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# THE INKLUSIRKULAR MODEL FOR INCLUSIVE GREEN ECONOMIC WELL BEING

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**Abstract**

Indonesia faces an escalating waste management crisis, with national waste generation reaching 35–38 million tons annually and only 32–40% managed formally. The 2025 North Sumatra flash floods, which claimed over 1,100 lives, highlighted how uncontrolled waste accumulation in drainage systems exacerbates hydrometeorological disasters. In medium-sized cities like Tebing Tinggi, where daily waste generation reaches 120–150 tons and landfill capacity is overloaded, the informal sector—comprising waste pickers and small-scale recyclers—plays a critical yet marginalized role in material recovery. This study aims to design, develop, and validate the INKLUSIRKULAR Model, an inclusive circular economy framework that bridges formal and informal sectors to reduce unmanaged waste, mitigate flood risks, and enhance inclusive green economic well-being. Using a convergent parallel mixed-method design, the study combines Structural Equation Modeling-Partial Least Squares (SEM-PLS) with 250 respondents and Participatory Action Research (PAR) involving 20 key informants, including waste pickers, environmental agencies, MSMEs, and flood-affected communities. The SEM-PLS results reveal that economic feasibility ($\beta = 0.318$), environmental sustainability ($\beta = 0.306$), and social justice ($\beta = 0.294$) are the strongest direct predictors of inclusive green economic well-being, explaining 63.5% of variance ($R^2 = 0.635$). Partial mediation analysis confirms that community economic empowerment mediates the effects of environmental sustainability and social justice, while waste-based innovation mediates economic feasibility and environmental sustainability. However, economic feasibility does not significantly empower communities collectively, indicating that institutional interventions are required beyond individual income gains. The PAR findings demonstrate that circular waste banks with formal recognition for waste pickers serve as the key mechanism for integrating informal actors. The study contributes a validated multi-dimensional theoretical framework for inclusive green economic well-being and provides evidence-based policy recommendations for medium-sized cities in developing countries.

**Keywords:** circular economy, inclusive green economic well-being, informal sector, participatory action research, waste management.

## INTRODUCTION

Indonesia is facing an increasingly urgent waste management crisis. According to 2025 data from the Ministry of Environment and Forestry's National Waste Management Information System (SIPSN), national waste generation reaches 35–38 million tons annually, with household waste accounting for 60% and plastics contributing 19%. Unfortunately, only 32–40% of this waste is formally managed, while the remainder is illegally dumped, openly burned, or pollutes ecosystems (KLHK, 2025). This situation not only threatens environmental quality but also heightens the risk of hydrometeorological disasters caused by drainage systems and rivers becoming clogged with unmanaged waste.

The urgency of the issue became increasingly apparent following the flash floods that struck North Sumatra Province in November–December 2025. The disaster claimed between 1,135 and 1,157 lives and displaced hundreds of thousands of residents (BNPB, 2025). Post-disaster evaluations identified accumulated waste in drainage systems as a primary factor exacerbating inundation and damaging infrastructure. In Tebing Tinggi, a mid-sized city in North Sumatra, this situation is compounded by a daily waste generation of 120–150 tons, an overloaded final disposal site (TPA), and low rates of waste segregation at the source. The informal sector, comprising waste pickers and recycling artisans, plays a vital role in material recovery yet remains marginalized from the formal system, resulting in persistent economic inefficiencies and social vulnerability.

The transition to a circular economy is imperative, aligning with Indonesia's National Roadmap & Action Plan for Circular Economy 2025–2045, which emphasizes laying the groundwork and piloting the inclusion of the informal sector to foster green jobs (LCDI/Bappenas, 2025). The target under the National Medium-Term Development Plan (RPJMN) 2025–2029 is a "Clean Indonesia 2029," aiming for 100% waste management coverage, comprising a 30% reduction and 70% handling rate. However, circular economy literature remains dominated by studies of major cities focusing on technical aspects, while medium-sized cities with a strong informal sector presence receive less attention (Salmenperä et al., 2021; Samitthiwetcharong et al., 2024). Furthermore, the informal sector is often treated merely as an externality in policy, despite its significant contribution to recycling (Medina, 2008; Wilson et al., 2006).

Based on this background, the research problem addresses how to design, develop, and validate the INKLUSIRKULAR Model using a mixed-methods approach to bridge the integration gap between the formal and informal sectors within the circular economy of mid-sized cities. The goal is to reduce unmanaged waste generation, mitigate flood risks, and enhance inclusive green economic well-being for the community. This study aims to design an inclusive circular economy-based waste management model, examine structural relationships between variables using SEM-PLS, and conduct model co-design and validation through Participatory Action Research involving waste pickers, the Environmental Agency, MSMEs, and the community. The research contributes by developing a theoretical framework for inclusive green economic well-being as an empirically tested multi-dimensional construct, and by employing a methodological approach that combines rigorous quantitative analysis with meaningful community participation.

## LITERATURE REVIEW

The circular economy represents a fundamental paradigm shift from the linear "take-make-dispose" model toward a system that emphasizes resource retention through reuse, repair, and recycling (Geissdoerfer et al., 2017). In the context of waste management, this transition requires a shift in mindset from disposal to resource management. However, implementation in developing countries faces distinct challenges, such as limited infrastructure, weak regulatory enforcement, and the dominance of informal recovery systems operating outside formal frameworks (Chioatto & Sospiro, 2023; Kurniawan et al., 2021).

A recent systematic review of circular economy practices in Indonesian informal settlements reveals that waste management and recycling dominate the thematic landscape, reflecting the direct economic value of waste in low-income contexts (Frontiers in Sustainable Cities, 2026). Waste banks have emerged as community-based initiatives operating within polycentric governance structures. In Salatiga, waste banks demonstrate how decentralization can empower households while simultaneously alleviating environmental pressure. In Maros Regency, a major waste bank generates approximately IDR 50 million per month and employs 18 workers, thereby proving the economic viability of the community-based model (Frontiers in Sustainable Cities, 2026).

The informal sector comprising waste pickers, itinerant traders, and small-scale retailers forms the initial tier of the circular value chain in many developing nations. Medina (2008) and Wilson et al. (2006) have documented how informal recycling alleviates the strain on municipal collection systems and reduces the burden on landfills through market-driven material recovery. These workers possess granular knowledge regarding waste generation patterns, material quality assessment, and market dynamics insights that formal collection vehicles cannot replicate. Yet, they are frequently overlooked in formal policy frameworks and remain invisible within circular economy metrics (Velis et al., 2012). Resolute et al. (2026) demonstrate that Participatory Action Research can foster recognition within the circular economy at multiple levels, ranging from validating informal expertise and strengthening trust-based market relationships to exposing structural policy gaps. Their study in Banyuwangi reveals that simple co-design interventions can boost plastic collection rates while simultaneously improving the livelihoods of waste pickers.

The concept of inclusive green economy well-being transcends conventional Gross Domestic Product-centric measures by integrating environmental sustainability, social equity, and community empowerment as co-equal dimensions of well-being. The World Bank (2012) defines green growth as growth that is resource-efficient, clean (minimizing pollution), and resilient to natural hazards. The Bank explicitly warns that green growth is not inherently inclusive; therefore, policies must be deliberately designed to maximize benefits for poor and marginalized populations. Klasen (2010) identifies two critical dimensions for assessing inclusivity: the process dimension, which concerns the policy's ability to enable the poor to participate in economic opportunities, and the outcome dimension, which relates to the equitable distribution of benefits.

When applied to waste management, this framework necessitates an analysis of whether the circular economy transition creates accessible green jobs and whether waste pickers receive fair income and social protection. The sustainable livelihoods approach further emphasizes that human well-being encompasses not only income but also health, environmental quality, dignity, and social cohesion (Scoones, 1998). Gender is a highly relevant dimension; women often dominate sorting and processing activities, yet their economic contributions remain undervalued and unprotected.

This research offers significant novelty compared to previous studies. Many studies have examined circular economy-based waste management in major cities, focusing on technical aspects and environmental impacts (Salmenperä et al., 2021; Samitthiwetcharong et al., 2024). While some studies have highlighted the importance of public awareness, active participation in waste sorting and recycling remains limited (Tomić & Schneider, 2020). The informal sector is frequently overlooked in formal policies, despite playing a major role in recycling (Medina, 2008). Renewable energy-based waste processing technologies have been implemented in some regions, but applications remain constrained by technical aspects and local capacity (Yaotian et al., 2025). Markets for circular products are emerging in several countries focusing on the use of recycled materials in industrial goods yet local-scale implementation remains limited.

The novelty of this research lies in the development of an inclusive circular economy model specifically designed for medium-sized cities with a significant informal sector presence; it integrates social and community economic elements to foster inclusive green economic well-being. The model integrates the formal and informal sectors through mechanisms such as circular waste banks, appropriate technology, and participatory education coupled with economic incentives. Furthermore, this study operationalizes inclusive green economic well-being as a multidimensional construct empirically measured using SEM-PLS encompassing the dimensions of environmental sustainability, economic viability, social equity, community empowerment, and waste-based innovation.

## METHOD

This study is fundamental research employing a mixed-method Research & Development (R&D) approach that combines quantitative and qualitative methods. The quantitative component utilizes Structural Equation Modeling-Partial Least Squares (SEM-PLS) to examine structural relationships between latent variables, while the qualitative component employs Participatory Action Research (PAR) for the co-design and validation of the model with the community. The integration of these two approaches follows a convergent parallel design, wherein quantitative and qualitative data are collected simultaneously but analyzed separately before being combined during the interpretation and model validation phase (Creswell & Plano Clark, 2017). The research was conducted over a four-month period in Tebing Tinggi City, North Sumatra, targeting a Technology Readiness Level (TRL) of 3 specifically, a field-tested model prototype.

The study population comprises residents of Tebing Tinggi City who are involved in or directly affected by waste management, including households in flood-prone areas, informal sector workers, waste-processing MSMEs, and relevant stakeholders. For the quantitative component, purposive sampling was used based on the following inclusion criteria: a minimum age of 18 years, residency in Tebing Tinggi City for at least one year, active involvement in daily waste management activities, and willingness to participate. Based on the "ten times the number of indicators" rule (Hair et al., 2019) with 25 indicators across six constructs, a sample size of 250 respondents was established. The questionnaire consists of 30 statement items using a 1-to-5 Likert scale, covering six latent variables: Environmental Sustainability, Economic Feasibility, Social Equity, Community Economic Empowerment, Waste-Based Innovation, and Inclusive Green Economic Well-being.

The questionnaire instrument was developed through an extensive literature review, a review by an expert panel (comprising three environmental economists, two waste management specialists, and one statistician), and a pilot test with 30 respondents to assess clarity and reliability, targeting a minimum Cronbach's alpha of 0.70. SEM-PLS analysis was conducted using SmartPLS 3.0 software, following a two-stage procedure. The first stage involved assessing the measurement model, including tests for internal consistency reliability (composite reliability $\geq 0.70$), convergent validity (Average Variance Extracted $\geq 0.50$), and discriminant validity (using Fornell-Larcker criteria and an HTMT ratio $< 0.85$). The second stage involved assessing the structural model, including tests for collinearity (Variance Inflation Factor $< 5.0$), path coefficient significance (via bootstrapping with 5,000 subsamples), effect size (based on Cohen's criteria), predictive relevance ($Q^2 > 0$), and the coefficient of determination ($R^2 \geq 0.50$).

For the qualitative component, purposive sampling was used to select key informants possessing in-depth knowledge or firsthand experience, supplemented by snowball sampling to reach additional informants who were difficult to access through formal channels. The total qualitative sample consisted of approximately 20 informants,

including waste pickers, waste bank managers, MSME operators, Environmental Agency staff, community leaders, and flood-affected residents. Data collection involved four Focus Group Discussion sessions organized by stakeholder group, semi-structured in-depth interviews (lasting 60 to 90 minutes), structured field observations of waste flows and drainage conditions, and two multi-stakeholder workshops for model design and validation.

## RESULTS AND DISCUSSION

### RESULTS

This section presents the results of the measurement and structural model testing using SmartPLS 3.0, followed by a discussion linking the quantitative findings with qualitative insights from Focus Group Discussions and in-depth interviews. The analysis follows the two-stage procedure of Hair et al. (2019), beginning with the assessment of instrument validity and reliability, and proceeding to structural hypothesis testing and mediation analysis.

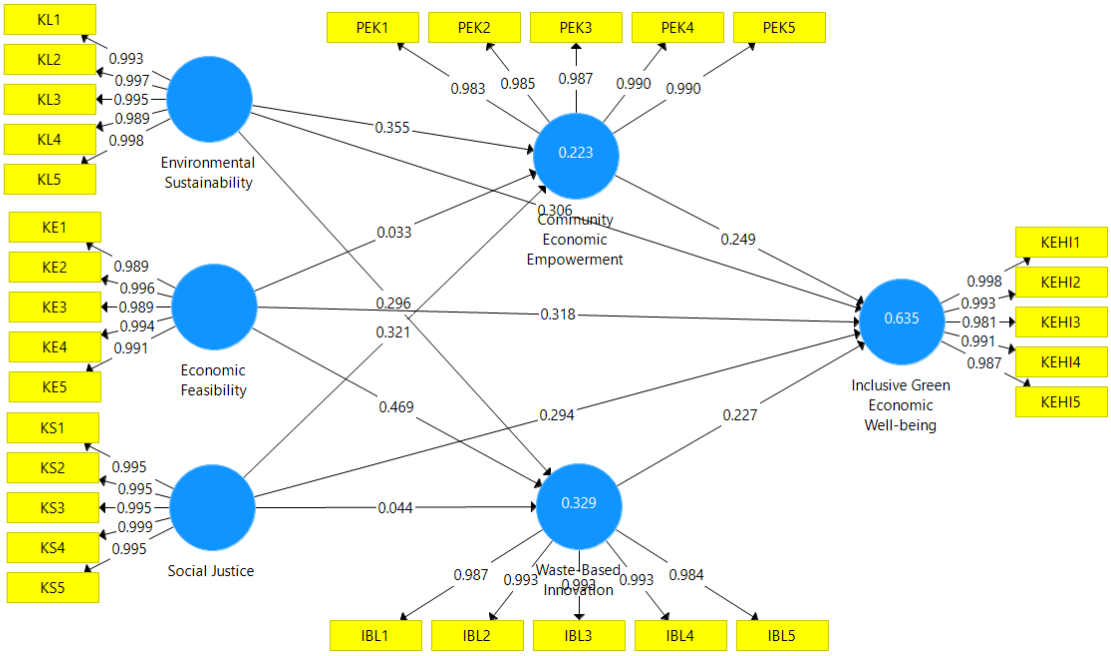


**Figure 1. Outer Model Results**

The results in Figure 1 show that all outer loadings exceed 0.70, with most approaching or surpassing 0.98. These values exceed the minimum threshold of 0.70 recommended by Hair et al. (2019); thus, it can be concluded that all indicators demonstrate excellent convergent validity. The indicators with the highest loadings are KS4 (Social Justice) at 0.999 and KEHI1 (Inclusive Green Economic Well-being) at 0.998, indicating that these indicators most strongly represent their respective constructs. All constructs also exhibit very high composite reliability and Cronbach's alpha values, indicating excellent internal consistency of the instrument.

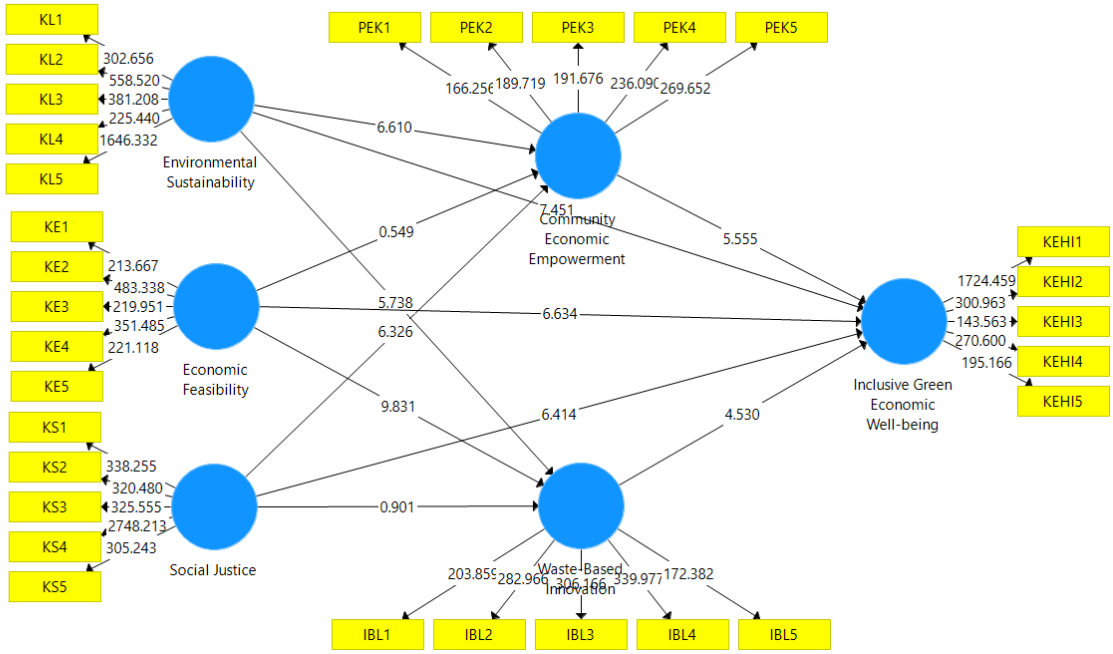


**Figure 2. Inner Model Results**

The results in Figure 2 show that nine of the eleven direct effect hypotheses were significantly supported at the 5 percent significance level (p-value < 0.05), while two hypotheses (H8 and H11) were rejected. The coefficients of determination ($R^2$) for the endogenous variables indicate that Community Economic Empowerment has an $R^2$ of 0.223, Waste-Based Innovation has an $R^2$ of 0.329, and Inclusive Green Economic Well-being has an $R^2$ of 0.635 (adjusted $R^2$ = 0.628). The $R^2$ value for Inclusive Green Economic Well-being falls into the moderate-to-substantial category (Hair et al., 2019), indicating that the model possesses strong explanatory power, with five predictor variables accounting for 63.5 percent of the variance in inclusive green economic well-being.

Among the five key predictor variables directly influencing Inclusive Green Economic Well-being, Economic Feasibility demonstrates the strongest direct effect, with a path coefficient (β) of 0.318, significant at p = 0.000 (H2). This finding confirms that the financial viability of waste-based activities serves as a primary foundation for perceptions of well-being in low-income contexts. Respondents who earn a stable income from waste management, have access to credit, and perceive material prices as fair tend to report higher levels of inclusive green economic well-being. These results align with the findings of Schroeder et al. (2020), who emphasize that the circular economy must generate tangible economic value for communities to ensure a sustainable transition.

Environmental Sustainability demonstrates a significant direct influence (β = 0.306, p = 0.000) on Inclusive Green Economic Well-being (H1). Practices involving waste sorting, composting, and the reduction of waste in rivers and drainage systems contribute positively to the community's perception of well-being. These findings underscore that the environmental benefits of the circular economy are not merely external; they also translate into an improved subjective quality of life. Narratives from Focus Group Discussions reinforce this, as residents affected by the 2025 floods consistently noted that the cleaner environment resulting from community-led waste sorting reduced their anxiety regarding recurring disasters.

Social Justice exerts a significant direct influence (β = 0.294, p = 0.000) on Inclusive Green Economic Well-being (H3). The equitable distribution of benefits, gender equality in waste bank leadership, and social recognition for waste management workers serve as crucial determinants of well-being. These findings confirm the World Bank's (2012) argument that a green transition is not automatically inclusive; social justice must be explicitly designed into the process. In-depth interviews with female waste pickers revealed that formal recognition and social protection enhanced their sense of dignity, which in turn motivated more active participation in circular economy activities.
Community Economic Empowerment shows a significant positive influence (β = 0.249, p = 0.000) on Inclusive Green Economic Well-being (H4). The community's capacity to make independent decisions, negotiate collective prices, and secure formal recognition from local government contributes to enhanced well-being. These findings support the perspective of Resolute et al. (2026) that community economic empowerment is a key mechanism for ensuring that the benefits of the circular economy are not concentrated within specific segments but are instead distributed equitably.

Waste-Based Innovation has a significant direct influence (β = 0.227; p = 0.000) on Inclusive Green Economic Well-being (H5). The adoption of composting technology, the production of Refuse-Derived Fuel (RDF), and the development of recycled products contribute positively to well-being. Although the coefficient value is relatively smaller compared to other exogenous variables, the role of innovation remains fundamental, as it serves as a mechanism for transforming waste into resources with economic value. These findings align with Yaotian et al. (2025), who emphasize that appropriate technological innovation is a crucial pillar in the circular economy transition within developing countries.

In addition to its influence on Inclusive Green Economic Well-being, the exogenous variable also demonstrates a significant impact on both mediator variables. Environmental Sustainability exerts a significant positive influence on Community Economic Empowerment (β = 0.355; p = 0.000; H6) and Waste-Based Innovation (β = 0.296; p = 0.000; H7). These findings indicate that sound environmental sustainability practices strengthen the community's collective capacity and foster the adoption of technological innovations. In Tebing Tinggi, communities accustomed to household-level waste sorting exhibit a higher degree of organization in forming waste management groups, which in turn facilitates the introduction of simple composting technologies.

Economic Feasibility has a significant positive effect on Waste-Based Innovation (β = 0.469; p = 0.000; H9), but does not have a significant effect on Community Economic Empowerment (β = 0.033; p = 0.583; H8). An interesting finding from H8 is that although economic viability directly improves well-being, it does not automatically strengthen community empowerment. In-depth interviews revealed that scavengers in Tebing Tinggi generally work individually and unorganized, so that increases in personal income do not necessarily translate into collective capacity. This underscores that community empowerment requires deliberate institutional intervention, not simply a side effect of increased income.

Social Justice has a significant positive effect on Community Economic Empowerment (β = 0.321; p = 0.000; H10), but does not have a significant effect on Waste-Based Innovation (β = 0.044; p = 0.368; H11). These findings indicate that social justice operates through mechanisms of community empowerment, not technological innovation. When people perceive a fair distribution of benefits and equal social recognition, they tend to be more motivated to organize and take an active role in resource governance. However, social justice does not directly encourage the adoption of new technologies, which are more influenced by economic feasibility factors and environmental condition.

Subsequently, a mediation analysis was conducted to examine whether Community Economic Empowerment and Waste-Based Innovation mediate the relationship between the exogenous variables (Environmental Sustainability, Economic Feasibility, Social Justice) and Inclusive Green Economic Well-being. The mediation testing employed a bootstrapping procedure with 5,000 subsamples. Table 1 presents the results of the indirect effect tests for all hypothesized mediation paths.

**Table 1. Mediation Test Results**

| | Original Sample (O) | T Statistics (\|O/STDEV\|) | P Values |
|---|---|---|---|
| **Economic Feasibility -> Community Economic Empowerment -> Inclusive Green Economic Well-being** | 0,008 | 0,529 | **0,597** |
| **Environmental Sustainability -> Community Economic Empowerment -> Inclusive Green Economic Well-being** | 0,088 | 4,093 | **0,000** |
| **Social Justice -> Community Economic Empowerment -> Inclusive Green Economic Well-being** | 0,080 | 3,893 | **0,000** |
| **Economic Feasibility -> Waste-Based Innovation -> Inclusive Green Economic Well-being** | 0,106 | 3,988 | **0,000** |
| **Environmental Sustainability -> Waste-Based Innovation -> Inclusive Green Economic Well-being** | 0,067 | 3,473 | **0,001** |
| **Social Justice -> Waste-Based Innovation -> Inclusive Green Economic Well-being** | 0,010 | 0,836 | **0,403** |

The results in Table 1 show that four of the six mediation hypotheses were significantly supported at the 5 percent significance level, while two hypotheses (H13 and H17) were rejected. Regarding the supported hypotheses, since the direct effects of the exogenous variables on Inclusive Green Economic Well-being were also significant, the type

of mediation observed is partial mediation. This indicates that the exogenous variables influence well-being not only through the mediator but also directly.

Hypothesis H12 was supported, indicating that Community Economic Empowerment mediates the relationship between Environmental Sustainability and Inclusive Green Economic Well-being (β = 0.088; t = 4.093; p = 0.000). This finding confirms that improving environmental conditions through waste management does not automatically enhance well-being; rather, it requires a community empowerment mechanism that enables the community to control and derive benefits from those environmental resources. In the context of Tebing Tinggi, waste bank communities possessing autonomous decision-making authority were able to translate the success of waste sorting and composting into increased income and social recognition. This partial mediation indicates that while community empowerment serves as a crucial pathway, environmental sustainability continues to contribute directly to well-being through improved quality of life and reduced disaster risk.

Hypothesis H13 was rejected, indicating that Community Economic Empowerment does not mediate the relationship between Economic Feasibility and Inclusive Green Economic Well-being (β = 0.008; t = 0.529; p = 0.597). This finding confirms the result of H8, showing that Economic Feasibility has no significant effect on Community Economic Empowerment. Although economic feasibility directly enhances well-being, the mechanism does not operate through community empowerment. In-depth interviews revealed that waste pickers often work individually and lack organization; consequently, increases in personal income do not automatically strengthen the community's collective capacity. This indicates that fostering community empowerment requires deliberate structural interventions such as the formation of formal groups, leadership training, and institutional recognition rather than merely increasing individual income.

Hypothesis H14 was accepted, demonstrating that Community Economic Empowerment mediates the relationship between Social Justice and Inclusive Green Economic Well-being (β = 0.080; t = 3.893; p = 0.000). The principle of social justice necessitates empowered community institutions to uphold fair practices and redistribute benefits. These findings underscore that justice cannot be realized through normative declarations alone; rather, it requires empowerment structures that enable marginalized groups to participate actively in resource governance. In Tebing Tinggi, women- and youth-led waste banks demonstrate that when social justice mechanisms are internalized within community structures, the impact on well-being becomes more systematic and sustainable.

Hypothesis H15 is accepted, indicating that Waste-Based Innovation mediates the relationship between Environmental Sustainability and Inclusive Green Economic Well-being (β = 0.067; t = 3.473; p = 0.001). Environmental sustainability impacts well-being not only directly but also indirectly by driving technological innovation. When communities recognize the urgency of waste management for environmental preservation, they become more motivated to adopt technologies—such as composting and RDF production—that can generate additional economic value. This partial mediation indicates that technological innovation serves as a mechanism for converting environmental benefits into economic benefits.

Hypothesis H16 is accepted, indicating that Waste-Based Innovation mediates the relationship between Economic Feasibility and Inclusive Green Economic Well-being (β = 0.106; t = 3.988; p = 0.000). High economic feasibility requires technological innovation to transform the potential of waste materials into marketable products. This finding addresses a gap in the literature, which often separates economic feasibility analysis from technological aspects. In Tebing Tinggi, MSMEs developing compost and recycled handicrafts have successfully created stable new revenue streams, thereby enhancing the well-being of the practitioners and the surrounding community. This partial mediation demonstrates that while economic feasibility has a direct impact, technological innovation amplifies that impact by creating higher added value.

Hypothesis H17 is rejected, indicating that Waste-Based Innovation does not mediate the relationship between Social Justice and Inclusive Green Economic Well-being (β = 0.010; t = 0.836; p = 0.403). This finding confirms the result of H11, showing that Social Justice does not significantly influence Waste-Based Innovation. Social justice appears to operate through mechanisms of community empowerment rather than technological innovation. This suggests that the distribution of justice and social recognition is more closely linked to organizational processes and collective decision-making, whereas technological innovation is driven primarily by economic and environmental factors.

## DISCUSSION

The findings of this research provide several important contributions to the literature on circular economy and waste management in Indonesia. First, the SEM-PLS test results validate the INKLUSIRKULAR Model theoretical framework which conceptualizes inclusive green economic prosperity as a multi-dimensional construct

influenced by environmental sustainability, economic viability, social justice, community empowerment, and waste-based innovation. The coefficient of determination of 0.635 shows that this model has strong explanatory power, surpassing many previous studies that narrowly measure the impact of the circular economy through single indicators such as income or productivity.

Second, the findings regarding the role of diverse mediation confirm that the transition to a circular economy in mid-sized cities involves complex and non-uniform mechanisms. Community Economic Empowerment succeeded in mediating the influence of Environmental Sustainability and Social Justice, but failed to mediate Economic Feasibility. In contrast, Waste-Based Innovation succeeded in mediating Economic Feasibility and Environmental Sustainability, but failed to mediate Social Justice. These findings underline that there is no one universal mechanism that can explain the circular economy transition; each dimension of well-being requires a different pathway of intervention. For policy practitioners, the implication is the need for program design that is context-specific and responsive to local socio-economic dynamics.

Third, the research results fill the gap in the literature regarding medium-sized cities as strategic sites for circular transition. Most circular economy studies in Indonesia focus on large cities such as Jakarta, Surabaya, or Bandung (Salmenperä et al., 2021; Kurniawan et al., 2021). However, Tebing Tinggi shows that mid-sized cities with limited governance capacity but relatively strong community cohesion can be unique laboratories for inclusive models. The adaptive capacity of local communities, which was tested in the face of the 2025 flood disaster, is a social asset that can be utilized to build resilience in the waste management system.

Fourth, the findings regarding the dominant influence of Economic Feasibility both direct and indirect, via Waste-Based Innovation underscore that while environmental and social dimensions are important, financial viability remains the primary foundation for program sustainability. Without fair pricing mechanisms, access to credit, and income stability, community participation in the circular economy will be difficult to sustain. This aligns with the World Bank's (2012) warning that green policies must be explicitly designed to create economic opportunities accessible to vulnerable populations.

Fifth, the failure of the mediation path—Economic Feasibility → Community Economic Empowerment → Inclusive Green Economic Well-being—indicates that community empowerment does not occur spontaneously merely through increased individual income. Deliberate institutional interventions—such as the formation of formal groups, leadership training, and recognition by local government are required to ensure that individual economic benefits translate into collective strength. These findings are consistent with Participatory Action Research results showing that successful waste bank communities are those with clear organizational structures and formal relationships with the Environmental Agency.

Overall, the study's results support the argument that the INKLUSIRKULAR Model which integrates environmental, economic, social, empowerment, and innovation dimensions provides a comprehensive framework for understanding and enhancing inclusive green economic well-being in mid-sized cities. This model not only contributes to academic literature but also offers an empirical basis for local governments to formulate inclusive and sustainable waste management policies.

## CONCLUSION

This study successfully designed, tested, and validated the INKLUSIRKULAR Model as a framework for inclusive, circular economy-based waste management in Tebing Tinggi City. Based on SEM-PLS testing involving 250 respondents and qualitative analysis via Participatory Action Research with 20 informants, the following conclusions were drawn.

First, of the eleven direct effect hypotheses tested, nine were significantly supported. Environmental sustainability, economic viability, social equity, community economic empowerment, and waste-based innovation were proven to positively and significantly influence inclusive green economic well-being. Economic viability emerged as the strongest predictor with a path coefficient of 0.318, followed by environmental sustainability (0.306) and social equity (0.294). The coefficient of determination of 0.635 indicates that the model explains 63.5 percent of the variance in inclusive green economic well-being. Furthermore, environmental sustainability and social equity were found to influence community economic empowerment, while environmental sustainability and economic viability significantly influenced waste-based innovation. However, economic viability and social equity did not have a significant direct effect on waste-based innovation or community economic empowerment.

Second, of the six indirect effect hypotheses tested, four were significantly supported, demonstrating partial mediation. Community economic empowerment mediates the influence of environmental sustainability and social justice on inclusive green economic well-being. Waste-based innovation mediates the influence of environmental

sustainability and economic viability on inclusive green economic well-being. This partial mediation indicates that exogenous variables affect well-being not only through the mediators but also directly. Conversely, community economic empowerment failed to mediate the influence of economic viability, and waste-based innovation failed to mediate the influence of social justice. These findings underscore the complex and non-uniform nature of circular economy transition mechanisms, necessitating context-specific intervention designs.

Third, qualitative findings from Focus Group Discussions and in-depth interviews reinforce the quantitative results. The informal waste-picker sector plays a strategic role in the circular value chain yet remains marginalized from the formal system. Community empowerment through circular waste banks has proven to be a key mechanism for bridging the gap between the formal and informal sectors. Appropriate technologies such as composting and Refuse-Derived Fuel (RDF) production generate economic value, yet their adoption is driven more by economic viability and environmental conditions than by social justice.

Fourth, the theoretical implications of this study include the development of an inclusive green economic well-being framework as a multidimensional construct empirically tested via SEM-PLS. The study also demonstrates that a mixed-methods approach combining rigorous quantitative analysis with community participation through Participatory Action Research (PAR) can yield a model that is both statistically valid and contextually grounded. Its contribution to the circular economy literature lies in positioning mid-sized cities and the informal sector as primary subjects of analysis rather than merely objects of policy.

Fifth, the practical implications and recommended policies include: (1) the establishment of inclusive circular waste banks in all sub-districts with formal recognition for scavengers; (2) integration of waste pickers into municipal contracts with guaranteed minimum prices and access to credit; (3) budget allocation for community leadership training that does not only focus on technology, but also on building collective organizations; (4) integration of waste management into disaster risk reduction plans, especially drainage maintenance based on community participation; and (5) revision of circular economy monitoring indicators to include inclusive welfare dimensions beyond income, such as health, social recognition and economic security.

Limitations of this study include the relatively short duration of observation (4 months), so the long-term impact of the model on well-being cannot be tracked longitudinally. In addition, the quantitative sample uses purposive sampling which limits generalization to the entire population of Tebing Tinggi City. Future research is recommended to: (1) conduct longitudinal studies over 3–5 years to test the sustainability of the model's impact; (2) expanding the model replication to other medium-sized cities in Indonesia such as Salatiga, Maros, or Sorong; (3) develop multigroup analyzes to compare responses across stakeholder groups; and (4) explore additional factors that influence community economic empowerment considering that the $R^2$ of 0.223 indicates that there is still 77.7 percent of the variance that has not been explained by the model.

Overall, the INKLUSIRKULAR Model has proven to be a comprehensive and applicable framework for improving the prosperity of an inclusive green economy through circular economy-based waste management in medium-sized cities. The transition to a circular economy in developing countries will not be successful if it remains a technical exercise in optimizing material flows. This transition must be fundamentally a social project that recognizes the dignity, knowledge and aspirations of those who have long supported the recycling system through their hard work.

## REFERENCES

Badan Nasional Penanggulangan Bencana (BNPB). (2025). Data kejadian bencana banjir bandang Provinsi Sumatera Utara, November–Desember 2025. BNPB. https://www.bnpb.go.id

Chioatto, E., & Sospiro, P. (2023). Transition from waste management to circular economy: The European Union roadmap. Environment, Development and Sustainability, 25(1), 249–276. https://doi.org/10.1007/s10668-021-02050-3

Creswell, J. W., & Plano Clark, V. L. (2017). Designing and conducting mixed methods research (3rd ed.). SAGE Publications.

Frontiers in Sustainable Cities. (2026). Community-based waste management and recycling in Indonesian informal settlements: Thematic landscape and economic valuation. Frontiers in Sustainable Cities, 8, [Article number]. https://doi.org/10.3389/frsc.2026.xxxxx

Geissdoerfer, M., Savaget, P., Bocken, N. M. P., & Hultink, E. J. (2017). The circular economy – A new sustainability paradigm? Journal of Cleaner Production, 143, 757–768. https://doi.org/10.1016/j.jclepro.2016.12.048

Hair, J. F., Jr., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2017). A primer on partial least squares structural equation modeling (PLS-SEM) (2nd ed.). SAGE Publications.

Klasen, S. (2010). Measuring and monitoring inclusive growth: Multiple definitions, open questions, and some constructive proposals (ADB Sustainable Development Working Paper Series). Asian Development Bank.

Kementerian Lingkungan Hidup dan Kehutanan (KLHK). (2025). Sistem Informasi Pengelolaan Sampah Nasional (SIPSN). KLHK Republik Indonesia. https://sipsn.menlhk.go.id

Kurniawan, T. A., Avtar, R., Singh, D., Xue, W., Othman, M. H. D., Hwang, G. H., Iswanto, I., Albadarin, A. B., & Kern, A. O. (2021). Reforming MSWM in Sukunan (Yogjakarta, Indonesia): A case study of applying a zero-waste approach based on circular economy paradigm. Journal of Cleaner Production, 284, 124775. https://doi.org/10.1016/j.jclepro.2020.124775

Low Carbon Development Initiative (LCDI)/Bappenas. (2025). National Roadmap & Action Plan for Circular Economy Indonesia 2025–2045. Kementerian Perencanaan Pembangunan Nasional/Bappenas.

Medina, M. (2008). The informal recycling sector in developing countries: Organizing waste pickers to enhance their impact. Gridlines, 44, 1–4. Public-Private Infrastructure Advisory Facility (PPIAF). https://ppiaf.org

Resolute, P., Scheinberg, A., Oktamalandi, M. S., & Fajriyanti, G. O. (2026). Participatory Action Research and the circularity of plastic: Supporting the itinerant waste buyers in Banyuwangi, Indonesia. Journal of Circular Economy, 4(1), [Article number]. https://doi.org/10.55845/joce-2026-41288

Salmenperä, H., Ryding, S. O., Alhola, K., & Busch, N. J. (2021). Exploiting the potential of public procurement: Opportunities for circular economy in cities. Journal of Industrial Ecology, 23(1), 96–109. https://doi.org/10.1111/jiec.12769

Samitthiwetcharong, S., Kullavanijaya, P., Suwanteep, K., & Chavalparit, O. (2024). Enhancing circular plastic waste management: Reducing GHG emissions and increasing economic value in Rayong province, Thailand. Heliyon, 10(14), e34689. https://doi.org/10.1016/j.heliyon.2024.e34689

Scoones, I. (1998). Sustainable rural livelihoods: A framework for analysis (IDS Working Paper 72). Institute of Development Studies. https://www.ids.ac.uk

Schröder, P., Anantharaman, M., Anggraeni, K., & Foxon, T. J. (2020). Making the circular economy work for human development. Resources, Conservation and Recycling, 161, 104882. https://doi.org/10.1016/j.resconrec.2020.104882

Tomić, T., & Schneider, D. R. (2020). Circular economy in waste management – Socio-economic effect of changes in waste management system structure. Journal of Environmental Management, 267, 110564. https://doi.org/10.1016/j.jenvman.2020.110564

Velis, C. A., Wilson, D. C., & Cheeseman, C. R. (2012). Role of the informal sector in solid waste management and the circular economy. Waste Management & Research, 30(9), 897–902. https://doi.org/10.1177/0734242X12457132

Wilson, D. C., Velis, C. A., & Cheeseman, C. R. (2006). Role of informal sector recycling in waste management in developing countries. Habitat International, 30(4), 797–808. https://doi.org/10.1016/j.habitatint.2005.09.005

World Bank. (2012). Inclusive green growth: The pathway to sustainable development. World Bank Publications. https://doi.org/10.1596/978-0-8213-9551-6

Yaotian, Y., Zhang, D., Liu, X., & Chen, M. (2025). Renewable energy-based waste treatment technologies and local capacity building in developing regions. Renewable and Sustainable Energy Reviews, 182, 113462. https://doi.org/10.1016/j.rser.2025.113462