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Sustainability Strategy for the Beef Cattle Manure Waste Management Program in Kediri City, Indonesia

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ABSTRACT: The purpose of this study was to analyze the characteristics of respondents in beef cattle waste processing and to formulate strategies for sustainable beef cattle waste processing. Data collection was conducted from February to April 2025. The study was specifically carried out in Kediri City, Indonesia with a total sample of 80 respondents. The main variables observed in this study were: characteristic respondent (X1) motivation (X2), perception (X3), role of stakeholders (X4), participation (Y1), and sustainability (Y2). This research study employed a descriptive survey method. Based on a survey of 80 respondents, the majority of beef cattle farmers in Kediri City exhibit the following characteristics: 85% are male, and 92.5% fall within the productive age category (17–59 years. Most respondents (58.75%) have a senior high school education. Additionally, 63.75% work primarily as farmers or livestock breeder. The study's findings reveal that the sustainability of the waste management program is strongly influenced by three key variables. The motivation-based strategy (X2) focuses on self-esteem needs (X2.4) as the dominant factor and includes symbolic rewards, formal recognition, storytelling of successful farmers, and involvement in community forums to strengthen intrinsic motivation and pride. The perception-based strategy (X3) emphasizes affective perception (X3.2), with initiatives such as visual and audio-visual education tools and participatory workshops rooted in local knowledge, aiming to cultivate positive emotions and environmental responsibility. Although stakeholder contribution (X4) is statistically significant, it has a negative influence, indicating a need to revise top-down approaches. The proposed strategy includes strengthening participatory methods, improving program transparency, building synergy among government, private sectors, and farmer groups, and recognizing local wisdom and grassroots initiatives. Finally, the participation-based strategy (Y1) identifies evaluation (Y1.4) as the dominant indicator, promoting sustainability through Participatory Monitoring and Evaluation (PME) and continuous training.

KEYWORDS: Livestock Waste, Participation, Stakeholder, Strategy, Sustainability

INTRODUCTION

The development of the livestock sector is no longer focused solely on meeting food needs such as milk and meat, but has also begun to expand into the utilization of livestock manure waste. This shift reflects an effort to enhance both efficiency and sustainability within the livestock industry (Huda & Wikanta, 2017). According to data from the Central Statistics Agency (Badan Pusat Statistik) of Kediri City in 2024, the population of beef cattle in the city experienced a decline of 9.36%, while the dairy cattle population decreased by 22.55%. In 2022, the total number of beef cattle in Kediri City was 3,279 head and dairy cattle 102 head, whereas in 2023, the beef cattle population declined to 2,972 head and dairy cattle to 79 head. If not properly managed, cattle manure can cause environmental pollution. Improper handling of cattle waste may lead to conflict among community members and environmental degradation (Utomo et al., 2023). Poor waste management can negatively affect both the environment and human health. Cattle feces and urine produce unpleasant odors, and local communities are generally aware of the adverse impacts associated with livestock waste. However, many stakeholders have already begun processing livestock waste into valuable products that can improve the welfare of the farmers themselves. These processed products include biogas, organic fertilizer, alternative fuel, and even bricks (Adetia et al., 2020). Compost, in particular, is an organic material that decomposes naturally, such as grass, leaves, kitchen waste, straw, and other organic matter, which plays an important role in improving soil quality (Ekawandani & Alvianingsih, 2018).

In 2023, the Food Security and Agriculture Office of Kediri City, through its livestock division, implemented a program to process beef cattle waste into compost that can later be used as fertilizer to increase crop yields. This waste processing program aims to encourage farmers to manage the waste generated by their livestock more effectively. In addition, the program is expected to raise farmers' awareness of the importance of appropriate and environmentally friendly waste management. The program was

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implemented in Tempurejo and Blabak Villages, located in Pesantren Sub-district, and in Pojok Village, located in Mojoroto Subdistrict, Kediri City. Furthermore, government support must be complemented by active participation from farmers. Their involvement is essential to improving livestock productivity in Kediri City and ensuring the sustainability of the livestock waste management program.

The concept of sustainability was first introduced at the Stockholm Environmental Conference in 1972 by Meadows, who emphasized the importance for companies to prioritize social, economic, and environmental aspects (Fathia and Sulfitri, 2023). Program sustainability is generally associated with suboptimal management and limitations in implementing community empowerment initiatives. Although the empowerment process can occur alongside other program activities, the potential of local communities plays a significant role in ensuring program sustainability, as it is assumed that awareness of the program's benefits for daily life has already been established. For example, the perceived benefits may include sources of income, skills development, environmental conservation, and efforts to protect residential areas from floods and landslides. Furthermore, program sustainability can also be supported by local or national government policies, which are reinforced by applicable laws and regulations (Sardjo et al., 2017). Community participation is essential to ensure a program's sustainability. When communities are actively involved in planning, implementation, and evaluation, they tend to develop a sense of ownership and a stronger commitment to maintaining the program. This engagement not only fosters ownership but also allows communities to provide relevant input based on local needs and conditions. As a result, programs that receive strong community support are generally more long-lasting and effective, as the community continues to contribute to the maintenance and development of the program over time.

In addition, community participation can foster collaboration with other stakeholders, such as government agencies and non-governmental organizations, which in turn strengthens the resources and support necessary for sustaining environmental, social, and economic impacts. Program or activity sustainability can be defined as an initiative that considers various aspects of life holistically. The level of program sustainability is largely determined by the level of participation from livestock farmers (Ittaqillah et al., 2020). The overall impact of a development program should provide both direct and indirect benefits to the target groups as well as the broader community. The outcomes of development programs may be positive, but they also carry the potential for negative effects depending on how the activities are managed and implemented. Information on program implementation is typically obtained through communication systems, program socialization, and community economic empowerment efforts that emerge as impacts of the program (Sardjo et al., 2017). Development programs aimed at target communities are expected to be interconnected, thus creating significant impacts on local populations in the Kediri region while also raising environmental awareness among the wider public. The success of such development programs will eventually be communicated to the broader public through external communication conducted by program managers. The impact of a program is strongly related to the level of community participation in its implementation. High levels of community participation can enable the program to run more effectively, resulting in more meaningful and sustainable outcomes in environmental, social, and economic aspects. When communities are involved at every stage of the program from planning to evaluation they develop a sense of ownership and become more motivated to achieve common goals. Therefore, the positive impact of a program tends to increase with active community involvement, as such impacts are realized through collaboration that directly considers the needs and aspirations of the community.

The Sustainable Livelihood Framework (SLF) is a conceptual framework developed by the United Kingdom's Department for International Development (DFID) to facilitate the understanding, analysis, and strengthening of strategies by communities, particularly vulnerable groups, in managing various available resources to meet their livelihood needs in a sustainable manner amid dynamic, complex, and vulnerable socio-economic and environmental changes. The main objectives of the SLF include:

- Assessing the conditions and dynamics of community livelihoods, particularly among vulnerable groups;
- Designing programs or interventions that are aligned with local needs and potential;
- Ensuring that the development process not only improves economic aspects but also strengthens the resilience and sustainability of community livelihoods.

The analysis of sustainable livelihoods involves various types of assets owned by the community. These assets refer to the potential resources available to livestock farmers, the extent to which those resources are utilized, and the opportunities available to develop sustainable livelihoods for beef cattle farmers. These assets include: a) natural resources (natural capital), b) financial or economic resources (financial capital), c) physical resources, d) human resources (human capital), and e) social resources (social capital) (Andarwati, et al., 2017). Additionally, access refers to institutional mechanisms and organizational structures that influence the

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livelihood options available to beef cattle farmers. Furthermore, activities refer to the range of actions taken by farmers to maintain and enhance their sources of livelihood.

The purpose of this study was to analyze the characteristics of respondents in beef cattle waste processing and to formulate strategies for sustainable beef cattle waste processing. The novelty of this research is analyzing respondents in waste processing in Kediri city and formulating strategies for the sustainability of waste processing in the long term.

METHOD

Research methods refer to a series of structured steps or procedures used in the research process to collect, analyze, and interpret data. The choice of method depends on the research objectives, the type of data required, and the research questions to be addressed. According to Yusuf (2016), research methods are generally divided into two main categories: a. Quantitative Research

This method focuses on collecting data that can be measured and analyzed statistically. Quantitative research typically uses instruments such as surveys, questionnaires, or experiments to gather data from a sample population. The primary goal is to test hypotheses, understand the relationships between variables, or measure the effects of one variable on another, ultimately providing objective conclusions about the research topic. b. Qualitative Research

Qualitative research aims to gain an in-depth understanding of phenomena by collecting descriptive data through interviews, observations, or document analysis. This method is used to explore perspectives, experiences, and meanings from the viewpoint of individuals. It is particularly suitable when researchers seek to understand the social context or an individual's perception of a particular event or issue. Data in qualitative research is analyzed interpretively to identify emerging themes or patterns.

This study employs an exploratory qualitative research design aimed to describe the characteristics of respondents and formulate a strategy for sustainable livestock waste processing in Kediri City. Primary data were collected through observation, interviews, and documentation, while secondary data were obtained from supporting sources such as journal articles and previous studies relevant to the research topic. The sampling technique in this study used the purposive sampling method. According to Fatihudin (2015) purposive sampling is a method in which researchers determine specific characteristics of prospective respondents that are in accordance with the objectives of the study so that they are expected to be able to answer the research problems. For sampling the population of farmers, it was obtained by the purposive sampling method, namely selecting respondents who participated in the beef cattle waste processing program in Kediri City.

DATA ANALYSIS

This research was conducted from February to April 2024 in Kediri City. The research site was selected at the Food Security and Agriculture Office (Department of Food Security and Agriculture, DKPP) of Kediri City, which serves as the implementing agency for government affairs in the fields of food, agriculture, and fisheries under the authority of the Kediri City Government. DKPP focuses on supporting and advancing the agricultural sector and food security within the Kediri City area. Kediri City consists of three sub-districts: Kota, Mojoroto, and Pesantren. The selection of research locations was based on field surveys and community complaints regarding unprocessed livestock waste that contributes to environmental pollution. The study was specifically conducted in Pesantren and Mojoroto sub-districts, namely in Tempurejo, Blabak, and Pojok villages. Data collection was carried out using semi-structured questionnaires, which were distributed to respondents who had provided written consent prior to participation, as well as through structured interviews. This study uses descriptive statistical data analysis methods to describe the characteristics of respondents and formulate a strategy for sustainable livestock waste processing. A total of 80 farmers were selected as the research sample. The main variables observed in this study were: respondent characteristics (X1), motivation (X2), perception (X3), role of stakeholders (X4), participation (Y1), and sustainability (Y2).

RESULT AND DISCUSSION

Waste processing plays a crucial role not only in increasing economic value but also in reducing the risk of environmental pollution caused by livestock waste. Based on research conducted in Kediri City, the findings regarding the implementation of beef cattle waste processing into compost fertilizer are presented as follows:

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Descriptive Test

The descriptive test is used to provide a general overview of the research data. This analysis was conducted using frequency distribution and mean (average) value calculations, with the results summarized below.

Table 1. Characteristic Respondent

No	Characteristic	Indicator	Measurement	Frequency (Respondents)	Percentage (%)
1.	Gender	Gender	Male	68	85
			Female	12	15
	Total			**80**	**100**
2.	Age	Age (Years)	17-59 Years	74	92,5
			>60 Years	6	7,5
	Total			**80**	**100**
3.	Education	Last Education	Elementary School	3	3,75
			Junior High School	24	30
			Senior High School	47	58,75
			Diploma/Bachelor/Master	6	7,5
	Total			**80**	**100**
4.	Occupation	Current Profession	Farmer/Livestock Breeder	51	63,75
			Student	14	17,5
			Civil Servant (Lecturer/Teacher)	3	3,75
			Housewife	12	15
	Total			**80**	**100**

Source: Processed primary data, 2025.

Gender

Based on the data obtained from 80 respondents, the majority of individuals involved in beef cattle manure waste management are male, totaling 68 people (85%), while female respondents make up 12 people (15%). Gender can influence participation in decision-making processes. In general, men and women often have different experiences and face distinct barriers to participation. The findings indicate that male involvement in the beef cattle waste management program is more dominant than that of females. However, the roles of men and women in managing beef cattle waste are complementary. Men tend to be more involved in leadership, decision-making, and hands-on processing activities. In contrast, women often contribute through the preparation of food, tools, and materials used in the waste processing. These contributions are crucial, as they can encourage male participation in waste management. Thus, the synergy between male and female roles is vital for joint participation in managing cattle waste effectively. A study by Syam et al. (2025) revealed that men are more dominant in accessing resources (65–67%), making strategic decisions (61–64%), and taking advantage of external opportunities (78%). Meanwhile, women tend to be more involved in managing domestic benefits (81%). These findings suggest that gender roles influence both strategic and operational aspects of beef cattle farming. Research by Baba et al. (2023) found that educational level and farming experience have a greater impact on the productive use of livestock waste compared to gender. In their study, age and household size did not significantly affect the adoption of waste processing technologies. Similarly, a study by Setiawan (2013) in Majalengka Regency supported these findings, showing that environmental factors (21.2%) and innovation characteristics (9.9%) contributed more significantly to successful waste management than farmer characteristics, including gender, which had only a 7% influence and was deemed statistically insignificant.

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Based on these comparative studies, it can be concluded that although gender differences influence participation in livestock-related activities, other factors such as education, experience, and environmental support play a more decisive role in successful cattle waste management. Therefore, a comprehensive and inclusive approach that considers these factors is essential for optimizing sustainable waste management.

Age

A person's age influences their level of activity, as increasing age is often associated with a declining ability to adopt innovations and engage in physically demanding work. Farmers within the productive age range are typically considered to be in their optimal years for employment and innovation adoption. Based on data collected from 80 respondents, the majority of individuals involved in beef cattle manure waste management are within the productive age category. Specifically, 74 respondents (92.5%) were between 17 and 59 years old, while only 6 respondents (7.5%) were over 60 years old, an age generally considered to be less productive in terms of labor capacity. These results indicate that most of the respondents in Kediri City are still within the productive age range an age group generally characterized by optimal physical and mental conditions, making them well-suited for work, creativity, and active participation in social and economic activities. The physical capacity of livestock farmers is closely related to their age. A farmer's ability to assess extension programs such as attending meetings, speaking in discussions, and planning future activities is influenced by their age (Astati et al., 2016). Age is commonly associated with work productivity; when individuals are still within the productive age range, they tend to be more active and efficient. The productive age range in society is typically between 15 and 60 years old. Farmers within this category generally demonstrate good physical and mental capabilities, making them well-suited to develop and expand livestock farming enterprises (Abdullah et al., 2019).

Education

Education level is an important factor that influences a person's role in the social environment and has a significant impact on individual economic status. It also affects the capacity for change, as it shapes the diversity of thought and perspectives. In this study, respondents' education levels were categorized into four groups: elementary school (SD), junior high school (SMP), senior high school or equivalent (SMA/SLTA), and higher education levels (Diploma, Bachelor's, and Postgraduate degrees – S2/S3). The results of the study show that the majority of respondents involved in livestock waste management had completed senior high school or its equivalent, totaling 47 respondents (58.75%). Meanwhile, elementary school graduates accounted for the smallest group, with only 3 respondents (3.75%), making it the lowest educational attainment represented in the livestock waste management program. The education level of farmers or respondents plays a crucial role in determining the success of beef cattle waste management. Farmers with higher educational backgrounds generally possess a better understanding of the importance of environmentally friendly waste processing and tend to adopt new technologies such as composting, biogas utilization, or bio-urine systems—more quickly. Findings by Baba et al. (2023) and Setiawan (2013) reinforce this fact by showing that formal education is a key factor influencing the extent to which farmers adopt technology and participate in waste management activities. Additionally,
Fitriyanto et al. (2018) emphasized that farmers' active participation in training and technical assistance significantly improves their technical skills, ultimately contributing to more sustainable livestock waste management. The education level of farmers is closely linked to the degree of community participation in beef cattle waste processing. Farmers with better education are generally more open and proactive in attending training programs and applying new technologies, thereby fostering environmentally friendly and sustainable waste management practices. Conversely, low education levels remain a major barrier to broader participation and result in less effective waste management.

Occupation

Based on the predefined occupational categories namely farmer/livestock breeder, student, civil servant, and housewife the results of the study, derived from 80 respondents, show that the majority of those involved in beef cattle waste management work as farmers or livestock breeders. This group accounts for 51 respondents (63.75%). Meanwhile, civil servants represent the smallest occupational group, with only 3 respondents (3.75%) participating in the program. This dominance of farmers/livestock breeders among respondents is due to the fact that many community members raise beef cattle, which naturally results in livestock waste that can be processed. As such, their involvement in waste management is more prevalent and directly relevant to their daily activities and livelihood. The type or primary occupation of livestock farmers significantly influences how actively they participate in beef cattle waste management. Farmers who work full-time in agriculture or livestock-related sectors are generally more involved in

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waste management activities. This is because they are already familiar with agribusiness practices and are highly motivated to manage waste properly to support the productivity and sustainability of their farming operations. Moreover, such individuals are more likely to be members of farmer groups or livestock communities, which facilitates easier access to training and resources for waste processing. In contrast, livestock farmers whose main occupations lie outside the agricultural sector such as laborers, traders, or informal workers end to be less engaged in waste management efforts. Limited time, different work priorities, and a lack of technical knowledge are common barriers that prevent these individuals from participating more fully. Several studies support this finding. Hidayat et al. (2021), in the Journal of Agribusiness, emphasize that farmers who work full-time in the agricultural or livestock sector are more actively involved in waste management, as it is considered a core component of their livelihood. Nuraini and Setyawan (2019) found that farmers with side jobs outside of agriculture tend to have lower levels of involvement due to divided time and attention. Similarly, Putra et al. (2020) revealed that livestock farmers who are members of agricultural or waste management groups tend to show higher participation levels, with the majority being full-time livestock farmers.

Analysis of The Cost

An analysis of the cost components incurred and the potential income generated is conducted to assess the economic feasibility of converting beef cattle waste into fertilizer in Kediri City. Table 10 presents a breakdown of the fixed costs incurred in a single compost fertilizer production cycle, including the purchase of primary materials such as dolomite, rice husks, ash, and EM4.

Table 2. Fixed Costs of Beef Cattle Waste Processing in Kediri City

Component	Value	Price
Beef Cattle Manure	1000 kg	-
Dolomite	150 kg	IDR 150.000
Rice Husk	200 kg	IDR 200.00
Ash/Charcoal	300 kg	IDR 100.00
EM4	4 Liters	IDR 80.000
Total		**IDR 530.000**

Source: Processed primary data, 2025.

Presents the Break-Even Point (BEP) analysis, which aims to determine the minimum production volume of organic fertilizer required to cover all operational costs, both fixed and variable.

Table 3. Beef Cattle Waste Processing Standard (BEP) in Kediri City

Component	Value
Fixed Costs	IDR 530.000/month
Variable Cost Per Unit	IDR 13.500/sack
Selling Price Per Unit	IDR 40.000/sack

Source: Processed primary data, 2025.

Feasibility studies are essential to determine whether a business is viable and capable of generating profit within a certain period. The BEP analysis indicates the volume of product sales required to cover all operational expenses. In this case, the sale of compost fertilizer can potentially enhance economic value. The waste management activity, which converts beef cattle manure into organic fertilizer, includes calculations of production cost, Break-Even Point (BEP), and Benefit-Cost Ratio (B/C). The manure, used as the main raw material, has no monetary cost (IDR0), and the total operational cost amounts to IDR 530,000. Each composting cycle produces 1.6 tons of organic fertilizer. At a selling price of IDR 40,000 per 40-kg sack, 1.6 tons produce 40 sacks, generating total monthly revenue of IDR 1,600,000 (40 sacks x IDR 40,000). The monthly profit is calculated by subtracting the production cost from the revenue: IDR 1.600.000 – IDR 530.000 = IDR 1.070.000. The Break-Even Point is calculated as:
BEP = Production Cost / Selling Price = IDR 530000 / IDR 40.000 = 13,25, which is rounded up to 14 sacks. This means that to reach the break-even point, a minimum of 14 sacks must be sold. The Benefit-Cost Ratio (B/C) is calculated as: Total Revenue /

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Total Production Cost = IDR 1.600.000 / IDR 530.000 = 3,01. Since the B/C ratio is greater than 1 (B/C > 1), specifically 3,01, this indicates that the business is economically feasible and profitable.

The income generated from beef cattle waste processing activities is strongly linked to the level of farmer engagement in such practices. Several studies have shown that when farmers experience direct economic benefits from waste management, they are more motivated to participate actively and sustainably in the process. Saputra and Gunawan (2021), in their study conducted in Babahan Village, Penebel Sub-district, Tabanan Regency, found that livestock waste management when converted into organic fertilizer had a positive economic impact on local farmers. This practice not only contributed to reducing environmental pollution but also created additional income opportunities. The income earned from utilizing livestock waste encouraged greater involvement of farmers in waste management activities, either individually or collectively through farmer groups. Similarly, a study by Rohmah and Maulana (2022) in Mekar Bakti Village, Pamulihan Sub-district, Sumedang Regency, showed that the Tunas Mekar livestock group successfully implemented technological innovations in dairy cattle waste utilization. The waste was processed into economically valuable products such as compost and biogas. This success not only had positive environmental effects but also generated significant financial benefits for the farmers. These findings affirm that economic incentives are one of the key factors that enhance farmer participation in livestock waste management.

Strategies and Implications Based on the Research Model

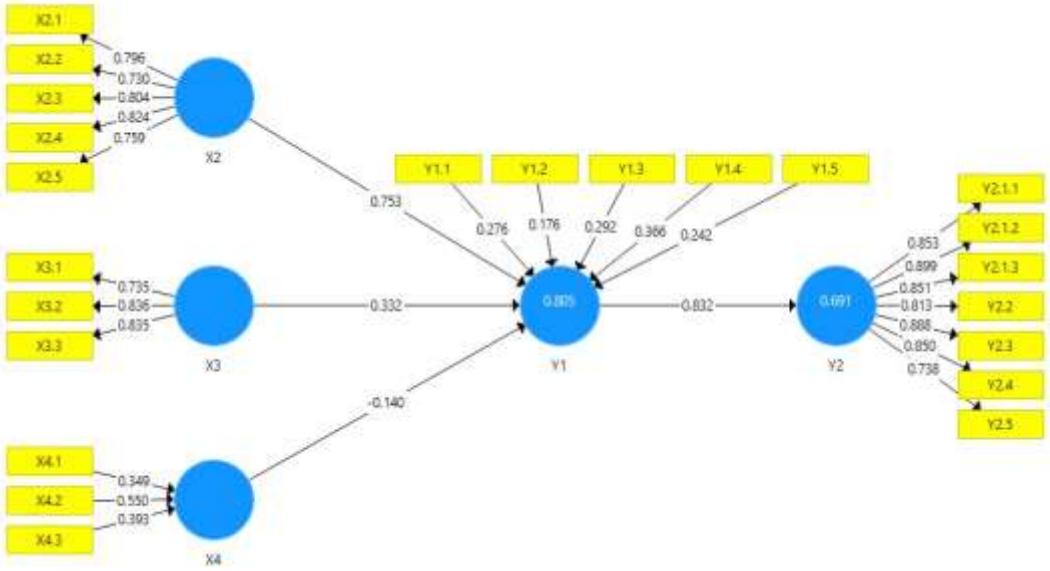

Figure 1. Research Model Path Diagram
Source: Processed Research Data, 2025

The outer model test for the motivation variable (X2) shows that indicator X2.4 (Need for Recognition), which includes the desire to be respected, acknowledged, and appreciated with a loading value of 0.824, is the strongest indicator. Thus, it is the dominant indicator in shaping the motivation variable (X2). For the perception variable (X3), indicator X3.2 (Affective Perception), which includes being disturbed by odors, concerns about health impacts, and disruptions to daily activities has the highest loading value of 0.836, making it the dominant indicator in shaping the perception variable (X3). In the stakeholder variable (X4), indicator X4.2 (Extension Agent) has the highest weight of 0.550, and therefore is the dominant indicator in defining the stakeholder variable (X4). The outer model test for the participation variable (Y1) reveals that indicator Y1.4 (Evaluation) has the highest weight of 0.366, indicating it is the dominant factor in forming the participation variable (Y1). For the sustainability variable (Y2), indicator Y2.1.2 has the highest loading value of 0.899, making it the dominant indicator contributing to the sustainability variable (Y2). Therefore, it is necessary to formulate strategies to maintain and enhance participation levels in order to support the sustainability of the beef cattle waste management program in Kediri City. These strategies should be derived based on the research model, which highlights the most significant variables and indicators identified through the analysis.

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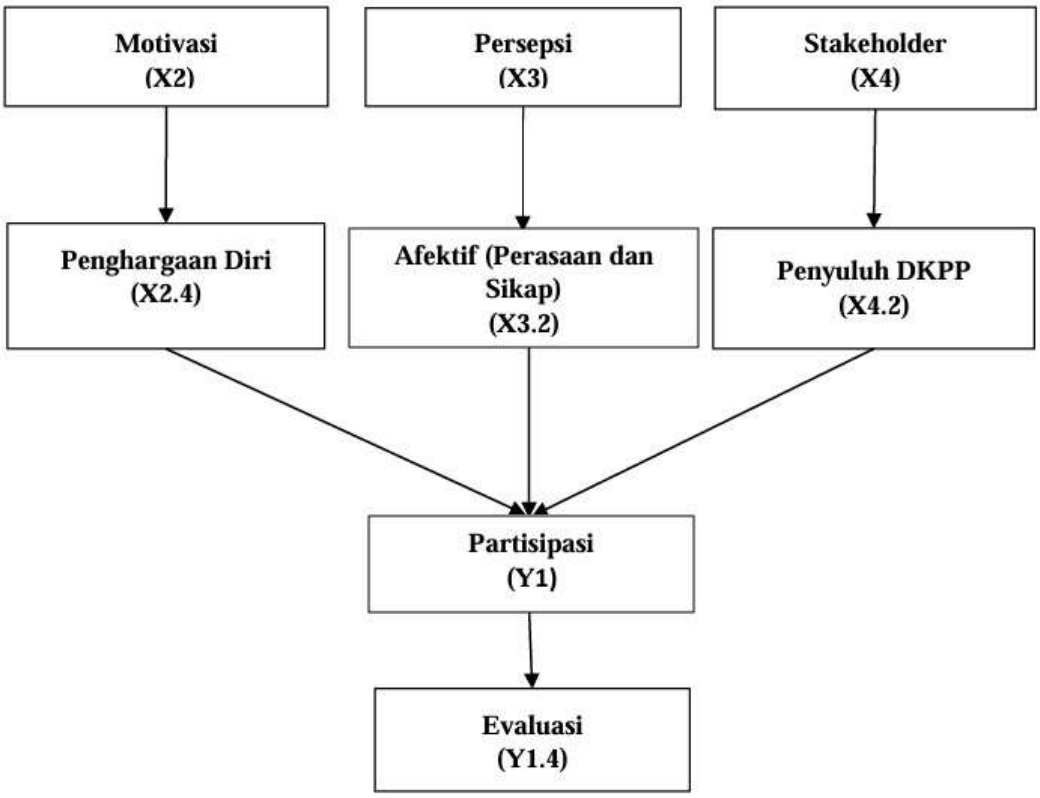

Figure 2. Diagram of the Most Significant Indicators for Each Variable
Source: Processed Research Data, 2025

Strategy Based on the Motivation Variable

Based on the research model and testing results, the motivation variable was identified as the most significant factor influencing the level of participation in the beef cattle waste management program. The most dominant indicator within this variable is X2.4, which reflects the need for self-esteem or recognition in relation to waste management activities. Accordingly, a sustainability strategy focused on motivation particularly this indicator can be formulated as follows:

a. Enhancing Recognition and Appreciation for Program Participants

Recognition plays a crucial role in sustaining motivation among farmers involved in the beef cattle waste management program. The findings show that X2.4 (need for recognition)—encompassing the desire to be respected, acknowledged, and appreciated—is the most influential indicator affecting motivation. To enhance program sustainability, strategic efforts should prioritize building a sense of appreciation and value among stakeholders, particularly the farmers. This can be implemented through symbolic awards, public recognition via community media, or by actively involving farmers in coaching sessions, training programs, and implementation processes. Such approaches can cultivate a sense of pride and enhance farmer motivation to continuously contribute, thereby fostering a long-term, environmentally sustainable waste management system. Strengthening social value and self-esteem is also essential. For instance, formal recognition from government or community institutions for farmers actively engaged in waste processing can reinforce their commitment. This aligns with Abraham Maslow's hierarchy of needs, where esteem and selfactualization are critical drivers for sustained engagement in meaningful activities like waste management. Strategies to increase farmer motivation through esteem can include public recognition of achievements, such as awarding certificates, appreciation plaques, or featuring success stories in community media. These measures can elevate self-confidence and internal motivation (intrinsic motivation). A study by Syah et al. (2023) on the relationship between motivation, perception, and willingness to develop goat farming in the Bonokeling community found that social appreciation and positive self-perception significantly influenced farmers' intentions to develop their livestock businesses. Actions such as awarding recognition in livestock group forums, publishing

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success stories, and acknowledging innovation can strengthen long-term farmer motivation and commitment. Therefore, in order to increase community participation, it is crucial for program managers to provide recognition, trust, and appreciation to every individual involved.

Strategy Based on the Perception Variable

Perception was identified as the second most significant variable influencing participation, following motivation. The most dominant and statistically significant indicator within this variable is X3.2**,** which reflects affective perception including feelings and attitudes. Based on this finding, the sustainability strategy for the beef cattle waste management program in Kediri City can be formulated by focusing on the affective perception (X3.2) as the dominant indicator, as follows:

a. Strengthening Affective Perception Through Visual and Audio-Visual Education

One key strategy to enhance the community's affective perception of the beef cattle waste management program is through visual and audio-visual educational media. Delivering information using educational videos, infographics, and podcasts can evoke positive emotions such as pride, concern, and environmental responsibility. This approach aligns with the findings of Silva and Stocker (2018), who emphasized that effective visual communication and appropriate framing such as through psychological distance, outcomes, benefits, and consequences can significantly influence public perception and emotional engagement. In the context of the Kediri City program, this strategy can be implemented through:

- Disseminating educational videos via social media,
- Creating interactive information boards at farming sites, and
- Organizing visual-based simulation training sessions.

Such methods are expected to enhance public affective perception**,** thereby reinforcing motivation and participation in ensuring the sustainability of the beef cattle waste management program.

b. Optimizing Participatory Workshops Based on Local Knowledge

Another effective strategy is the implementation of participatory workshops that emphasize local knowledge and real-life experience**s** of local farmers. These workshops go beyond merely transferring technical knowledge; they serve as platforms for valuing farmers' indigenous knowledge and practices, thereby fostering a sense of pride and environmental responsibility**.** This is consistent with the study by Sunari and Nurhayati (2023) on plastic waste management based on local wisdom, which found that incorporating local knowledge into educational programs increases community awareness and participation, as people begin to see value in their own cultural practices. The same principle can be applied to cattle waste processing by:

- Demonstrating traditional composting or liquid fertilizer techniques that already exist in the local community, and
- Utilizing participatory mapping to help communities identify potential, risks, and direct benefits of the program within their area.

Furthermore, Subekti et al. (2022) emphasized the effectiveness of extension activities using lectures and demonstrations in promoting organic fertilizer production. In their study, 9 out of 10 farmers successfully produced organic fertilizer after participating in the demonstration-based training. Evaluation methods based on local activities such as enhancing skills and encouraging the continuation of practices can strengthen emotional bonds and technical competencies of participants. With this approach, participatory workshops not only build technical capacity but also develop affective commitment and social responsibility, both of which are essential factors for ensuring the long-term sustainability of the livestock waste management program.

Strategy Based on the Stakeholders Variable

Stakeholders emerged as a significant variable influencing participation, following motivation and perception. However, research findings revealed that stakeholder involvement in beef cattle waste management programs exerts a negative influence on both participation and program sustainability. Based on these findings, the sustainability strategy for the beef cattle waste management program can be formulated as follows:

1. Comprehensive evaluation of current stakeholder approaches,
2. Strengthening participatory engagement methods,
3. Enhancing program transparency, and
4. Reinforcing synergy among government institutions, private sectors, and farming communities.

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The statistical analysis indicates that the contribution of stakeholders (X4) to program sustainability showed a negative indirect effect, with a coefficient of -0.116 and p-value of 0.046. Although still within the level of significance, the negative direction suggests a misalignment between stakeholder roles—including those of local governments, agricultural extension officers, and academic institutions—and the actual needs and expectations of the cattle-farming communities.

This misalignment implies that stakeholder engagement remains suboptimal, particularly in empowering the community through inclusive and bottom-up approaches. The prevalent top-down methodology is insufficient in fostering a sense of ownership among farmers, thus limiting their motivation and participation.

The findings emphasize that the sustainability of livestock waste management programs in Kediri City is highly dependent on the extent to which farmers feel ownership and are actively involved in the process. Therefore, it is critical to:

- Strengthen farmers' internal motivation,
- Enhance positive perceptions regarding the program's benefits, and
- Adjust stakeholder engagement strategies to be more inclusive and locally responsive.

A shift toward participatory and collaborative approaches is essential. This includes facilitating co-decision-making, integrating local knowledge and values, and fostering transparent communication across all stakeholder levels. Only through such approaches can the livestock waste management program achieve real sustainability, yielding long-term environmental benefits and improved community welfare.

According to Marganingsih and Hartono (2021), the role of local government is crucial in the management of livestock waste. The government can act as a facilitator by providing the necessary infrastructure and facilities to address waste-related issues, including by involving relevant stakeholders. At the village level, the government serves as a mediator, positioning itself as a neutral third party that prioritizes consensus-based problem-solving. Additionally, village governments function as motivators, offering encouragement, raising awareness, and providing guidance on environmental conservation. Marganingsih and Hartono further assert that in its role as a mediator for resolving cattle waste pollution issues, the government places itself in a neutral position, aiming to achieve collaborative solutions through deliberative forums that include all relevant stakeholders. As a motivator, the local government is responsible for instilling motivation, enhancing awareness, and offering guidance to both cattle farmers and nonfarming residents on the importance of environmental preservation. However, the role of stakeholders in the beef cattle waste management program in Kediri City has been found to be ineffective, as evidenced by the results of SEM-PLS analysis, which show a negative effect of stakeholders on participation (X4 → Y1 = -0.140) and on program sustainability (X4 → Y2 = -0.116), although both are statistically significant. These findings indicate that despite the presence of key stakeholders—such as local government officials, extension workers, and academic experts—their involvement has not effectively driven active participation from farmers nor ensured long-term program sustainability. This ineffectiveness may stem from poor two-way communication between policymakers and primary actors (i.e., farmers), limited budget allocation, lack of continuous training, and insufficient incentives and access to necessary waste processing facilities. These factors contribute to farmers' weak perception of the usefulness and impact of stakeholder roles. Therefore, in the context of Kediri City, there is an urgent need for a more robust participatory approach, increased program transparency, and stronger synergy between government entities, the private sector, and farming communities. Only by strengthening stakeholder engagement in a responsive and inclusive manner can the sustainability of livestock waste management initiatives be effectively supported.

The research findings also reveal a negative relationship between the contribution of stakeholders—including local governments, agricultural extension agents, and academics—and farmers' participation in beef cattle waste management activities in Kediri City. Specifically, the lower the involvement of stakeholders, the higher the level of farmer participation in waste management. This indicates that farmers in the region have developed a degree of independence in community-based livestock practices, particularly in utilizing cattle waste as organic fertilizer. It reflects that locally rooted systems, built on experience, routine practices, and real field needs, are more effective and sustainable. Conversely, stakeholder interventions are often perceived as irrelevant or lacking direct benefit. Many government or expert-driven programs tend to adopt a top-down approach, failing to involve farmers in the planning and decision-making processes, and overly emphasizing technical or theoretical aspects that are not easily understood or applicable by farmers. Stakeholder involvement also tends to be episodic—active only when specific projects are underway—thus weakening the long-term sustainability of such programs. Additional obstacles include the use of technical jargon, limited communication, and the lack of tangible benefits perceived by farmers. As a result, farmers are more likely to participate actively

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when the initiatives originate from within their own communities, such as through local farmer groups or informal networks. This scenario also reflects a trust gap between farmers and stakeholders, which undermines the potential for effective collaboration in managing livestock waste. Therefore, a comprehensive evaluation of the current stakeholder engagement approach is urgently needed. A more participatory model must be pursued—one in which farmers are treated as active partners, rather than passive beneficiaries. Enhancing local capacity, recognizing traditional knowledge and practices, and designing programs based on actual field needs are critical to increasing meaningful involvement from all parties. These findings further highlight that the success and sustainability of livestock waste management programs are not only determined by internal farmer factors such as motivation and perception, but also by the extent to which stakeholders are able to engage in a collaborative and responsive manner toward field-level needs. A healthy synergy between stakeholders and farmers can only be built through open communication, deep contextual understanding, and mutual respect for the local initiatives and wisdom that have evolved within the farming communities of Kediri City.

Strategy Based on the Participation Variable

Participation is a critical variable in empowerment programs, as a higher level of participation typically leads to more effective implementation of such programs. In this study, the most significant indicator of participation is Y1.4, which reflects evaluation of program implementation in the context of livestock waste management. Based on this finding, a sustainability strategy for the beef cattle waste management program is formulated by focusing on the dominant evaluation variable, as follows:

a. Participatory Monitoring and Evaluation (PME)

Participatory monitoring and evaluation is a key strategy for ensuring the sustainability of the program, as it can foster a strong sense of ownership among community members. One effective approach is the application of Participatory Monitoring and Evaluation (PME), which actively involves all stakeholders—particularly local communities—in measuring, analyzing, and assessing program outcomes. Through community involvement, a stronger sense of ownership can be nurtured, thereby reinforcing the program's sustainability in the long term. Direct community involvement in monitoring activities such as focus group discussions, evaluation of waste processing outcomes, and regular reporting allows residents to function not only as program beneficiaries, but also as active agents in program development. Furthermore, this evaluation approach encourages two-way feedback between program implementers and participants, enabling timely identification and resolution of issues encountered in the field.

b. Continuous Training and Extension Services

Ongoing training and extension services are crucial to enhancing the technical skills and confidence of the community in managing livestock waste. According to Ajzen (1991), increasing knowledge can strengthen an individual's intention and behavior toward adopting environmentally friendly practices. Participatory extension methods are more effective than one-way approaches, as they involve the community in discussions and problem-solving, thus enhancing a sense of ownership toward the program. In addition, study tours or field visits to other regions that have successfully implemented livestock waste management can provide valuable hands-on experiences and inspiration, thereby promoting the adoption of best practices at the local level. With sustained training and extension activities, communities do not only gain new knowledge and skills, but also become more motivated to remain actively involved in waste management programs. This is because they perceive tangible environmental benefits and recognize the potential for increased household income, particularly for livestock farmers.

CONCLUSION

Based on a survey of 80 respondents, the majority of beef cattle farmers in Kediri City exhibit the following characteristics: 85% are male, and 92.5% fall within the productive age category (17–59 years), indicating strong physical and mental readiness to actively engage in waste management. Most respondents (58.75%) have a senior high school education, suggesting an adequate understanding of waste management technology and innovation. Additionally, 63.75% work primarily as farmers or livestock breeders, highlighting their proximity to waste sources and strong potential for direct involvement in waste management programs. These characteristics reflect a community that is relatively well-prepared and highly capable of active participation in waste processing initiatives. The study's findings reveal that the sustainability of the waste management program is strongly influenced by three key variables: motivation, perception, and stakeholder involvement. The motivation-based strategy (X2) focuses on selfesteem needs (X2.4) as the dominant factor and includes symbolic rewards, formal recognition, storytelling of successful

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farmers, and involvement in community forums to strengthen intrinsic motivation and pride. The perception-based strategy (X3) emphasizes affective perception (X3.2), with initiatives such as visual and audio-visual education tools and participatory workshops rooted in local knowledge, aiming to cultivate positive emotions and environmental responsibility. Although stakeholder contribution (X4) is statistically significant, it has a negative influence, indicating a need to revise top-down approaches. The proposed strategy includes strengthening participatory methods, improving program transparency, building synergy among government, private sectors, and farmer groups, and recognizing local wisdom and grassroots initiatives. Finally, the participation-based strategy (Y1) identifies evaluation (Y1.4) as the dominant indicator, promoting sustainability through Participatory Monitoring and Evaluation (PME) and continuous training to ensure that the community acts not only as recipients but as active agents in sustaining the waste management program.

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