

COMMUNITY-BASED CIRCULAR ECONOMY IN RURAL AREAS: WASTE VALORIZATION AND ECONOMIC INCENTIVES IN WASTE BANKS (*THE CASE OF THE CIAMIS WASTE BANK*)

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Abstract

This study aims to analyze the role of the Ciamis Waste Bank within a community-based circular economy framework by examining the relationship between community participation, institutional support, waste valorization, and economic incentives. The study employs an explanatory quantitative approach using a cross-sectional survey design involving 80 active participants of the Ciamis Waste Bank selected through purposive sampling. Data were collected using a five-point Likert scale questionnaire and analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM) with SmartPLS 4. The results indicate that community participation has a positive effect on economic incentives and waste valorization, while institutional support has a positive effect on waste valorization but does not directly affect economic incentives. Waste valorization was also not found to have a direct effect on economic incentives. Furthermore, institutional support positively moderated the relationship between community participation and waste valorization, and negatively moderated the relationship between waste valorization and economic incentives. These findings indicate that the success of rural waste banks is determined not only by community involvement and material recovery processes but also by institutional capacity in managing value conversion and the distribution of economic benefits. This study contributes to strengthening community-based circular economy models within the context of rural entrepreneurship.

Keywords: waste bank, circular economy, community participation, waste valorization, economic incentives.

INTRODUCTION

In the context of community-based waste management in Indonesia, the main challenges are not only related to the volume of waste but also to the lack of a well-established system for sorting, collecting, and processing materials that can be recovered as valuable resources. Studies on plastic flows and waste banks indicate that when separation and processing systems are not robust, valuable materials risk not entering the recycling stream optimally (van Leeuwen & Surya, 2024; Pambudi et al., 2025). Therefore, the context of waste banks must be analyzed specifically based on regional characteristics, institutional capacity, and material flow patterns operating in each location, including within the context of Ciamis Regency.

On the other hand, rural economic development requires strategies rooted in local assets, conditions, and opportunities. The OECD (2014) emphasizes the importance of a place-based approach and investments that build local capacity, rather than merely providing subsidies. Separately, the OECD also highlights that coordination across sectors, across levels of government, and between public and private actors constitutes a governance challenge that must be addressed in the modernization of the rural economy. With this logic, the transition from a waste management approach that treats waste as a byproduct to one that positions it

as a valuable resource becomes relevant for strengthening local innovation and community-based circular economies.

In the context of the transition toward a more circular economy, waste valorization becomes a key mechanism. Valorization can be understood as the process of transforming waste into materials or products with economic value, so that waste no longer ends at the disposal stage. Circular economy literature emphasizes that post-consumer materials need to be recovered, reprocessed, and reintroduced into the utilization loop to become valuable resources, while simultaneously minimizing the generation of new waste and pressure on primary resources (Mandpe et al., 2023; Pambudi et al., 2025). Thus, the success of valorization must be viewed as the result of the integration of technical sorting/recovery processes, institutional support, and economic mechanisms that enable the reuse of material value.

One micro-institution frequently used to bridge the concept of the circular economy to the community level is the waste bank. Waste banks are positioned as community mechanisms that organize sorting and collection until materials can be recovered or reused (Pambudi et al., 2025; Rachman, Komalasari, & Hutagalung, 2021). In studies of material flow networks, waste banks can also form new nodes within recycling networks and divert waste flows from municipal solid waste systems to recycling networks; in certain contexts, this shift may create exclusionary effects for informal actors who previously accessed valuable material streams (van Leeuwen & Surya, 2024). Therefore, the implementation of waste banks must be analyzed contextually, rather than simply assuming it always produces uniform impacts.

The context of waste bank implementation indicates that community participation and institutional support are key determinants of the system's sustainability. Changes in behavior and increased participation after communities become waste bank customers suggest that citizen engagement can strengthen community-based waste management practices (Abdussalam & Gunawan, 2023). From a governance perspective, external support has been shown to be linked to community involvement as waste bank customers; mechanisms highlighted in the literature include invitations/encouragement, encouragement from managers, and instructions from the village (Annashr et al., 2024). Thus, participation and institutional support must be understood as two complementary elements, not as standalone factors.

The implementation of relevant waste bank mechanisms can be observed in the case of the Ciamis Central Waste Bank. Martiandi et al. (2025) reported that the waste bank system in Ciamis Regency contributed to a 15% reduction in waste sent to landfills, an increase in the recycling rate from 25% to 60%, and the production of approximately 150 kg of organic fertilizer per month. These achievements indicate the presence of a valorization process; however, the relationship between community participation, institutional support, valorization, and economic incentives still requires more structured testing.

LITERATURE REVIEW AND FORMULATION OF HYPOTHESES

Community Participation

Community participation in waste banks can be understood as the active involvement of households in a series of community-based waste management practices, ranging from source separation, regular deposits, recording of deposits, to participation in outreach or program-strengthening activities. Within the circular economy framework, this participation serves as a driver of material flows: waste, which was previously viewed as an environmental burden, is transformed into valuable inputs; however, this transformation process is only possible if households genuinely function as suppliers of materials and users of the waste bank ecosystem (Antriandarti et al., 2025; Abdussalam & Gunawan, 2023).

Empirically, the literature indicates that the success of waste banks is highly dependent on the intensity of participation. Previous studies highlight that participation is linked to the community's willingness to engage in waste management and has the potential to generate economic benefits. Rachman et al. (2021) demonstrate that participation through waste banks has the potential to improve village economic conditions, while Antriandarti et al. (2025) found that community participation in waste bank operations,

including collection activities, has a positive tendency toward sustainability and economic benefits. Thus, community participation need not be positioned as an overly far-reaching causal claim, but rather as a social-operational prerequisite that enables household materials to enter the recovery system and potentially generate economic benefits.

On the other hand, for such participation to translate into active and sustainable deposit behavior, a psychosocial foundation and knowledge literacy regarding waste bank practices are required. Empirical evidence using the Theory of Planned Behavior indicates that attitudes, subjective norms, and knowledge regarding methods/types and consequences simultaneously influence the intention to engage as an active customer at a waste bank; this intention was subsequently found to significantly influence active behavior at the waste bank (Astuti et al., 2021). These findings confirm that participation is not an automatic process, but rather the result of a combination of individual internal factors and the readiness of knowledge to carry out sorting and deposit practices.

Institutional Support

Institutional support in waste banks refers to the facilitation and capacity provided by local institutions to ensure the waste bank process runs effectively. Such support can take the form of training, provision of operational infrastructure, coordination with downstream parties, strengthening of record-keeping, and partnerships with village governments, community organizations, or CSR schemes. In this context, institutional support must be understood as a governance aspect encompassing collaboration among actors, clarity of responsibilities, and the availability of adequate resources to support program sustainability (Latanna et al., 2023; Budiarto et al., 2025).

The conceptual rationale for positioning institutional support as an enabling factor is that institutions function as enabling conditions, not merely as supporting actors. From the perspective of institutional theory and the circular economy, consumption policies, regulations, and information can influence demand for circular economy products as well as the development of circular economy business models (Arranz & Arroyabe, 2023). Thus, as public participation increases, responsive institutional support can strengthen the system's capacity to manage materials, maintain operational procedures, and distribute benefits more effectively.

Waste Valorization

Waste valorization is the process of transforming waste into products or materials with economic value, thereby recovering what was previously treated as waste as a resource. In the circular economy literature, valorization is understood not only as a technical act of material recovery but also as an institutional and governance process involving regulatory roles in transforming waste into resources of economic and social value (Wildeboer & Savini, 2022). In a waste bank, valorization can occur through the trading of recycled materials, the composting of organic waste, and the utilization of inorganic waste into valuable products. This framework positions valorization as an endogenous variable representing the system's success in carrying out resource recovery.

In the case of the Ciamis Waste Bank, empirical evidence demonstrates relevant operational outcomes that indicate the valorization process. Martiandi et al. (2025) report that the waste bank system in Ciamis Regency contributed to a 15% reduction in waste sent to landfills, an increase in the recycling rate from 25% to 60%, and the production of approximately 150 kg of organic fertilizer per month. In this study, these findings serve as the contextual basis that valorization does not stop at sorting activities but leads to material-based outputs that can hold economic value.

Conceptually, waste bank valorization can also be understood as the process of trading recovered materials. Van Leeuwen and Surya (2024) explain that waste banks receive waste from customers and transform it into economically valuable materials through trading mechanisms. This reference is used to

affirm the economic function of waste banks, while the analysis in this study is aimed at determining whether this function is related to participation, institutional support, and economic incentives.

In the context of community-based waste banks, the success of valorization is influenced by the system's ability to maintain the value of recovered materials. The practices of reduce, reuse, and recycle can be positioned as the operational foundation of material recovery, while the circular economy approach to solid waste management emphasizes the processing of post-consumer materials into valuable resources, closing the loop, and reducing pressure on primary resources (Mandpe et al., 2023). Therefore, valorization must be understood as a process that combines sorting, recovery, reuse, and institutional management to enable the productive reuse of secondary materials.

Economic Incentives

In this study, economic incentives are understood as the financial benefits received by waste bank participants. These incentives may include redeemable waste credits, income from the sale of recycled materials, prizes or awards, and other forms of compensation that encourage participants to view the waste bank as a valuable activity. The inclusion of economic incentives as an endogenous variable (outcome) aligns with the logic of the circular economy: incentives emerge as a consequence of successful valorization and consistent participation.

In a study assessing the economic contribution of rural waste banks, waste banks are described as community-based strategies that encourage households to sort and trade recyclable waste, thereby generating economic value while reducing environmental burdens (Antriyandarti et al., 2025). The study's results indicate that the routine operational activities of waste banks are significantly associated with economic benefits at the 1% significance level (Sig. 0.001), while outreach and training programs are also significantly associated with economic benefits (Sig. 0.007). In terms of perceived benefits, 70.3% of respondents reported an improvement in the village's economic conditions, and 66.1% of respondents observed an increase in BUMDes revenue from the waste bank initiative (Antriyandarti et al., 2025). This pattern indicates that economic incentives can be understood as outcomes that follow the successful operationalization of waste bank schemes and consistent participation therein.

More specifically, the economic contribution to households through the waste bank in Surakarta is estimated at Rp 26,461 per month; however, the study also emphasizes the need for improvements in human capacity, infrastructure/facilities, time management, economic incentives, and the program itself to optimize the contribution to household income (Antriyandarti et al., 2024). Additionally, research on the effectiveness of waste banks in Bogor indicates that economic and environmental benefits are recognized by the community, but financial sustainability is vulnerable to fluctuations in the recycled materials market. Therefore, income diversification is necessary to reduce financial uncertainty, while strengthening participatory governance must be prioritized as a prerequisite for long-term success, not merely as an immediate solution to market price fluctuations (Al Zahra & Shohibuddin, 2025).

Hypothesis Development

Based on the synthesis of the literature review outlined in the previous subsection, the development of hypotheses in this study is aimed at explaining the direct relationships and moderating effects among constructs within the research model. This section does not reiterate the detailed sources but rather formulates the logical consequences of the literature review regarding community participation, institutional support, waste valorization, and economic incentives. Thus, the hypothesis is built on the line of reasoning that rural waste banks can generate economic value if community involvement, institutional capacity, material recovery processes, and benefit distribution mechanisms operate in a mutually supportive manner.

Community Participation and Economic Incentives

Community participation is an operational prerequisite for the emergence of economic benefits in waste banks. Economic incentives can only be generated if residents actively engage in sorting, depositing, and participating in the program on a sustainable basis. The higher the level of community participation, the greater the likelihood that materials will enter the waste bank system, be recorded as deposits, and be converted into savings or additional income. Empirical findings indicate that the operational activities of community-participation-based waste banks contribute to increased economic benefits at the household level (Antriyandarti et al., 2025; Rachman et al., 2021). Thus, participation serves not only as a social indicator but also as an initial mechanism enabling participants to receive financial benefits from waste management activities.

H1: Community Participation has a positive effect on Economic Incentives

Community Participation and Waste Valorization

In the waste bank scheme, valorization cannot occur without a sufficient, sorted, and sustainable supply of materials from the community. Resident participation determines the quality and quantity of materials entering the system, thereby forming the foundation for the waste recovery and reuse process. Previous studies have shown that community involvement plays a crucial role in enhancing the effectiveness of community-based waste management (Abdussalam & Gunawan, 2023; Antriyandarti et al., 2025). This indicates that the higher the level of community participation, the greater the likelihood of waste valorization within the waste bank system.

H2: Community Participation Has a Positive Effect on Waste Valorization

Waste Valorization and Economic Incentives

Waste valorization represents the success of waste banks in transforming waste into materials or products with both use value and exchange value. From a circular economy perspective, successfully recovered materials can serve as a source of economic benefits through various forms of utilization (Mandpe et al., 2023; van Leeuwen & Surya, 2024). However, the literature also indicates that the economic value of the valorization process does not always directly translate into financial benefits for the community without adequate market support and distribution systems (Al Zahra & Shohibuddin, 2025). Therefore, waste valorization is expected to have a positive impact on economic incentives.

H3: Waste Valorization has a positive effect on Economic Incentives

Institutional Support and Waste Valorization

Waste valorization requires a more systematic process than merely collecting materials. Sorted waste must be recorded, classified, stored, processed, and linked to downstream utilization chains to be transformed into valuable materials or products. In this process, institutional support acts as an enabling condition by providing operational guidelines, facilities, coordination, guidance, and networks that connect community activities with resource recovery processes. Without adequate institutional support, collected materials risk remaining as routine deposits without value-added processing. Conversely, strong institutional support can enhance the capacity of waste banks to transform secondary materials into valuable outputs. Previous research indicates that the presence of institutional support can improve the effectiveness of waste management and strengthen the system's capacity to generate added value (Ismiraj et al., 2023; Budiarto et al., 2025). Thus, institutional support is expected to have a positive impact on waste valorization.

H4: Institutional Support has a positive effect on Waste Valorization

Institutional Support and Economic Incentives

Institutional support has the potential to be a key prerequisite for the formation of economic incentives within the waste bank system. In a rural context, economic incentives are not only determined by the amount of waste deposited but also by the institutional system's ability to provide training, operational resources, deposit tracking, coordination with downstream managers, and market access. Such support can improve process regularity, ensure service continuity, and create opportunities for the value of materials collected by the community to be converted into economic benefits. Theoretically, a strong institutional framework can enhance system efficiency and open opportunities for the creation of economic benefits (Arranz & Arroyabe, 2023). However, several studies also indicate that the role of institutional support is more dominant in operational aspects than in the direct distribution of economic benefits (Budiarto et al., 2025). Therefore, institutional support is expected to have a positive impact on economic incentives.

H5: Institutional Support has a positive effect on Economic Incentives

Institutional Support as a Moderator of the Relationship Between Community Participation and Waste Valorization

Community participation provides the primary input for waste banks, namely sorted household waste that is routinely deposited. However, high participation does not necessarily automatically result in valorization if the collected materials are not managed through an adequate system. In the absence of strong institutional support, participation may stop at the collection stage, while subsequent processes such as further sorting, processing, value recording, and distribution to the market do not develop optimally. Conversely, when institutional support is strong, community participation is more likely to translate into the recovery of valuable materials because coordination mechanisms, facilities, guidance, and access to downstream networks are available. Thus, institutional support is positioned as a factor that can alter the strength of community participation's influence on waste valorization. This is supported by research showing that external support plays a role in increasing community engagement in waste bank programs (Annashr et al., 2024). Consequently, institutional support is expected to strengthen the relationship between community participation and waste valorization.

H6: Institutional Support Moderates the Effect of Community Participation on Waste Valorization

Institutional Support as a Moderator of the Relationship Between Waste Valorization and Economic Incentives

Waste valorization aims to generate economic value from materials previously considered waste. However, technical success in recovering, processing, or trading materials does not always directly correlate with the economic benefits received by participants. The economic value received by the community can be influenced by material quality, deposit volume, market prices, buyer access, benefit-sharing schemes, and the operator's ability to maintain relationships with downstream parties. In this context, institutional frameworks can either strengthen or even limit the conversion of value into economic benefits, depending on the governance structure implemented (Mandpe et al., 2023; Al Zahra & Shohibuddin, 2025). Therefore, institutional support is expected to act as a moderator in the relationship between waste valorization and economic incentives.

H7: Institutional Support moderates the effect of Waste Valorization on Economic Incentives

RESEARCH METHODS

This study employs an explanatory quantitative approach using a cross-sectional survey design. This approach was chosen because the study aims to empirically test the relationships among the constructs—

community participation, institutional support, waste valorization, and economic incentives—as formulated in the study's structural model.

Research Location and Subject

This study was conducted in Ciamis Regency, West Java, Indonesia, with the research focus on the Ciamis Waste Bank (Ciamis Central Waste Bank / BSI Ciamis). This location was chosen because it represents a rural waste bank initiative that holds organizational and operational relevance to the circular economy transition. Recent evidence identifies BSI Ciamis as a large-scale waste bank handling over 10 tons of waste per month and serving as a strategic coordinator within the Ciamis Regency waste bank system. Therefore, this location is deemed suitable for examining how waste banks operate as community-based circular economy mechanisms that support rural entrepreneurship through waste valorization, resource efficiency, and local eco-industrial linkages.

Population and Sample

The population of this study consists of members or participating households of the Ciamis Waste Bank in Ciamis Regency. The sample was drawn from active participants directly involved in waste bank activities, such as waste sorting and deposit. The sampling technique employed purposive sampling with the following criteria: (1) active members of the waste bank; (2) having participated for at least 1 year; and (3) willing to complete the questionnaire. In this study, the margin of error was set at 10% of the total population, resulting in a minimum sample size of 80 individuals.

Data Collection and Data Analysis Techniques

Research data were collected through a structured questionnaire distributed to respondents who met the sampling criteria. The research instrument was designed based on indicators for each variable—community participation, institutional support, waste valorization, and economic incentives—adapted from relevant literature.

Operationalization of Variables

The research instrument was developed based on four main constructs: Community Participation, Institutional Support, Economic Incentives, and Waste Valorization. The Community Participation construct was measured through indicators of household waste sorting, waste drop-off, participation in community-based waste bank activities, and involvement in environmental waste management activities. These indicators were selected because community participation is a critical prerequisite for the success of community-based waste banks, particularly in channeling materials from households toward recovery processes and value creation (Rachman et al., 2021; Antriandarti et al., 2025; Pambudi et al., 2025).

The Institutional Support construct is measured through indicators of manager guidance, outreach or information, support from village/subdistrict governments, support for facilities and infrastructure, and support from non-governmental organizations. These indicators reflect the institutional capacity required for waste banks to operate consistently, as the operational sustainability of waste banks requires managerial support, government support, infrastructure, and the involvement of various stakeholders (Ismiraj et al., 2023; Annashr et al., 2024; Budiarto et al., 2025).

The Economic Incentives construct is measured through indicators of the economic benefits of waste deposits, the attractiveness of the savings or reward system, rewards for members, and the ease of payment through a cashback system. These indicators were developed because waste banks not only function as a waste reduction mechanism but also as a means of generating economic benefits for the community through the sale of recycled materials and income distribution schemes or incentives for participants (Antriandarti et al., 2025; Ismiraj et al., 2023).

The Waste Valorization construct is measured through indicators of waste's ability to become marketable material, waste reuse, further sorting to generate added value, and the existence of higher-value recycled products. These indicators align with the circular economy concept, which positions waste as a

recoverable resource through sorting, reprocessing, and the creation of products or materials with economic value (Mandpe et al., 2023; van Leeuwen & Surya, 2024; Martiandi et al., 2025).

Table 1. Operationalization of Variables

Construct	Code	Indicator	Questionnaire Statement	Source of Adaptation
Community Participation	PM1	Household Waste Sorting	I routinely sort household waste before taking it to the waste bank.	Rachman et al. (2021); Antriyandarti et al. (2025); Pambudi et al. (2025)
Community Participation	PM2	Waste Drop-off	I actively drop off waste at the Ciamis Waste Bank or a related facility.	Antriyandarti et al. (2025); Rachman et al. (2021)
Community Participation	PM3	Participation in waste bank activities	I participate in activities organized by the waste bank.	Abdussalam & Gunawan (2023); Astuti et al. (2021)
Community Participation	PM4	Involvement in community waste management	I participate in joint activities related to waste management in my community.	Rachman et al. (2021); Pambudi et al. (2025)
Institutional Support	DK1	Support for waste bank managers	The Ciamis Waste Bank management provides good support to members/customers.	Ismiraj et al. (2023); Annashr et al. (2024)
Institutional Support	DK2	Outreach or information	I received sufficient information or outreach regarding waste management from the waste bank.	Annashr et al. (2024); Astuti et al. (2021)
Institutional Support	DK3	Support from the village/subdistrict government	There is support from the village/subdistrict government for waste bank activities.	Budiyarto et al. (2025); Latanna et al. (2023)
Institutional Support	DK4	Support in the form of facilities, equipment, and infrastructure	Support in the form of facilities, resources, and infrastructure is provided by ministries, provincial governments, and local governments to support the operational activities of waste banks.	Budiyarto et al. (2025); Ismiraj et al. (2023)
Institutional Support	DK5	Support from non-governmental organizations	There is support from non-governmental organizations that assist in the smooth management of waste at waste banks.	Ismiraj et al. (2023); Latanna et al. (2023)
Economic Incentives	IE1	Economic benefits of depositing waste	I receive economic benefits from depositing waste at the waste bank.	Antriyandarti et al. (2025); Antriyandarti et al. (2024)
Economic Incentives	IE2	Attractiveness of the savings or reward system	The savings or reward system at the waste bank is quite attractive to me.	Antriyandarti et al. (2025); Al Zahra & Shohibuddin (2025)
Economic Incentives	IE3	Rewards for members	I receive a reward if I meet the criteria to be the best member.	Antriyandarti et al. (2025); Ismiraj et al. (2023)
Economic Incentives	IE4	Convenient payments via cashback	The cashback system makes it easier for me to pay bills such as electricity, water, and property tax.	Antriyandarti et al. (2025); Al Zahra & Shohibuddin (2025)
Waste Valorization	VS1	Waste becomes a marketable material	Waste managed by waste banks can be converted into marketable materials.	Fatmawati et al. (2024); van Leeuwen & Surya (2024)

Construct	Code	Indicator	Questionnaire Statement	Source of Adaptation
Waste Valorization	VS2	Waste reuse	Waste deposited at waste banks is not simply discarded, but is actually reused.	Fatmawati et al. (2024); Pambudi et al. (2025)
Waste Valorization	VS3	Advanced sorting for value enhancement	There is a further waste sorting process to process it into higher-value products.	Fatmawati et al. (2024); Mandpe et al. (2023)
Waste Valorization	VS4	Higher-value recycled products	There are various types of higher-value recycled products produced by the Waste Bank.	Fatmawati et al. (2024); Martiandi et al. (2025)

Source: Developed from the research questionnaire and literature cited in the manuscript.

Based on this operationalization, all indicators are positioned as reflective indicators because each item is a manifestation of the latent construct being measured. The moderating effect of Institutional Support does not require new indicators on the instrument but is formed through an interaction term in the PLS-SEM analysis.

Partial Least Squares Structural Equation Modeling (PLS-SEM)

Using SmartPLS 4, data analysis was conducted via Partial Least Squares Structural Equation Modeling (PLS-SEM). PLS-SEM was chosen because it does not strictly require the fulfillment of the assumption of multivariate normality, is reliable for small to medium sample sizes, and is suitable for predictive research with complex structural models (Hair et al., 2019; Ringle et al., 2015). Evaluation of the measurement model (external model) and the structural model (internal model) was conducted as two separate stages of analysis.

Convergent validity in the assessment of the outer model was examined through external loadings (≥ 0.70), Average Variance Extracted ($AVE \geq 0.50$), cross-loadings, and composite reliability, which was verified using Cronbach's Alpha ($\alpha \geq 0.70$). The internal model was analyzed based on the coefficient of determination (R^2), effect size (f^2), and path estimates. To test the hypotheses, the bootstrapping method with 5,000 resamples was applied to generate t-values and p-values for each structural path. Below the significance threshold of $\alpha = 10\%$ using a two-tailed approach, the hypothesis was considered accepted when the t-statistic exceeded 1.645 (Hair et al., 2019). There is a potential for common method bias (CMB) since all constructs were measured using self-report questionnaires at the same time. To minimize CMB, the study implemented procedural mitigations, including: maintaining respondent anonymity, formulating clear and context-relevant item wording specific to the waste bank context, and uniformly using a five-point Likert scale to ensure respondents provided consistent and easily understandable answers.

In addition to procedural mitigation, to assess the model's suitability regarding potential multicollinearity, the study examined the Variance Inflation Factor (VIF) for constructs and interaction terms. The model is considered free of serious multicollinearity issues if the VIF value is < 5 . If the authors report stricter additional criteria (e.g., < 3.3), such reporting is positioned as an alternative/confirmatory criterion to strengthen the consistency of interpretation.

RESULTS AND DISCUSSION

This study employs a conceptual framework illustrating the relationships among four main constructs: Community Participation (CP) as the exogenous variable; Institutional Support (IS) as both a predictor and a moderator; Waste Valorization (WV) as the endogenous variable that also serves as a predictor of Economic Incentives; and Economic Incentives (EI) as the final endogenous variable. Community Participation is measured through four reflective indicators (CP1–CP4), Institutional Support through five reflective indicators (IS1–IS5), Waste Valorization through four reflective indicators (WV1–WV4), and Economic Incentives through four reflective indicators (EI1–EI4). The following is the Factor Loading Model used in this study.

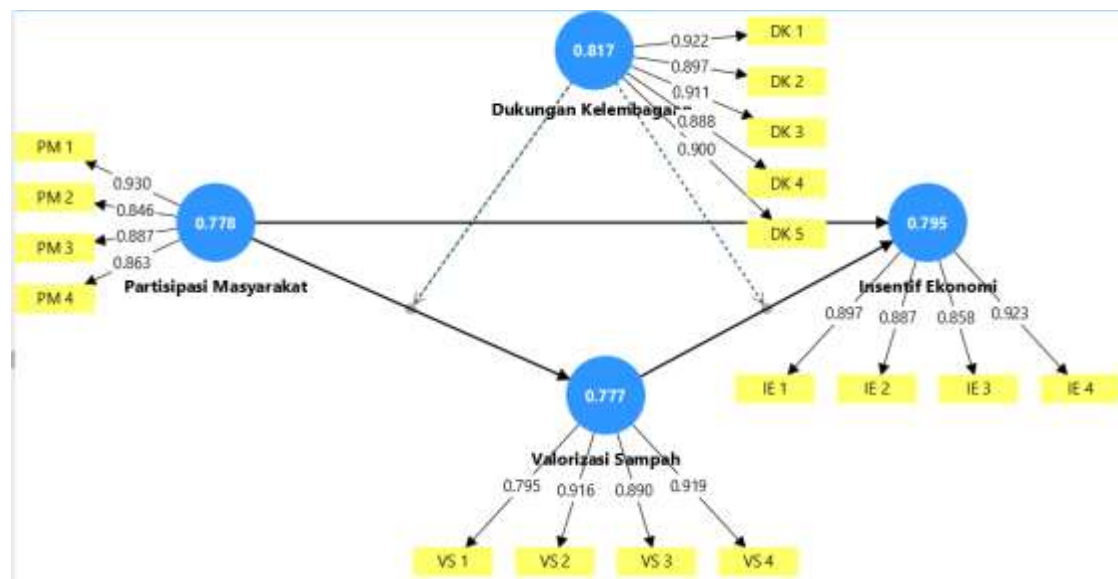


Figure 1. Factor Loading Model

This research model proposes several relationship pathways that were empirically tested. First, the direct relationship between Community Participation and Economic Incentives, reflecting the influence of community involvement in waste bank activities on the economic benefits obtained. Second, the relationship between Community Participation and Waste Valorization, illustrating the role of participation in driving the process of processing and utilizing waste to create value. Third, the relationship between Institutional Support and Waste Valorization, which highlights the importance of institutional roles in strengthening the waste valorization process. Fourth, the relationship between Waste Valorization and Economic Incentives, which examines whether the outcomes of waste processing can directly generate economic impacts.

Additionally, this model also examines the role of Institutional Support as a moderating variable—specifically in the relationship between Community Participation and Waste Valorization, as well as between Waste Valorization and Economic Incentives. With this structure, the study also allows for an assessment of whether the influence between variables becomes stronger or weaker in the presence of institutional support. Based on the results of data analysis using SmartPLS 4, all indicators in this study showed outer loading values above 0.70, indicating that all indicators met the criteria for convergent validity. The complete results of the outer loading and AVE values are presented in Table 2:

Table 2. Factor Loadings

Variable	Indicator	Outer Loading	AVE	Description
Community Participation	PM1	0.930	0.778	Valid
Community Participation	PM2	0.846	0.778	Valid
Community Participation	PM3	0.887	0.778	Valid
Community Participation	PM4	0.863	0.778	Valid
Institutional Support	DK1	0.922	0.817	Valid
Institutional Support	DK2	0.897	0.817	Valid
Institutional Support	DK3	0.911	0.817	Valid

Variable	Indicator	Outer Loading	AVE	Description
Institutional Support	DK4	0.888	0.817	Valid
Institutional Support	DK5	0.900	0.817	Valid
Waste Valorization	VS1	0.795	0.777	Valid
Waste Valorization	VS2	0.916	0.777	Valid
Waste Valorization	VS3	0.890	0.777	Valid
Waste Valorization	VS4	0.919	0.777	Valid
Economic Incentives	IE1	0.897	0.795	Valid
Economic Incentives	IE2	0.887	0.795	Valid
Economic Incentives	IE3	0.858	0.795	Valid
Economic Incentives	IE4	0.923	0.795	Valid

From the table above, it can be seen that the outer loading values of all indicators meet the criterion of ≥ 0.70 , and the Average Variance Extracted (AVE) values for each construct meet the criterion of ≥ 0.50 . Thus, all indicators are declared convergent valid; no indicators need to be removed from the model, and all indicators are suitable for application in the next testing stage. Discriminant validity was evaluated based on cross-loadings. The cross-loading results are presented in Table 3 below:

Table 3. Cross-Loading

Indicator	Institutional Support	Economic Incentives	Community Participation	Waste Valorization	DKxPM	DKxVS
PM1	0.576	0.761	0.93	0.622	-0.42	-0.359
PM2	0.547	0.715	0.846	0.593	-0.386	-0.334
PM3	0.634	0.749	0.887	0.656	-0.417	-0.372
PM4	0.513	0.661	0.863	0.688	-0.321	-0.267
DK1	0.922	0.606	0.498	0.725	-0.521	-0.526
DK2	0.897	0.658	0.64	0.762	-0.446	-0.463
DK3	0.911	0.682	0.597	0.801	-0.425	-0.407
DK4	0.888	0.672	0.536	0.771	-0.442	-0.483
DK5	0.9	0.693	0.633	0.793	-0.452	-0.521
VS1	0.586	0.55	0.539	0.795	-0.159	-0.27
VS2	0.75	0.668	0.682	0.916	-0.292	-0.393
VS3	0.815	0.718	0.645	0.89	-0.354	-0.357
VS4	0.829	0.729	0.679	0.919	-0.385	-0.423

IE1	0.646	0.897	0.663	0.634	-0.539	-0.468
IE2	0.639	0.887	0.749	0.687	-0.491	-0.483
IE3	0.668	0.858	0.723	0.674	-0.444	-0.44
IE4	0.664	0.923	0.778	0.715	-0.487	-0.468
DKxPM	-0.505	-0.549	-0.439	-0.347	1	0.824
DKxVS	-0.53	-0.521	-0.378	-0.414	0.824	1

Based on the SmartPLS 4 output in Table 3, the loading values of each indicator on the original construct are greater than the cross-loading values on other constructs. Therefore, all indicators from all variables used in this study are deemed to meet discriminant validity. In addition to cross-loading, discriminant validity was also examined using the Fornell-Larcker Criterion. The Fornell-Larcker Criterion values in this study, based on the SmartPLS 4 output results, are presented in Table 4.

Table 4. Fornell-Larcker Criteria

Variable	Institutional Support	Economic Incentives	Community Participation	Waste Valorization
Institutional Support	0.904			
Economic Incentives	0.734	0.892		
Community Participation	0.644	0.819	0.882	
Waste Valorization	0.854	0.761	0.725	0.881

Based on the SmartPLS 4 output results in Table 4, the model has good discriminant validity because the root mean square error of approximation (RMSEA) values for each construct are greater than the correlations between those constructs and other constructs. Reliability test values were assessed using Cronbach's Alpha and Composite Reliability, with recommended values of ≥ 0.70 (Ghozali & Latan, 2015, p. 74). The reliability results for the constructs in this study, based on the SmartPLS 4 output, are presented in the following table:

Table 5. Cronbach's Alpha and Composite Reliability

Variable	Cronbach's Alpha	Composite Reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
Institutional Support	0.944	0.945	0.957	0.817
Economic Incentives	0.914	0.915	0.939	0.795
Community Participation	0.904	0.905	0.933	0.778
Waste Valorization	0.904	0.916	0.933	0.777

Based on the SmartPLS 4 output results in Table 5, all variables have reliability values that meet the ≥ 0.70 criterion. Thus, all latent constructs in this study are deemed reliable. Furthermore, after the measurement model is declared valid and reliable, the next step is to evaluate the structural model (inner model). This evaluation aims to assess the model's ability to explain the relationships among the variables under study. The test conducted was the coefficient of determination (R-square) test, which is used to measure the extent of the influence of independent variables on the dependent variable in the research model. The R-square values for this study, based on the SmartPLS 4 output, are presented in Table 6.

Table 6. R-square

Variable	R-squared	Adjusted R-square
Economic Incentives	0.767	0.755
Waste Valorization	0.801	0.793

Based on the results of the coefficient of determination (R-square) test, the Economic Incentives variable has an R^2 value of 0.767, indicating that 76.7% of the variance in Economic Incentives can be explained by the variables in the model, namely Community Participation, Institutional Support, Waste Valorization, and the moderating effect. Meanwhile, the Waste Valorization variable has an R^2 value of 0.801, meaning 80.1% of its variance can be explained by Community Participation, Institutional Support, and the moderating interaction. This value indicates that the model has strong explanatory power.

The structural model evaluation continued with an assessment of the effect size (f^2) to evaluate the influence of independent variables on the dependent variable, determining whether the influence was substantial. An f-square value of 0.02 is categorized as small, 0.15 as moderate, and 0.35 as large. The f-square values in this study, based on SmartPLS 4 output calculations, are presented in the following table.

Table 7. F-square

Independent Variables	Economic Incentives	Waste Valorization
Institutional Support	0.024	1.371
Waste Valorization	0.03	
Community Participation	0.557	0.313
Institutional Support x Community Participation		0.096
Institutional Support x Waste Valorization	0.084	

Based on the results of the effect size test (f^2), community participation has a large effect on economic incentives ($f^2 = 0.557$), while institutional support has a very large effect on waste valorization ($f^2 = 1.371$). Community participation also has a moderate effect on waste valorization ($f^2 = 0.313$). Meanwhile, the effects of institutional support and waste valorization on economic incentives are classified as small ($f^2 = 0.024$ and 0.030). The moderating effects of institutional support on the relationship between community participation and waste valorization, as well as on the relationship between waste valorization and economic incentives, are also in the small category.

These results indicate that community participation and institutional support are key factors in the model, particularly in driving economic incentives and waste valorization. Furthermore, the multicollinearity test using VIF values showed that all indicators were below the threshold, thus the model was deemed free of multicollinearity.

Model evaluation also showed an excellent level of fit, with a GoF value of 0.788 and an SRMR of 0.062, indicating that the model effectively explains the relationships among variables and possesses strong predictive power. Thus, the research model is deemed suitable for hypothesis testing. Hypothesis testing was

then conducted using a bootstrapping approach on the PLS-SEM model with 5,000 subsamples to obtain stable estimates. The results of the testing are presented in Table 8.

Table 8. Path Coefficients

Relationship	Original Sample (O)	Sample Mean (M)	Std Dev	T-Statistic	P-Value	Notes
Community Participation has a positive effect on Economic Incentives	0.527	0.526	0.085	6.199	0	Accepted
Community participation has a positive effect on waste valorization	0.331	0.327	0.076	4.379	0	Accepted
Waste Valorization has a positive effect on Economic Incentives	0.179	0.171	0.159	1.127	0.26	Rejected
Institutional support has a positive effect on waste valorization	0.722	0.73	0.072	10.026	0	Accepted
Institutional Support has a positive effect on Economic Incentives	0.154	0.16	0.155	0.993	0.321	Rejected
Institutional Support moderates the effect of Community Participation on Waste Valorization	0.141	0.144	0.049	2.868	0.004	Accepted
Institutional Support moderates the effect of Waste Valorization on Economic Incentives	-0.157	-0.158	0.073	2.153	0.031	Accepted

The research results indicate that community participation has a positive and significant effect on economic incentives, with a coefficient of 0.527. This confirms that active community involvement in waste bank activities is a key factor in generating economic benefits, consistent with findings that participation-based operational activities contribute to increased community income (Antriyandarti et al., 2025; Rachman et al., 2021). Additionally, community participation also influences waste valorization with a coefficient of 0.331, indicating that resident involvement contributes to the availability of sorted materials for further processing (Abdussalam & Gunawan, 2023).

On the other hand, waste valorization does not significantly affect economic incentives, with a coefficient of 0.179. This suggests that success in processing waste into valuable products does not automatically generate economic benefits for the community. This finding aligns with research confirming that the economic value of the recycling process is heavily influenced by market access, material prices, and benefit-sharing mechanisms (Al Zahra & Shohibuddin, 2025; Mandpe et al., 2023).

Institutional support was found to have a positive and significant effect on waste valorization with a coefficient of 0.722, indicating the crucial role of institutions in strengthening waste management and utilization processes. This is supported by research stating that institutional support can enhance the capacity of community-based waste management systems (Ismiraj et al., 2023; Budiarto et al., 2025). However, institutional support does not have a significant effect on economic incentives, with a coefficient of 0.154, so its role is more as a system enhancer than a direct source of economic benefits (Arranz & Arroyabe, 2023).

In terms of moderation, institutional support was found to amplify the influence of community participation on waste valorization with a coefficient of 0.141, indicating that participation is more effective when supported by good governance. This finding aligns with research showing that external support increases community engagement in waste bank programs (Annashr et al., 2024). Conversely, in the relationship between waste valorization and economic incentives, institutional support exhibits a negative direction with a coefficient of -0.157. This indicates that institutional strengthening has been more focused on operational aspects, so economic value has not yet been fully distributed to the community (Mandpe et al., 2023).

Overall, these results suggest that community participation and institutional support are key factors in the waste bank system; however, the generation of economic benefits still depends on the system's ability

to effectively link the waste valorization process with value distribution.

CONCLUSION

This study examines the structural relationship between Community Participation, Institutional Support, Waste Valorization, and Economic Incentives using the Partial Least Squares Structural Equation Modeling (PLS-SEM) approach. Based on the evaluation of the measurement model, all indicators for each construct met the validity and reliability criteria, as evidenced by factor loadings, Average Variance Extracted (AVE), and Cronbach's Alpha values that exceeded the established thresholds. Thus, the research instruments were deemed suitable for measuring the constructs under study.

The results of the structural model testing yielded several key findings. First, Community Participation was found to have a positive and significant influence on Economic Incentives and Waste Valorization, indicating that active community involvement is a key factor in creating economic value and driving the material recovery process. Second, Institutional Support has a positive and significant effect on Waste Valorization, but does not have a direct effect on Economic Incentives, indicating that the institutional role is more dominant in strengthening system capacity than in generating direct economic benefits. Third, Waste Valorization does not show a significant influence on Economic Incentives, suggesting that technical success in waste processing does not automatically translate into financial benefits for the community.

Furthermore, this study also found that Institutional Support acts as a significant moderating variable. Institutional support was found to strengthen the relationship between Community Participation and Waste Valorization, yet it exerts a negative effect on the relationship between Waste Valorization and Economic Incentives. These findings suggest that institutional strengthening has not yet fully succeeded in optimizing the conversion of the value generated from waste management into economic benefits directly felt by the community.

Overall, the results of this study provide empirical evidence that the success of a circular economy-based waste bank system is determined not only by technical aspects of waste management but also by the interaction between community participation, institutional support, and mechanisms for distributing economic value. The role of institutional support as a moderating factor underscores that institutions are not merely supporting elements but factors that can strengthen or even limit the effectiveness of relationships among variables within the system.

Based on these findings, several recommendations can be proposed. For waste bank managers, it is necessary to strengthen the economic benefit distribution system, including transparency in value sharing, innovation in incentive schemes, and the development of business models based on valorization outcomes. For the government and stakeholders, institutional support should be directed not only toward operational and administrative aspects but also toward strengthening market access, stabilizing material prices, and developing partnership networks with the recycling industry. For future researchers, the suboptimal value of the coefficient of determination indicates the need to develop a model by incorporating additional variables, such as market access, management quality, product innovation, and economic behavioral factors, as well as using a broader sample to enhance the generalizability of the research findings.

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