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RESEARCH ARTICLE

STAKEHOLDER COLLABORATION IN HOUSEHOLD ORGANIC WASTE MANAGEMENT IN SEMARANG CITY

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Abstract

Household organic waste presents a specific challenge for Semarang City, as its waste volume represents the highest proportion in Central Java Province. The rising accumulation of household organic waste has led to a continuous increase in the volume of waste disposed of at Final Processing Sites (TPA). Without active stakeholder support, achieving sustainability and a positive environmental impact in household organic waste management remains difficult.Although stakeholder involvement in waste management and the implementation of Supply Chain Management (SCM) are often discussed separately, there is still a lack of conceptual models that integrate these two perspectives within the context of household organic waste in Semarang. This study aims to examine stakeholder collaboration in the implementation of the supply chain for household organic waste management. The research utilizes a quantitative method approach. Primary data from 177 respondents—representing every sub-district (kelurahan) across the 16 districts of Semarang—were collected via questionnaires. Respondents were selected using the stratified random sampling method. Data analysis was conducted using the Partial Least Square (PLS) method through SmartPLS 4.0 software. The data for analysis consisted of scores from scale-based responses. The findings indicate that active stakeholder involvement is a key factor in improving system or organizational performance. In the context of the organic waste supply chain, SCM relies not only on technical and operational aspects but also on social support and collaboration between actors.

Introduction:-

Waste represents a specific challenge for the city of Semarang, as its waste volume accounts for the largest share in Central Java Province. Data from the National Waste Management Information System (SIPSN) in 2024 shows that Semarang generates 434,243.97 tons of waste annually, out of a total of 5,922,936.85 tons in Central Java Province

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(1), as illustrated in Figure 1. Of this waste, only 27.17% is managed, while the remaining 72.83% is discharged into the environment. A point of particular concern is the composition of waste in Semarang, which primarily consists of food waste (60.8%). The primary source of this food waste (72%) is household waste (1);(2);(3).

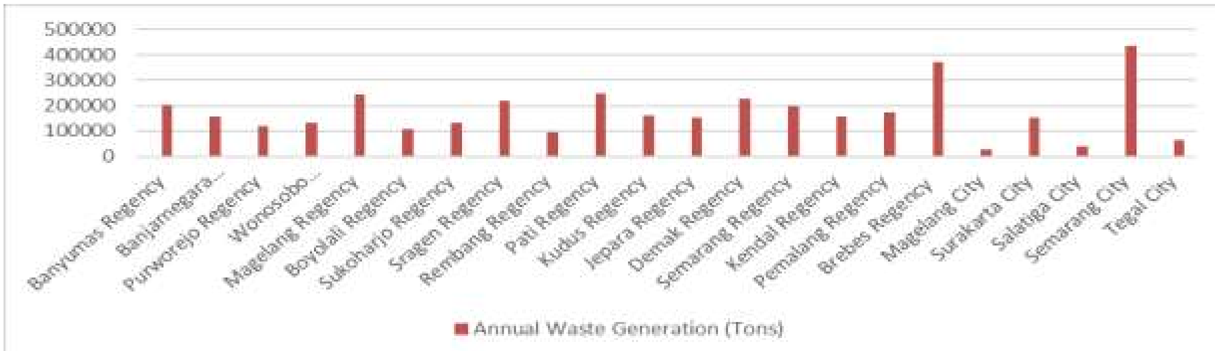

Figure 1. Waste Generation in Central Java in 2024

Source: (1)

Inadequate waste management leads to an increase in waste accumulation and negatively impacts ecosystems. A further consequence is the rising volume of household organic waste, which also results in increased waste volumes at management facilities. Ministry of Environment and Forestry Regulation (Permen LHK) No. 14 of 2021 considers that waste management needs to be carried out comprehensively and in an integrated manner from upstream to downstream (supply chain management) using a circular economy approach by the central government, local governments, and the community, thereby providing economic benefits while being healthy for the public and safe for the environment.The successful implementation of a circular economy is supported by proper supply chain management (4);(5);(6). Implementation requires the cooperation and participation of relevant stakeholders (government, community, private sector) to ensure an integrated and holistic waste management system that prioritizes circular economy principles to enhance the economic benefits of waste. Without active stakeholder support, it will be difficult to make organic waste management sustainable and achieve a positive environmental impact. As emphasized by Muhammad et al., the roles of stakeholders—such as government policies, private sector involvement, and public awareness campaigns—are vital for a successful transition toward sustainable management (7).

One of the primary issues in organic waste supply chain management is the lack of synchronization among stakeholders, particularly between the government, the private sector, communities, and the general public (8). Normatively, local governments have encouraged waste segregation policies at the source as part of national waste reduction targets coordinated by the Ministry of Environment and Forestry. However, in practice, these policies are often not followed by the readiness of separate transportation systems or adequate processing infrastructure. Consequently, waste that has been sorted by the community becomes mixed again during the collection stage, thereby reducing the quality of raw materials for the composting process. On the other hand, the private sector investing in organic waste processing facilities experiences uncertainty regarding the supply of raw materials because there is no clear partnership scheme with either households or local governments. Based on these gaps, it is necessary to analyze how stakeholder collaboration influences the implementation of the supply chain in household organic waste management in Semarang City.

Literature Review:-

The Concept of Household Organic Waste:-

Kadir et al. state that organic waste is biodegradable waste. This waste is generated from various sources, such as agricultural waste, market waste, kitchen waste, municipal solid food waste, and municipal solid waste (9). According to Law Number 18 of 2008, household waste is defined as waste originating from daily household activities, excluding feces and specific waste. Karatas notes that organic waste is a significant factor in environmental pollution (10). Without proper waste management, it can lead to several environmental issues (9). Furthermore, Kalonde et al. argue that improper waste management—specifically open dumping in the environment—creates unpleasant odors and contaminates water resources (11). This view is supported by Ferdinan (12), who states that poorly managed household waste has the potential to pollute the environment and interfere with public health. Proper household waste management is an effort to preserve the environment and increase independent household waste control (12).

Waste management is defined as various approaches and procedures designed and implemented to identify, control, and handle different types of waste from production to disposal (13). According to (14), household waste management includes the collection, transportation, and processing of waste. Under Law No. 18 of 2008, waste management consists of household waste reduction activities (VI Article 20), which include limiting waste generation, recycling, and reuse; and household waste handling (Chapter VI, Article 22), which includes sorting, collection, transportation, and final processing. The concept of organic waste management in Indonesia underwent a paradigm shift (fundamental transformation) in 2025. The focus is now on the mandatory segregation of waste at the source, the economic cycle, and the prohibition of organic waste disposal in Final Processing Sites (TPA). In accordance with the Decree of the Minister of Environment and Forestry No. 2569 of 2025, food scraps and leaf waste must be processed into fertilizer, energy, or animal feed.

Supply Chain Management (SCM) in Waste Management:-

Mukhamedjanova states that Supply Chain Management (SCM) is the integration of key business processes for end-users through tangible suppliers that provide value-added products, services, and information that complement each other for customers and other stakeholders (15). According to Prasetyo et al., SCM is the process of linking core business functions across a network consisting of suppliers, manufacturers, distributors, retailers, and customers with the goal of improving the sustainable flow of information, products, and services from the supplier to the end-user (16).Waste SCM, which still focuses primarily on collection, transportation, and disposal with minimal efforts toward waste prevention, results in high waste volumes ending up in Final Processing Sites (TPA). This hinders the achievement of the "No TPA" and "Zero Waste" targets by 2045. Therefore, integrated waste management reform from upstream to downstream (Waste SCM) is identified as one of the most important transformative steps for Indonesia, as stated in the National Long-Term Development Plan (RPJPN) 2025-2045 (17). Household waste SCM in Indonesia is further regulated in Government Regulation (PP) No. 81 of 2012, which specifically encourages the supply chain, including the role of waste banks, recycling, and waste reuse by producers.

Gupte & Saptarshi argue that there are three main elements of integrated supply chain management: information systems (information management) and financial flows; inventory management (product and material flow management); and supply chain relationships (stakeholder relationship management) (18). While SCM generally regulates the flow of food production and distribution from households that eventually results in waste, there is a need for reverse logistics that regulates the collection and processing of organic waste into useful products to ensure sustainability, where nothing is discarded as waste.Reverse logistics in household organic waste is a system for collecting and re-processing organic waste from homes so it gains utility value and does not end up as trash. The goal of reverse logistics, besides reducing waste to the TPA and reducing methane emissions, is to generate new economic value and support the circular economy.

Elma Sibonghanoy Groenewald also states that the implementation of a circular economy emerges as a viable solution to address the environmental and economic challenges posed by traditional linear production and consumption models. Integrating circular economy principles into supply chain management has gained attention as a way to achieve zero waste and enhance sustainability (19).Thus, SCM in household organic waste management regulates the flow from the source (households producing organic waste such as food scraps, rotten fruits/vegetables, and kitchen leaf waste), followed by reverse logistics (collection, material flow moving from the consumer back to the production or utilization system, e.g., households storing organic waste separately).Transportation **(o**rganic waste is transported from households to temporary disposal sites (TPS) or processing facilities by sanitation departments, community waste managers, or composting units.Processing (organic waste is processed into valuable products through methods such as composting, biogas, animal feed, or liquid organic fertilizer.Re-utilization (the processed results are reintroduced into the economic system e.g., compost for agriculture, biogas for household energy, or liquid fertilizer for farming) (20).

Stakeholder Participation in the Organic Waste Supply Chain:-

Aschemann-Witzel et al. and Franchina et al. state that collaboration between stakeholders is a key success factor in the implementation of supply chain management. Similarly, in household organic waste management, stakeholder collaboration is highly essential (4);(21). Michael Ayorinde Dada also asserts that stakeholder collaboration is a critical success factor in the implementation of supply chain management (22).Agustang et al., in their findings, state that stakeholders play a significant role in community empowerment related to sustainable environmental sanitation management, particularly urban waste (23). Muhammad et al. also emphasize that stakeholder roles—such as government policies, private sector involvement, and public awareness—are vital for driving a successful transition toward sustainable waste management (24).

The views of Agustang et al. and Muhammad et al. are further supported by Siems et al., who state that stakeholder participation is the role of an organization in managing and interacting with individuals or groups (stakeholders) who influence or are affected by their business operations. Regarding waste management practices, stakeholders can be categorized into two parts: institutional (external) and communal/societal (internal) (25).External stakeholders consist of the government (central, provincial, and city/regency levels) and private parties (NGOs, academics, corporations, etc.), while internal stakeholders comprise the household community acting as the suppliers of organic waste. The roles of each stakeholder are as follows:Government **(**primarily responsible for formulating policies, regulations, and waste management programs, as well as providing infrastructure such as integrated waste processing sites (TPST), composting facilities, and waste collection and processing systems; Private Sector (acts as a partner in organic waste management operations; NGOs (LSM) (play a role in community assistance, increasing environmental awareness, encouraging public participation in waste management, and acting as a liaison between stakeholders); Academics (responsible for conducting research, developing organic waste processing technology, and providing scientific recommendations for effective and sustainable waste management systems; whereas, Internal Stakeholders is the community acting as the primary source and supplier of household organic waste.
Empirically, based on the researcher's findings during a pre-survey at the TPS 3R in Semarang City, stakeholders have not yet demonstrated comprehensive participation. The community, government, and private sector have not yet participated in a collective, synchronized manner.

Methods:-

Research regarding stakeholder participation in household organic waste management is a quantitative study utilizing questionnaires for data collection. The study was conducted across 16 districts in Semarang City. Data were collected through surveys distributed to 177 households, serving as the sample, by responding to specific inquiries. Households were selected as the target group because they represent the largest portion of waste production in Semarang, a finding supported by Becerra et al. and Ayu Safitri Dika (26);(3).A stratified random sampling method was employed for this study. According to Firmansyah & Dede; Iliyasu &Etikan, this method involves selecting several groups of elements from a population using classification and random selection (27). The population was divided into strata for each sub-district (kelurahan), with one respondent randomly selected from each. The selected respondents were either heads of households or household members actively involved in managing domestic waste. Written questionnaires were distributed to respondents via Google Forms.

The primary data collection instrument, in the form of a questionnaire, was developed based on several previous studies, such as those that define stakeholders as individuals or groups who can influence or be influenced by the achievement of an organization's objectives (28).Stakeholders consist of both external and internal actors. Numerous external and internal supply chain stakeholders encourage, facilitate, or monitor the implementation of sustainable supply chain management practices. While governmental and non-governmental organizations are primary drivers for implementing these practices, they also support their execution. Furthermore, proactive engagement with external supply chain stakeholders facilitates organizational learning through capability development, increased sustainability awareness, and knowledge creation (25).

Regarding the household organic waste supply chain management variable, the theory states that Supply Chain Management (SCM) describes the coordination of all supply chain activities, starting from suppliers, manufacturers/service providers, to distributors, wholesalers, and retailers delivering products/services to the end consumer (29). SCM involves supplier selection, logistics planning, and supply distribution. It encompasses the management of activities aimed at transforming raw materials into work-in-progress or finished goods and subsequently delivering those products to consumers through a distribution system (16).
These theories were selected to support the research, specifically as a reference for developing the research instrument. Based on this literature, the research measurement tools can be summarized as follows:

Table 1. Indicators of Stakeholder Participation and SCM Implementation

Stakeholder Participation		
No	**Indicator**	**Number of Question Items**
A	Participation of household organic waste suppliers (The Community)	7
B	Participation of household waste managers	6
C	Participation of organic waste product users	8
D	Participation of other parties in the business sector	5
E	Participation of other parties in the non-business sector	8
Supply Chain Management (SCM) Implementation Household Organic Waste		
No	**Indicator**	**Number of Question Items**
A	Product development	9
B	Procurement	5
C	Planning and control	6
D	Operation/Production	13
E	Delivery/Distribution	6

Source: Primary Data, 2025

Data processing results using structured reports were prepared at all stages of this study. Based on the variables definitions "stakeholder participation" and "household organic waste supply chain management (SCM)," a questionnaire was used as the data collection instrument. Respondents were asked to rate various indicators using a 5-point Likert scale toindicate the level of agreement or disagreement, where 1for "Strongly Disagree" (STS), 2 for "Disagree" (TS), 3 for "Neutral" (N), 4 for "Agree" (S), and 5 for "Strongly Agree" (SS). The collected data were processed using the Partial Least Square (PLS) method via SmartPLS 4.0 software and subsequently analyzed descriptively.Based on the SmartPLS test results, the R-Square value for the SCM variable was 0.284. This indicates that the independent variable in this study is able to explain 28.4% of the variation in SCM, while the remaining 71.6% is driven by other factors outside the research model. The Adjusted R-square value of 0.270 suggests that the model has an adequate level of explanation and does not exhibit significant overfitting.

Discriminant validity testing was conducted using the Fornell-Larcker criterion. This criterion requires the square root of the Average Variance Extracted(√AVE)for each construct to be greater than its correlation with any other construct. The results show a value of 0.835 for Stakeholders and 0.813 for SCM, while the correlation between Stakeholders and SCM is 0.524.The result showed that √AVEvalues in each construct exceed the inter-construct correlation; which can be concluded that all variables in this study has met the criteria for discriminant validity based on Fornell-Larcker method.Discriminant validity testing using the cross-loadings method aims to ensure that each indicator has its highest loading on the construct it is intended to measure compared to other constructs. Findings obtained from the stakeholder construct analysis show that the loading values for each indicator on the stakeholder construct range from 0.771 to 0.896. These values are higher than the cross-loadings between stakeholders and SCM, which range from 0.253 to 0.568.Meanwhile, the SCM construct analysis shows loading values between 0.715 and 0.881, compared to cross-loadings between stakeholders and SCM ranging from 0.253 to 0.568. It can be concluded from the cross-loadings analysis that all indicators for both the stakeholder and SCM constructs have the highest loadings on their respective measured constructs. Therefore, it can be stated that there are no discriminant validity issues between constructs; each indicator can distinguish its construct effectively, and the measurement model meets the criteria for discriminant validity.

To evaluate discriminant validity, the Heterotrait-Monotrait Ratio (HTMT) values were compared against commonly used thresholds of0.85 (conservative criterion) or 0.90 (more liberal criterion). Good discriminant validity indicates that a construct is uniquely distinct from other constructs and does not correlate excessively. The HTMT analysis results yielded a value of 0.522 between Stakeholder and SCM, which is below the maximum threshold of 0.85. Thus, both tested constructs—Stakeholder and SCM—demonstrate good discriminant validity.
Based on the construct reliability and validity analysis, the quality of the research instrument can be evaluated using PLS-SEM. The recommended threshold for reliability (Cronbach's Alpha, rho a, rho c) is 0.70, while for convergent validity (AVE), it is > 0.50. The results for the Stakeholder construct show that the Cronbach's Alpha, rho a, and rho c values are 0.938, 0.943, and 0.949, respectively. These values are above 0.70, indicating excellent reliability.

Furthermore, rho a and rho c values approaching 1 indicate a very high and satisfactory level of internal consistency. The AVE test result for this study is 0.698, meaning that 69.8% of the stakeholder indicator variance can be explained by the stakeholder construct; this is a very good result as it exceeds 0.50.For the SCM construct, the analysis shows that the Cronbach's Alpha, rho a, and rho c values are 0.980, 0.983, and 0.981, respectively. These are all above 0.70, indicating that the construct possesses excellent reliability. Similarly, rho a and rho c values near 1 indicate a very high and satisfactory level of internal consistency for the indicators used. The AVE validity result in the study is 0.662, implying that 66.2% of the variance in SCM indicators can be explained by the SCM construct. This value is considered very good (> 0.50), confirming that convergent validity has been met.

Results and Discussion for the Stakeholder Construct:-

This study involved 177 heads of households or household members who are actively engaged in household waste management. The participants represent 16 districts within Semarang City with characteristic profile as follows:

Table 2. Respondent's Characteristic Profile

Characteristic	Category	Frequency	Percentage (%)
Gender	Female	90	51
	Male	87	49
Age Group	20-30 years old	29	16
	31-40 years old	49	28
	41-50 years old	55	31
	51-60 years old	35	20
	61-70 years old	9	5
Education	High School	25	15
	Diploma	55	31
	Bachelor	54	30
	Master	43	24

Source: Processed Primary Data, 2025

Based on Table 2, the respondent profile describes the distribution is relatively balanced between female (51%) and male (49%), indicating inclusive gender representation in research participation. The majority of respondents fall within productive and mature age ranges, specifically 41–50 years (31%) and 31–40 years (28%). This suggests that respondents possess sufficient life experience and perspective to respond effectively to the research instruments. The profile is dominated by Diploma graduates (31%) and Bachelor's degree holders (30%). This high level of education supports the validity of the data, as respondents are deemed to have the intellectual capacity to comprehend and accurately answer the survey items.The descriptive analysis of this study includes the description of the Supply Chain Management variable and the Stakeholder Participation variable. The details of the descriptive analysis are as follows:

Supply Chain Management Variable Description:-

Table 3. Supply Chain Management Description

No.	Variable Indicator	Average Response
1.	Product Development	4,449
2.	Procurement	4,383
3.	Planning and control	4,351
4.	Operation or Production	4,585
5.	Delivery or Distribution	4,717
Average		4,497

Source: Processed Primary Data, 2025

Based on the descriptive analysis results presented in Table 3, the Supply Chain Management variable has an overall mean score of 4.497. This value indicates that, in general, respondents provided ratings within the "Very High" category. This suggests that SCM practices in household organic waste management are performing well according to the respondents' perceptions. In detail, the indicator with the highest mean score is Delivery or Distribution at 4.717.This finding shows that the distribution aspect of processed waste (such as compost or other derivative products) is considered the most effective compared to other indicators. This may indicate a relatively smooth and well-coordinated product distribution system within the supply chain. The second highest indicator is Operations or Production, with a mean score of 4.585, showing that the organic waste processing has been implemented optimally.

A robust production process plays a vital role in maintaining the quality and continuity of the processed output. Meanwhile, the Product Development indicator obtained an average of 4.449, followed by Procurement at 4.383, and Planning & Control at 4.351. Although all indicators fall within the "Very High" category, the lowest score is found in the Planning & Control aspect.This indicates that there is still room for improvement in terms of coordination, monitoring, and controlling the supply chain flow to ensure it is systematic and integrated. Overall, these results show that the operational and distribution components of the supply chain are functioning excellently; however, strengthening strategic planning and control aspects could further enhance the overall effectiveness of the system.

Stakeholder Participation Variable Description:-

Table 4. Stakeholder Participation Variable Description

No.	Variable Indicator	Average Response
1	Household-scale organic waste suppliers	4,053
2	TPS 3R waste management operators	4,079
3	Users of processed organic waste product	4,106
4	Other parties in the business sector	4,166
5	Other parties in the non-business sector	4,025
Average		4,085

Source: Processed Primary Data, 2025

Based on the descriptive analysis, the Stakeholder Participation variable has an overall mean score of 4.085. This indicates that the level of stakeholder participation in the Supply Chain Management (SCM) of household organic waste is in the "High" category (assuming a Likert scale of 1–5). This suggests that stakeholders play an active role in supporting the sustainability of the organic waste supply chain.Specifically, the indicator with the highest mean score is Other parties in the business sector (4.166). This shows that business actors, such as processing enterprises or distribution partners, have the strongest level of involvement in the supply chain system. The engagement of the business sector is crucial for maintaining operational sustainability and the economic aspects of organic waste management. The next highest indicator is Users of processed organic waste products (4.106), indicating market acceptance and support for products like compost or organic fertilizer.The high participation of end-users reflects a demand that supports system continuity. Furthermore, Waste management operators obtained a mean of 4.079, showing that operational processing units contribute significantly to the supply chain. Meanwhile, Household-scale organic waste suppliers had a mean of 4.053, indicating that the community is sufficiently active in supplying or sorting organic waste as the primary raw material. The lowest mean score was for Other parties in the non-business sector (4.025), though it remains within the "High" category.

The SmartPLS analysis reveals an R-Square value of 0.284 for the SCM variable. This indicates that the independent variables in this study explain 28.4% of the variation in SCM, while the remaining 71.6% is influenced by other factors outside this research model. In the context of Partial Least Squares Structural Equation Modeling (PLS-SEM), an R-Square of 0.284 is categorized as moderate to low. The Adjusted R-Square of 0.270 suggests that after adjusting for the number of independent variables, the model's explanatory power remains relatively stable.The Fornell-Larcker criterion results show that each construct in the model has a strong ability to distinguish itself from other constructs. With discriminant validity satisfied, the measurement model is considered robust and fit for structural model testing. Conceptually, this reinforces that each variable has a clear theoretical definition without overlap. Further more, Cross-Loading results demonstrate that each indicator empirically represents its assigned

construct more strongly than other constructs. Most loading values are above 0.70, indicating that the indicators contribute significantly to forming the constructs without measurement overlap.
To ensure even stricter differentiation, the Heterotrait-Monotrait Ratio (HTMT) was applied with a threshold of 0.85. The relationship between Stakeholders and SCM showed an HTMT value of 0.522 (well below the 0.85 limit). This confirms that the Stakeholder and SCM constructs meet discriminant validity criteria, proving that performance measurement is conceptually and empirically distinct from SCM measurement.Reliability testing yielded Cronbach's Alpha values above the 0.70 minimum threshold. Similarly, convergent validity tests (rhoa and rho c) for all constructs were above 0.92, confirming that both Stakeholder and SCM constructs are highly reliable. This indicates that the research instrument can consistently measure the variables. Additionally, all constructs (Stakeholder, SCM) achieved an Average Variance Extracted (AVE) > 0.50, satisfying the requirements for strong convergent validity.

Conclusion:-

Based on the data analysis conducted using SmartPLS 4.0, the following conclusions can be drawn:
The research model demonstrates a sufficient level of explanatory power. However, there remains an opportunity to enhance the model's predictive capability by incorporating other variables theoretically relevant to SCM practices such as information technology factors, supply chain integration, collaboration between business partners, and management support, aligning with the perspectives of Gupte & Saptarshi (18).Based on the Fornell-Larcker discriminant validity test using SmartPLS, all constructs in the research model successfully met the discriminant validity requirements. Furthermore, the cross-loading discriminant validity analysis result indicates no issues regarding discrimination between constructs; every indicator effectively distinguishes its respective construct, measurement model met discriminant validity criteria. Discriminant validity according to the MTHT can be concluded that there are no multicollinearity or overlapping between constructs that differentiate one another.

Construct Reliability and Validity analysis concludes that all instruments used in this study demonstrate very high reliability and consistency in measuring their respective variables. Regarding convergent validity, each construct is capable of explaining a major portion of its indicators' variance, ensuring that convergent validity is well-satisfied.These findings reinforce the perspective of Stakeholder Theory, which posits that active stakeholder engagement is a key factor in improving system or organizational performance. In the context of the organic waste supply chain, SCM depends not only on technical and operational aspects but also on social support and collaboration between actors. Thus, improving the quality of stakeholder participation serves as a primary strategy for strengthening sustainable SCM integration and performance.

Recommendations:-

Future researchers are suggested to expand the research model by adding variables theoretically relevant to SCM practices, such as the utilization of information technology, supply chain integration, business partner collaboration, and management support, to provide a more comprehensive explanation of SCM variations.For Academics, the measurement model in this study can serve as a reliable reference, as it has met all validity and reliability criteria. This indicates that the research instruments are robust and suitable for reuse in similar research contexts.For Waste Management Operators, the results highlight the importance of active stakeholder involvement in improving organic waste SCM performance. In line with stakeholder theory, collaboration between the government, the community, business actors, and other related parties is essential to create a more effective and sustainable management system.For Policy Makers, there is a need for policies that encourage increased stakeholder participation and strengthen the links between all parties involved in the organic waste supply chain. Policy support is expected to enhance system integration and improve SCM performance sustainably.

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