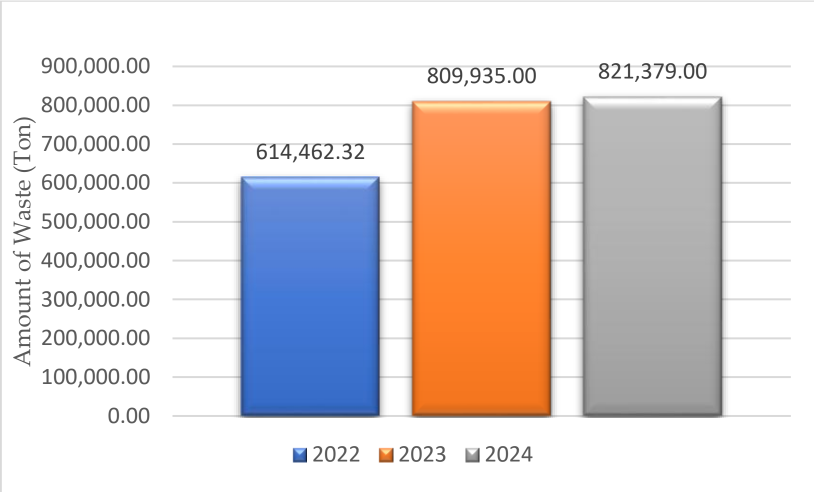

Figure 1. Amount of Waste Generation in Bekasi Regency in 2022-2024

Based on the amount of waste generated, as shown in Figure 1, approximately 60.4% of the waste is organic, with the remainder being inorganic. This demonstrates the urgency of focusing more on organic waste management and handling. This demonstrates that the management and handling of organic waste in Bekasi Regency requires serious attention from the Bekasi Regency government and all its citizens.

Figure 2. Bekasi Regency Waste Management Data For 2022-2024

Figure 2. also shows that the percentage of managed or handled waste in Bekasi Regency has been declining year after year over the past three years. The issue of waste management in Bekasi Regency is further reinforced by information gathered from the SIPSN, which indicates that waste management in Bekasi Regency remains largely focused on inorganic waste, while organic waste remains largely unaddressed and is a significant challenge. This demonstrates that organic waste management in Bekasi Regency requires greater attention from the public and the Bekasi Regency government. Waste management and handling are closely linked to the role of supply chain management (SCM). SCM refers to a series of activities for managing products from upstream to downstream (forward supply chain) and vice versa (reverse supply chain). Many previous researchers have applied SCM methods to examine issues related to waste management supply chains, including studies on both organic and non-organic waste management [6],[7]. The application of SCM has been proven to increase the effectiveness of waste management, both organic and inorganic.

Based on the background described above, this study will focus on the study of strategies for improving SCM performance in the management and handling of organic waste (organic waste management supply chain) in Bekasi Regency. The approaches that will be used are Interpretive Structural Modeling (ISM) and Analytical Hierarchy Process (AHP). ISM is a method that can be used to build relationships between variables in the Organic Waste Management Supply Chain (OWMSC), so that later priority policies can be taken in organic waste management. However, the results of the ISM method are sometimes quite difficult to implement directly in the real world, so it needs to be combined with the AHP method. The combination of the ISM-AHP method has been widely used to study SCM performance [8], [9]. These proposed methods are expected to provide input to improve the performance of organic waste management and handling in Bekasi Regency [10].

2. MATERIALS AND METHODS

This study was initiated by reviewing relevant literature, particularly regulations and policies of the Bekasi Regency government, as well as academic publications concerning organic waste management. The literature review was further enriched by conducting Focus Group Discussions (FGD) with experts in the field. A total of six experts participated in this research, consisting of four practitioners and two academics. The practitioners were representatives from the Bekasi Regency environmental office and local waste management facilities, each with more than 10 years of professional experience in municipal waste handling. Meanwhile, the two academics were senior lecturers specializing in SCM and environmental systems, who also have professional experience as consultants in community-based waste treatment initiatives in Bekasi.

Through the preliminary study and expert discussions, a set of constraint elements influencing organic waste management in Bekasi Regency was identified. These elements were subsequently analyzed using the ISM method. ISM is a structured group decision-making approach that facilitates the development of a hierarchical model representing interrelationships among factors within a complex system. The method was originally introduced by J. N. Warfield in 1974 and has since been widely applied in various fields to analyze complex systems and support strategic decision-making [11]. ISM has been widely applied across multiple disciplines to capture and evaluate key determinants in SCM. The data processing stage followed the ISM procedure, beginning with the identification of contextual relationships among elements and the construction of a Structural Self-Interaction Matrix (SSIM). This was followed by the development of a reachability matrix, which served as the basis for two subsequent analyses: (1) designing the driver–dependency matrix and (2) determining the hierarchical level partitioning of the elements. The results of this level partitioning were then used to construct the final ISM, which visually represents the strategic structure of constraint elements in organic waste management in Bekasi Regency. Following the ISM analysis, the AHP was applied to prioritize strategic alternatives for improving the performance of organic waste management in Bekasi Regency. AHP is a multi-criteria decision-making approach developed, which enables complex problems to be structured into a hierarchical framework consisting of goals, criteria, sub-criteria, and alternatives. The method has been widely adopted in decision science due to its systematic ability to integrate qualitative judgments and quantitative evaluations in complex decision-making problems [12], [13].

In this study, the AHP hierarchy was structured into three levels. The first level represented the overall research objective, namely, identifying the most effective strategy for enhancing the organic waste management supply chain in Bekasi Regency. The second level consisted of five main criteria: human resources (SDM), technology, financial support, facilities and infrastructure, and institutional aspects. Each criterion was further divided into relevant sub-criteria, forming the third level of the hierarchy. Finally, three alternative strategies were formulated as the decision-making focus: (1) developing competent human resources in waste management, (2) strengthening waste management methods supported by technology, and (3) optimizing land, equipment, and material provision through institutional collaboration [14]. Expert judgments were obtained from the same six experts involved in the ISM stage. Pairwise comparisons were conducted using Saaty's 1–9 scale to evaluate the relative importance of criteria, sub-criteria, and strategies.

The geometric mean method was used to aggregate expert opinions, ensuring the reliability of group decision-making [15]. Consistency Ratio (CR) values were calculated at each comparison stage, and all results were found to be within the acceptable threshold (CR < 0.1). The weighted priorities derived from the AHP process were then used to determine both local and global weights of the sub-criteria, as well as the final ranking of alternative strategies. This integration of ISM and AHP provides a comprehensive framework for formulating strategic recommendations for organic waste management in Bekasi Regency. Thus, by integrating ISM to identify the structural relationships among constraint elements and AHP to prioritize alternative strategies, this study establishes a robust methodological framework. The combination of both approaches ensures that the formulated strategies for organic waste management in Bekasi Regency are not only grounded in systemic analysis but also aligned with expert-driven priorities, thereby enhancing their practical applicability and policy relevance.

3. RESULTS

3.1. Identify Constraint Elements

The FGD was conducted to identify various constraints in organic waste management from a supply chain perspective, from upstream (waste collection and sorting) to downstream (processing and distribution of processed products). Each expert was asked to provide input on the actual challenges faced in organic waste management practices in Bekasi Regency.

Based on the literature review and FGD results, several key factors influencing the performance of the organic waste management supply chain in Bekasi were identified. These factors were then used as variables in the development of the SSIM and Reachability Matrix during the ISM analysis stage. Based on the results of a literature study that was deepened through an FGD involving six research experts, the results obtained were constraints of organic waste management in Bekasi Regency, Based on the literature review and FGD involving six experts, several constraint elements affecting organic waste management in Bekasi Regency were identified. These constraint elements are presented in Table 1.

Table 1. Elements of constraints in handling organic waste in Bekasi regency

Variables	Constraint Elements
A	Burangkeng landfill overcapacity
B	Minimal synergy between actors
C	Low community participation
D	Limited supply chain monitoring system
E	Weak local regulations
F	High TPS3R operational costs
G	Limited TPS3R/TPST land availability
H	Inconsistent local government support
I	Low processing technology capacity
J	Unclear compost product distribution chain
K	Lack of multi-stakeholder forums

3.2. Structural Self – Interaction Matrix (SSIM) and Reachability Matrix

The preparation of the SSIM was carried out through FGD with six experts, to agree on the contextual relationship between constraint elements of management organic waste management in Bekasi Regency. Results of SSIM are presented in Table 2. It can be seen that the elements have a total contextual relationship with the following details:

- V with a total of 11 relationships
- A with a total of 0 relationships
- X with a total of 1 relationship
- O with a total of 43 relationships

The contextual relationship shows the relationship between elements connected by row (i) and column (j). For example, row 2 (element B) column 3 (C) is written with the symbol X, meaning that the elements of the number of human resources and human resource capabilities influence each other. In the SSIM, the contextual relationship between two elements is represented using four symbols, namely V, A, X, and O. Symbol V indicates that element *i* influences element *j*, while symbol A indicates that element *j* influences element *i*. Symbol X represents a mutual influence between both elements, whereas symbol O indicates that no contextual relationship exists between the two elements. The frequency of each symbol obtained in this study is presented above and reflects the overall pattern of relationships among the identified constraint elements.

Table 2. Structural Self-Interaction Matrix (SSIM)

Formation of SSIM											
(i,j)	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
A	(-)	O	O	O	V	O	O	V	O	O	V
B		(-)	X	O	O	O	O	O	O	O	O
C			(-)	O	O	O	O	O	O	O	O
D				(-)	O	O	O	O	V	V	O
E					(-)	O	O	V	O	O	O
F						(-)	O	O	V	O	O
G							(-)	O	V	V	O
H								(-)	V	O	O
I									(-)	V	O
J										(-)	O
K											(-)

The next step is to calculate the reachability matrix by converting the SSIM symbols into binary values (0 and 1). The results of this conversion are presented in Table 3. After the conversion process, the row totals are calculated to obtain the Driver Power (D.P.) values, while the column totals are used to determine the Dependence Power (DEP.) values. Based on Table 3, element G has the highest Driver Power value, indicating that it exerts the strongest influence on other elements. Meanwhile, element D has the highest Dependence Power value, meaning that it is the element most influenced by other factors within the system. The reachability matrix therefore serves as the basis for determining the relative influence and dependency of each constraint element.

Table 3. Reachability Matrix

Reachability Matrix													
(i,j)	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**D.P.**	**Rank**
A	1	1	1	1	1	1	1	1	1	1	1	11	1
B	0	1	1	0	0	0	0	0	0	0	0	2	5
C	0	1	1	0	0	0	0	0	0	0	0	2	5
D	0	0	0	1	0	0	0	0	1	1	0	3	4
E	0	1	1	1	1	1	1	1	1	1	0	9	2
F	0	0	0	0	0	1	0	0	1	1	0	3	4
G	0	0	0	0	0	0	1	0	1	1	0	3	4
H	0	0	0	0	0	1	1	1	1	1	0	5	3
I	0	0	0	0	0	0	0	0	1	1	0	2	5
J	0	0	0	0	0	0	0	0	0	1	0	1	6
K	0	1	1	1	0	1	1	1	1	1	1	9	2
DEP.	1	5	5	4	2	5	5	4	8	9	2	*D.P. = Driver Power	
Rank	6	3	3	4	5	3	3	4	2	1	5	*DEP. = Dependence Power	

3.3. Driver – Dependency Matrix

Next, the Driver Power values and Dependence Power values become the X axis and Y axis in the Driver - Dependency matrix, as shown in Figure 3. Based on the category, the driver – dependence power matrix is divided into four categories. Sector I means the element is in the Autonomous category, while Sector II means the element is in the Drivers category. For elements that are in Sector III, this means they are included in the Linkage category, and elements that are included in Sector IV mean they are included in the Dependent category.

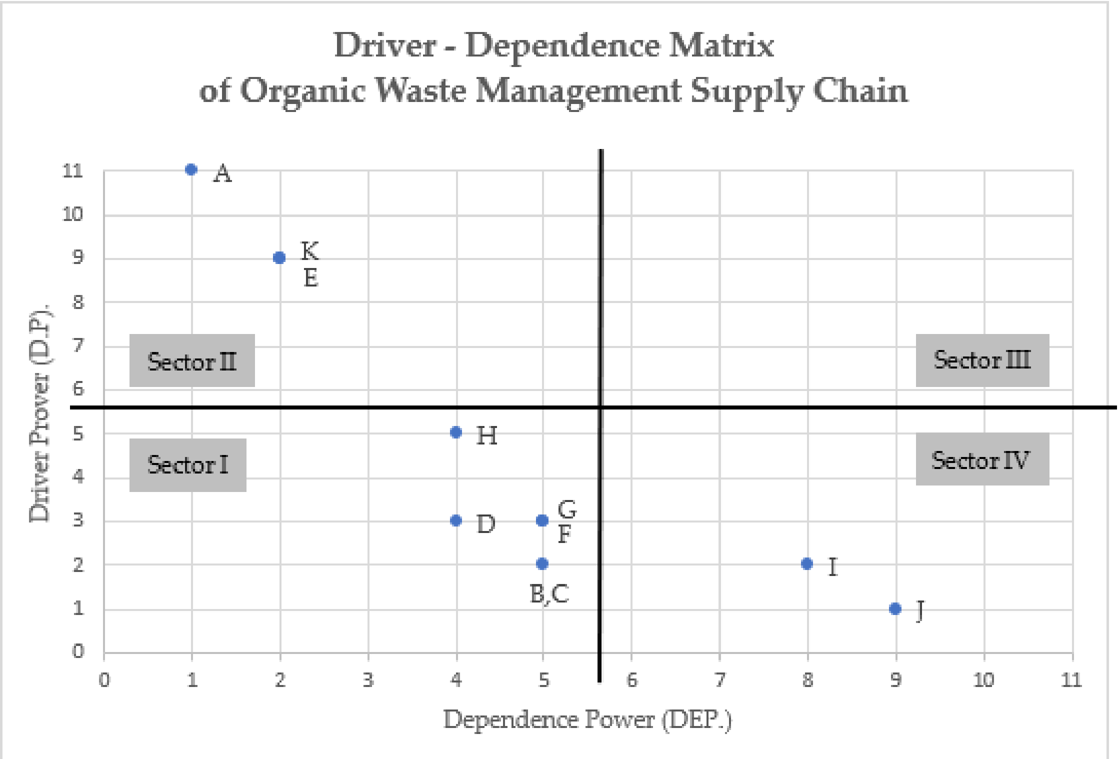

Figure 3. Driver - dependency matrix

Figure 3 shows that the 11 elements of the organic waste management supply chain are divided into three sectors, namely sectors I, II, and IV. Elements A, K, and E are in sector II, which means that these three elements have a strong influence on other elements and are not greatly influenced by other elements. Meanwhile, elements I and J are in sector IV, which means that these two elements are highly dependent on other elements, but their influence on other elements is relatively small. Sector I is occupied by the most elements, namely 6 elements. These elements are B, C, D, G, F, and H. Elements in sector I mean that their driver power and dependence power are equally strong, or in other words, the elements in this sector have a large influence and dependence on other elements.

3.4. Levelling

The next step is Leveling, which is the separation of elements into several levels. To perform Leveling, you must begin by identifying the binary results in the reachability matrix. The number 1 indicates a relationship between elements, while 0 means there is no relationship between elements. This basis is used to identify the reachability set, antecedent set, and intersection set. The reachability set is an element (including the element itself) that influences other elements, while the antecedent set is an element that is influenced by other elements. The elements that overlap/are the same between the reachability set and the antecedent set are called the intersection set, and this intersection set is the reference for determining the level of each element.

Based on the leveling results, element A occupies the highest hierarchical level and serves as the most fundamental driving factor influencing the performance of the organic waste management supply chain in Bekasi Regency. Therefore, addressing the overcapacity issue of the Burangkeng Landfill should become the primary focus of strategic interventions. Table 4 shows a recapitulation of the leveling results for the eleven identified elements of organic waste management. The results indicate that the elements are distributed across six hierarchical levels according to their respective driving and dependence characteristics.

Table 4. Recapitulation of organic waste management leveling results

Variables	Reachability Set	Antecedent Set	Intersection Set	Level	Assign Iteration
A	A, B, C, D, E, F, G, H, I, J, K	A	A	VI	Yes
B	B, C	A, B, C, E, K	B, C	I	Yes
C	B, C	A, B, C, E, K	B, C	I	Yes
D	D, I, J	A,D,E,K	D	III	Yes
E	B, C, D, E, F, G, H, I, J	A, E	E	V	Yes
F	F, I, J	A, E, F, H, K	F	III	Yes
G	G, I, J	A, E, G, H, K	G	III	Yes
H	F, G, H, I, J	A, E, H, K	H	IV	Yes
I	I, J	A, D, E, F, G, H, I, K	I	II	Yes
J	J	A, D, E, F, G, H, I, J, K	J	I	Yes
K	B, C, D, F, G, H, I, J, K	A, K	K	V	Yes

3.5. ISM Model

The results of the equalization analysis, summarized in Table 4, form the basis for developing an ISM model for the organic waste management supply chain in Bekasi Regency. In this model, nodes represent elements, while arrows depict contextual relationships, as previously structured in SSIM. The ISM representation for Bekasi Regency is shown in Figure 4.

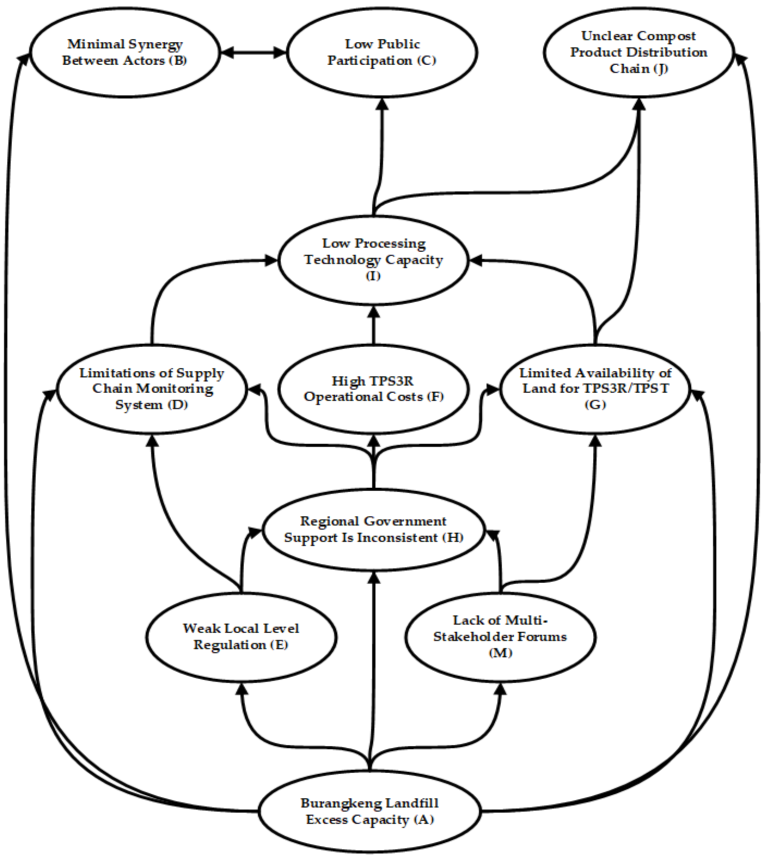

Figure 4. ISM Model of organic waste management supply chain in bekasi regency

Figure 4 clearly demonstrates the priority order of the eleven elements. The most fundamental element is the excess capacity of the Burangkeng Landfill, which serves as a driving factor at the lowest level of the hierarchy. This condition serves as the basis for decision-making, as the landfill's inability to accommodate the continuous increase in organic waste is the most pressing challenge shaping subsequent strategies.

Elements at higher levels, such as the availability and capability of human resources, technological readiness, financial schemes, provision of facilities and land, and institutional support, are positioned as enabling factors dependent on resolving the landfill capacity issue [16]. This structural arrangement suggests that strategic efforts in Bekasi Regency must begin with addressing landfill excess capacity through expansion planning, optimizing waste diversion, and improving recycling or alternative processing facilities.

Once the landfill capacity issue is resolved, the next strategy can focus on strengthening human resources, increasing technology adoption, securing sustainable financing, and enhancing institutional collaboration. In other words, the ISM analysis confirms that addressing the Burangkeng landfill's overcapacity is the most urgent priority, with other elements following as interconnected layers that collectively contribute to building a resilient organic waste management supply chain in Bekasi Regency [17].

3.6. Analytical Hierarchy Process (AHP)

3.6.1. Expert Assessment

The AHP assessment involved six experts from local government, landfill management practitioners, and academia [18]. Their judgments were combined using the geometric mean method. Consistency ratios (CR) were confirmed to be below 0.1, indicating acceptable reliability. A consistency ratio (CR) value below 0.1 indicates that the pairwise comparison judgments provided by the experts are logically consistent and reliable. This threshold is commonly accepted in AHP-based decision-making studies to ensure that the resulting priority weights accurately reflect expert preferences and minimize subjective bias.

3.6.2. Pairwise Comparison Matrices

The pairwise comparison process was carried out at three hierarchical levels: criteria, sub-criteria, and alternative strategies. Table 5 illustrates an example of the aggregated pairwise comparison matrix for Level 1 (criteria).

Table 5. Geometric mean pairwise comparison – level 1 criteria

Level	Criteria Pair	Expert						Geometric Mean
		E1	E2	E3	E4	E5	E6	
1	Human Resources – Technology	3	2	3	4	3	2	2.7495
	Human Resources – Finance	1/2	1/3	½	½	1/2	1/2	0.4673
	Human Resources – Facilities/Infrastructure	2	3	2	2	2	1	1.9064
	Human Resources – Institutions	1/2	1/3	½	1/3	1/3	1/2	0.4082
	Technology – Finance	1/3	1/4	1/3	¼	1/4	1/4	0.2752
	Technology – Facilities/Infrastructure	1/2	1/2	1/3	½	1/3	1/2	0.4368
	Technology – Institutions	1/3	1/4	1/3	¼	1/4	1/3	0.2887
	Finance – Facilities/Infrastructure	3	2	3	3	4	3	2.9417
	Finance – Institutions	1/3	1/3	1/3	¼	1/2	1/2	0.3637
	Facilities/Infrastructure – Institutions	1/2	1/6	1/3	1/3	1/7	1/2	0.2952

3.6.3 Priority Weights

The normalized weights of Level 1 criteria are shown in Table 1 finance (32.0%) and facilities/infrastructure (25.0%) emerged as dominant factors, followed by institutional support (21.7%), technology (15.0%), and human resources (6.3%). These findings indicate that financial capability is considered the most influential factor in improving organic waste management performance in Bekasi Regency. Adequate funding is required to support waste collection, processing facilities, transportation, and operational activities. Infrastructure also plays a significant role because the availability of waste processing facilities, transportation systems, and supporting equipment directly affects the effectiveness of waste management operations.

Institutional support and technology contribute by strengthening governance, coordination, and operational efficiency, while human resources receive the lowest priority because stakeholders considered that improvements in financial resources and infrastructure should be addressed before enhancing workforce capacity.

Table 5. Normalized weights of criteria (level 1)

Criteria	Human Resource	Technology	Finance	Infrastructure	Institutional	Priority Weight
Human Resources	0.06	0.10	0.09	0.05	0.07	0.063
Technology	0.12	0.17	0.15	0.14	0.11	0.150
Finance	0.36	0.15	0.28	0.46	0.18	0.320
Infrastructure	0.29	0.20	0.10	0.17	0.32	0.250
Institutional	0.17	0.38	0.38	0.18	0.32	0.217

To link criteria with decision-making, the global weights of alternative strategies were calculated. Table 6. Global weights of alternative strategies shows that the highest priority is the provision of land and facilities with institutional support (48.6%), followed closely by human resource development (32.3%). Technological improvement (19.1%) was ranked last.

Table 6. Global weights of alternative strategies

Sub-Criteria	Global Strategy Weight		
	Human Resources	Technology	Infrastructure
Number of Workers	0.005	0.002	0.012
Workforce Skills	0.013	0.007	0.024
Technological Ease	0.010	0.031	0.010
Technological Innovation	0.015	0.069	0.015
Capital Availability	0.043	0.054	0.118
Financing/Incentives	0.032	0.032	0.042
Equipment Management	0.018	0.030	0.071
Land Provision	0.013	0.027	0.093
Government Support	0.006	0.024	0.031
Regulations	0.011	0.037	0.026
Inter-Agency Coordination	0.016	0.032	0.032

The priority weights of the main criteria obtained from the AHP analysis are presented in Figure 5 The figure illustrates the relative importance of each criterion in supporting the improvement of the organic waste management supply chain in Bekasi Regency.

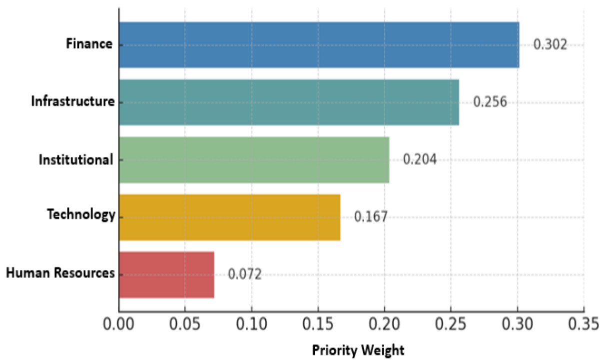

Figure 5. Priority weights of criteria (level 1)

Figure 6 presents the priority weights of alternative strategies at Level 3 of the AHP hierarchy. The results indicate the relative contribution of each strategic alternative toward improving the organic waste management supply chain performance.

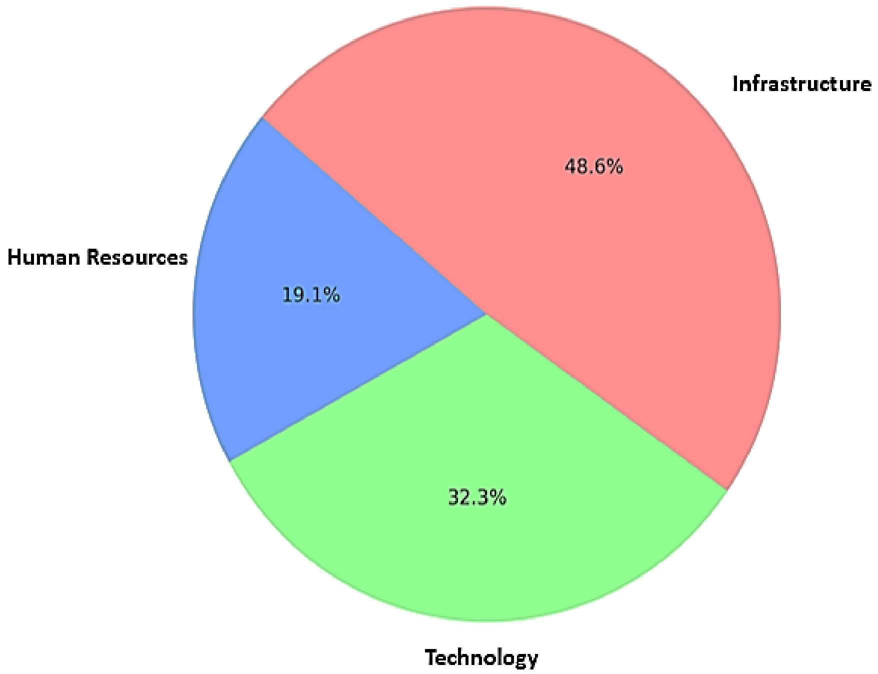

Figure 6. Priority Weights of Alternative Strategies (Level 3)

3.6.4. Sensitivity Analysis

A sensitivity analysis was conducted to evaluate the robustness and stability of the priority results obtained from the AHP analysis. Figure 7 presents the dynamic sensitivity analysis, while Figure 8 shows the performance sensitivity analysis of the alternative strategies. These analyses were performed to determine whether changes in criteria weights would significantly affect the ranking of strategic priorities.

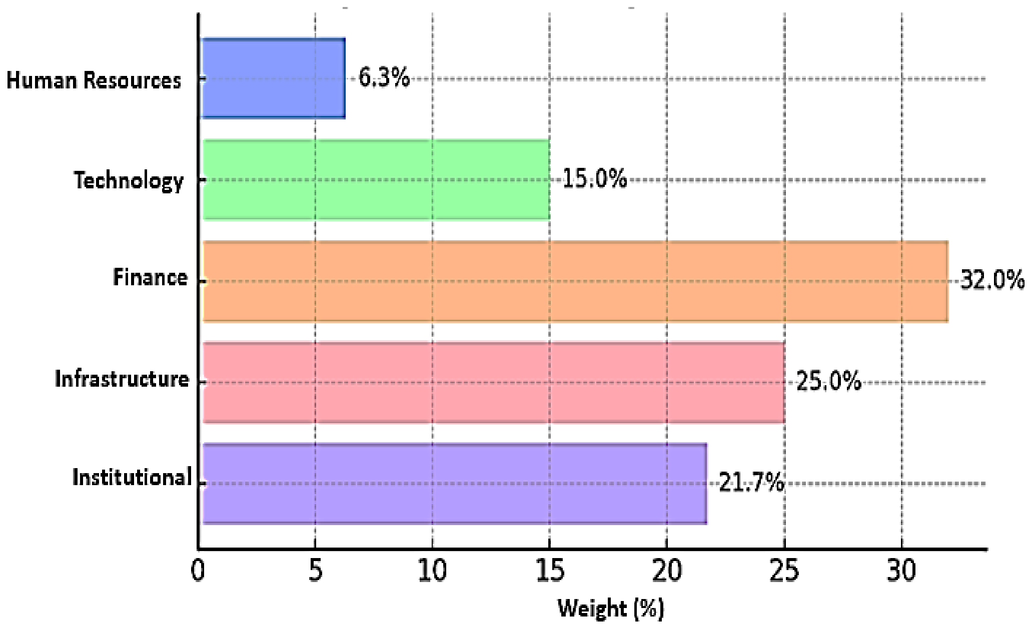

Figure 7. Dynamic Sensitivity Analysis of Alternative Strategies

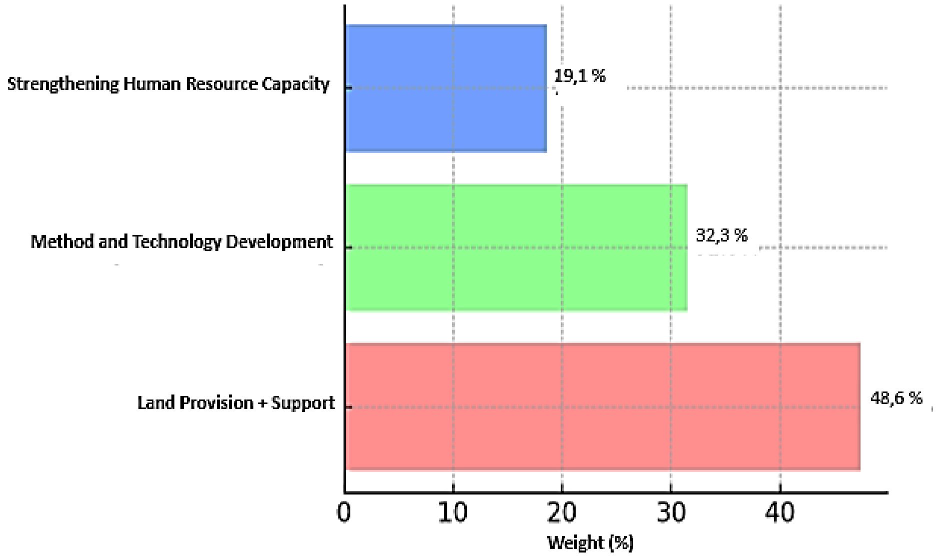

Figure 8. Performance Sensitivity Analysis of Alternative Strategies

The sensitivity analysis results demonstrate that the ranking of strategic priorities remains relatively stable despite changes in criteria weights. This indicates that the proposed strategies are robust and consistent under different decision-making scenarios. The strategy related to land provision and institutional support continues to show the highest contribution, highlighting the importance of infrastructure readiness and government collaboration in improving the organic waste management supply chain in Bekasi Regency. In addition, the sensitivity analysis confirms that technological improvement and human resource development remain important supporting strategies, although their priority levels are lower compared to infrastructure-related strategies. These findings strengthen the conclusion that solving infrastructural limitations, particularly landfill overcapacity and land availability, should become the primary focus of policy implementation in Bekasi Regency.

4. DISCUSSION

This study has successfully identified constraint elements in the organic waste management supply chain of Bekasi Regency by engaging experts from government institutions, practitioners, and academia. Through the ISM method, eleven elements were structured into six hierarchical levels. The most fundamental element is the overcapacity of Burangkeng landfill, which acts as the primary driver that influences subsequent elements in the system. In contrast, technological innovation was positioned as the last priority, reflecting that immediate challenges in Bekasi Regency are more infrastructural than technological [19]. These findings are consistent with the reality faced by the Bekasi Regency government, where the landfill has been operating beyond its designed capacity for years. The overcapacity issue forces policymakers to reconsider short-term and long-term strategies, including diversion of organic waste to alternative treatment, expansion of waste processing capacity, and strengthening recycling initiatives. Previous studies have similarly highlighted the role of landfill capacity and infrastructure readiness as critical drivers in waste supply chains.

The AHP analysis complements these results by prioritizing strategic alternatives. The findings reveal that provision of land and facilities with institutional support (48.6%) and human resource preparation (32.3%) are nearly equal as the top strategies, while technological improvement (19.1%) ranks lower. This implies that capacity building and institutional collaboration must accompany infrastructural development to ensure sustainability. These results align with the literature emphasizing the role of governance and human resources in shaping the success of environmental management strategies [20], [21]. The contribution of this research lies in providing a systemic and structured perspective on the waste management challenges of Bekasi Regency. Unlike previous studies that emphasized input availability, this study highlights infrastructural bottlenecks—specifically landfill overcapacity—as the primary concern. This shift underscores the importance of aligning local policy and investment priorities with the actual constraints faced in the field [22]–[24].

Future research could expand this study by integrating downstream perspectives, particularly examining the value-added products of organic waste processing, such as compost, biogas, or animal feed. Exploring the downstream supply chain can enrich the understanding of circular economy practices and further improve the sustainability of organic waste management in urban-regional contexts [24].

5. CONCLUSION

Based on the analysis using the ISM method with the involvement of six experts, this study identified eleven key constraint elements in the organic waste management supply chain of Bekasi Regency. The ISM results structured these elements into six hierarchical levels. The most fundamental driver is the overcapacity of burangkeng landfill, which becomes the central issue shaping the entire system. At the other end, elements related to technological innovation and ease of adoption were placed at the highest level of dependence, indicating that their effectiveness relies heavily on resolving more basic infrastructural constraints [27],[28]. This conclusion is reinforced by the driver–dependency matrix, which positioned landfill capacity as a strong driver (high influence, low dependence), while technological aspects were categorized as dependent elements (low influence, high dependence). This confirms that addressing landfill overcapacity is the most urgent priority for improving the overall performance of the organic waste management supply chain in Bekasi Regency.

The AHP further validated these findings by showing that the most prioritized strategies are provision of land and facilities supported by institutions (48.6%) and human resource preparation (32.3%), followed by technological improvement (19.1%). These results emphasize that a sustainable waste management strategy must start with resolving infrastructural limitations and strengthening institutional and human resource capacity, before transitioning to more advanced technological solutions [29]. In summary, the study highlights that the resolution of landfill overcapacity is the cornerstone of effective organic waste management in Bekasi Regency. Once this challenge is addressed, further improvements can be pursued through capacity building, governance strengthening, and gradual technological adoption [30].

ACKNOWLEDGMENT

The authors would like to express sincere gratitude to the Ministry of Education, Culture, Research, and Technology of the Republic of Indonesia (Kemendikbudristek) for the financial support through the Penelitian Dosen Pemula (PDP) grant program 2025. Appreciation is also extended to the Universitas Sains Indonesia for the institutional support provided during the research activities. Finally, the authors thank the research team members and expert respondents who contributed valuable insights and assistance throughout the study, enabling this research to be completed. The authors also acknowledge the use of artificial intelligence tools for language refinement and editorial assistance, while ensuring that all scientific content, analysis, and conclusions remain the full responsibility of the authors.

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DECLARATION OF AI-TOOL USAGE

The authors used artificial intelligence (AI)-based language assistance tools only for language refinement, grammar checking, and minor editorial improvements during manuscript preparation. All research design, data analysis, interpretation of results, and scientific conclusions were conducted entirely by the authors. The authors take full responsibility for the content of this manuscript.