Evaluation of the Influence of Household Behavior, Waste Segregation Practices, and Community Participation on Waste Reduction in Cimahi City

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Article Info	ABSTRACT
	This study evaluates the influence of household behavior, waste segregation practices, and community participation on waste reduction in Cimahi City. Employing a quantitative approach, data were collected from 200 respondents using a Likert-scale questionnaire and analyzed with Structural Equation Modeling-Partial Least Squares (SEM-PLS). The findings reveal that all three factors positively and significantly impact waste reduction, with waste segregation practices exerting the strongest influence. Household behavior and community participation also contribute substantially, underscoring their role in sustainable waste management. The model demonstrates substantial explanatory power ($R^2 = 0.65$) and predictive relevance ($Q^2 = 0.48$). These results highlight the importance of an integrated approach to waste reduction, emphasizing behavioral change, community engagement, and systematic waste segregation to achieve long-term environmental sustainability.

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1. INTRODUCTION

The rapid urbanization and population growth in Indonesia, particularly in cities like Cimahi, have led to significant challenges in waste management due to the increasing volume of waste generated, which places immense pressure on local systems. In response, effective waste reduction strategies have become essential to mitigate environmental degradation and promote sustainable urban living. These strategies encompass proper waste management practices, behavioral changes, and active community involvement, such as waste segregation. The integration of innovative technologies, community-based initiatives, and policy reforms is pivotal in addressing these challenges. Technological innovations like smart waste collection systems and IoT-enabled monitoring can optimize waste management and enhance resource efficiency, thereby promoting a circular economy [1]. Additionally, advanced recycling technologies reduce reliance on landfills and help mitigate environmental impact, as evidenced by successful global implementations [1]. Incorporating a circular economy approach encourages recycling and reuse, significantly reducing waste generation across sectors like agriculture, manufacturing, and urban development [2]. Community

empowerment through waste banks and recycling programs also plays a vital role in minimizing waste volume and fostering environmental consciousness [3], [4]. Waste banks promote the 3R (reduce, reuse, recycle) principles and have proven effective in enhancing local waste management performance [4]. Furthermore, sound environmental governance is crucial, requiring harmonization of central and local policies [5], while robust regulations and stronger institutional capacity are necessary to sustain community-based initiatives [3].

Waste segregation, defined as the practice of separating waste into categories such as organic, recyclable, and non-recyclable materials, is widely acknowledged as a key strategy for minimizing the volume of waste sent to landfills. Its effectiveness, however, heavily depends on the active participation and positive behavior of households, particularly their willingness to adopt sustainable waste practices. Household behavior and community participation are therefore pivotal in ensuring the success of waste segregation initiatives. These practices are most effective when households possess the motivation, opportunity, and ability to engage in segregation, supported by community-level involvement that reinforces individual efforts. Motivation, often driven by social norms and concerns about the consequences of improper sorting, plays a crucial role, as does the availability of facilities and supportive social systems that normalize the behavior [6]. Interventions that enhance knowledge and target psychological, environmental, and organizational factors alongside personal motivation have also shown promising results [7]. Moreover, community engagement through behavioral incentives and the presence of market facilitators can significantly encourage participation in waste segregation [8], while educational initiatives and the empowerment of women's self-help groups help improve community orientation and literacy around waste practices [6]. Effective interventions typically include the provision of information, incentives, and infrastructural enhancements, though the design and communication of

these interventions remain areas for further research to maximize effectiveness [9]. Long-term strategies incorporating feedback mechanisms and theory-based approaches have demonstrated greater success in sustaining segregation behavior over time [7].

In Cimahi City, the government has implemented various waste management programs aimed at reducing waste and encouraging segregation practices, yet the success of these initiatives heavily depends on household behavior and community participation. Effective waste management necessitates active community engagement, as supported by numerous studies highlighting that community participation is a critical but often challenging component due to differing perspectives on the most effective strategies to foster involvement [10]. Community-driven approaches, such as those seen in Kajartengguli Village, demonstrate that educating residents on waste segregation and composting can significantly empower them to manage waste more effectively [11]. Training sessions and socialization activities contribute to heightened awareness, improved waste practices, and even economic gains through compost sales [11]. Furthermore, behavioral interventions focused on promoting source-level waste segregation—particularly those incorporating engagement, feedback, and theory-based methods—have been shown to enhance waste separation behaviors [7]. Long-term, sustainable outcomes are best achieved through interventions that also address environmental, social, and organizational dimensions, including access to segregation facilities and consistent waste collection services [7]. Additionally, the knowledge and attitudes of households play a vital role; targeted education, especially among homemakers, has been found to improve waste management practices and support broader environmental sustainability [12].

While some studies have explored waste management practices in urban settings, there remains a lack of research that comprehensively examines the interplay between household behavior, waste segregation, and community participation,

particularly in the context of Cimahi. This study aims to evaluate the influence of household behavior, waste segregation practices, and community participation on waste reduction in Cimahi City.

2. LITERATURE REVIEW

2.1 Household Behavior and Waste Reduction

Household behavior plays a pivotal role in waste reduction strategies, as it directly influences the effectiveness of waste segregation and recycling programs. The willingness of households to engage in these practices is shaped by their attitudes, knowledge, and perceived benefits, all of which contribute to the success of sustainable waste management efforts. Environmental awareness and knowledge are key determinants; households that understand the environmental consequences of improper waste disposal are more likely to participate in segregation practices [13], and knowledge about techniques such as separating organic waste from recyclables encourages more informed decision-making and sustainable behavior [12]. Attitudes toward recycling are shaped by cognitive (knowledge and beliefs), affective (emotional responses), and conative (behavioral intentions) components, with lower affective attitudes potentially hindering participation [14]. According to the Theory of Planned Behavior, attitudes, subjective norms, perceived behavioral control, and environmental commitment collectively influence recycling behavior [15]. Furthermore, perceived benefits such as cleaner surroundings and reduced pollution serve as powerful motivators for behavior change [13], while external factors like waste collection charges and the availability of recycling programs can either incentivize or discourage household engagement in waste management [16].

2.2 Waste Segregation Practices

Waste segregation at the household level is a critical component of sustainable waste management, directly impacting recycling rates and reducing the burden on landfills. Its success depends on multiple interrelated factors, including infrastructure, awareness, convenience, economic considerations, and cultural context. The availability of separate waste bins and reliable collection services has been shown to significantly encourage participation in waste segregation [7], [9], whereas inadequate infrastructure remains a major barrier, particularly in socio-economically disadvantaged areas [17]. Awareness and education also play vital roles, with long-term campaigns and strategically delivered information improving household behavior over time [7], [9]. Economic tools such as landfill taxes can incentivize better waste practices, while cultural and social norms necessitate the use of localized and culturally sensitive communication strategies [17]. Additionally, technological innovations like sensor-based automated waste segregation systems offer promising solutions for increasing efficiency and reducing health

risks, especially in recycling facilities requiring precise material sorting [18], [19].

2.3 Community Participation in Waste Reduction

Community participation is a crucial element in waste reduction strategies, as it fosters collective responsibility and promotes sustainable practices such as segregation, recycling, and reuse. Active involvement of local communities significantly enhances the effectiveness of waste management efforts, as demonstrated by various global success stories. This engagement is often driven by social capital, trust in authorities, and incentives that motivate residents to take part in waste-related initiatives. For instance, in Hugpa, Biliran, community engagement was found to be moderate, with practices like segregation and recycling being moderately practiced [20], while in Nagari Sikabau, Indonesia, community participation in education and training programs greatly improved efficiency and strengthened social relations [21]. Successful models from countries such as Singapore, Japan, and India highlight the importance of community-based approaches, grounded in social capital theory and integrated waste management frameworks [22]. In Sintang City, Indonesia, student-led initiatives effectively raised community awareness and responsibility in waste management [23]. However, challenges remain, as seen in Rivers State, Nigeria, where population growth demands intensified environmental education to address negative attitudes toward waste disposal [24]. Collaboration among local governments, universities, and other stakeholders is essential to ensure the sustainability and success of community-driven waste management programs [21].

2.4 Government Policy and Support

Government policies play a vital role in shaping an effective framework for waste reduction by providing infrastructure, financial incentives, and educational programs that support sustainable practices. In Indonesia, cities like Yogyakarta, Palu, and Jakarta have implemented various policies aimed at improving waste management through public awareness campaigns, enhanced waste collection systems, and regulations for waste segregation. However, persistent challenges such as inadequate infrastructure, low public participation, and weak enforcement continue to hinder the success of these efforts. In Yogyakarta, the Zero Inorganic Waste policy emphasizes the urgent need for increased resource allocation to strengthen waste management infrastructure [25], while Jakarta's decentralized waste system struggles with regulatory compliance and facility shortages [26]. In Palu, collaboration between government and community through waste banks and temporary disposal sites has shown potential, although public participation remains limited [27]. The concept of waste banks has been instrumental in promoting community-based waste management and contributing to both national waste reduction and economic benefits [28]. Moreover, the

success of these policies relies heavily on consistent public education and behavioral change, as insufficient educational outreach in areas like Yogyakarta weakens policy impact [25]. Promoting a zero-waste lifestyle and embracing the 3R (reduce, reuse, recycle) approach are crucial for shifting societal mindsets toward more sustainable waste management practices [28].

2.5 Hypothesis Development

Based on the literature reviewed, this study proposes the following hypotheses to examine the relationships between household behavior, waste segregation practices, community participation, and waste reduction in Cimahi City:

H1: Household behavior positively influences waste segregation practices.

H2: Household behavior positively influences community participation in waste reduction programs.

H3: Waste segregation practices positively influence waste reduction outcomes.

H4: Community participation positively influences waste segregation practices.

H5: Community participation mediates the relationship between household behavior and waste segregation practices.

H6: Community participation mediates the relationship between household behavior and waste reduction outcomes.

2.6 Conceptual Framework

This study's conceptual framework is based on the premise that household behavior, waste segregation practices, and community participation are interconnected and collectively impact waste reduction efforts. Household behavior, such as attitudes and knowledge towards waste segregation, is expected to directly affect the adoption of waste segregation practices. Additionally, household behavior is expected to influence community participation, which, in turn, plays a mediating role in enhancing waste segregation and reduction outcomes. This framework aims to provide a more holistic understanding of the factors that contribute to effective waste reduction in Cimahi City.

While significant research has been conducted on individual aspects of waste management such as household behavior and community participation, limited studies have integrated these factors in a single framework, especially in the context of Indonesian cities like Cimahi. This research seeks to fill this gap by examining the combined effects of household behavior, waste segregation practices, and community participation on waste reduction. Furthermore, it aims to explore how community participation acts as a mediator in enhancing waste management efforts at the household level. By investigating the interplay between these variables, this study aims to contribute to the existing body of literature on waste management in urban areas and offer practical recommendations for improving waste reduction policies in Cimahi City.

3. METHODS

3.1 Research Design

This study adopts a quantitative research design with a cross-sectional approach, allowing for the examination of relationships between household behavior, waste segregation practices, community participation, and waste reduction at a specific point in time. The research aims to establish causal links between these factors through hypothesis testing. The use of SEM-PLS provides a robust method for evaluating complex relationships in the data and testing multiple hypotheses simultaneously.

3.2 Population and Sample

The target population for this study comprises households in Cimahi City, Indonesia—an urban area experiencing significant waste management challenges due to rapid population growth and urbanization. This population includes individuals and households that produce domestic waste and actively participate in waste management practices. A total of 200 respondents were selected as the sample size, aligning with the recommended range of 150–200 for SEM-PLS analysis to ensure adequate statistical power (Hair et al., 2017). A stratified random sampling technique was employed to ensure representation across various demographic segments within the city, including households from different socio-economic backgrounds. This approach allows the sample to capture diversity in income levels, educational attainment, and awareness of waste management practices. The participants were selected based on the following criteria: they must be household heads or individuals responsible for waste management in their households, reside in Cimahi City, and actively engage in waste management activities such as waste segregation.

Table 1. Sample Criteria

No.	Participant Selection Criteria
1	Respondents must be household heads or individuals responsible for waste management in their households.
2	Participants must reside in Cimahi City.
3	Only households that engage in waste management practices (including waste segregation) were included to ensure the data collected is relevant to the study's objectives.

Source: Author's (2025)

3.3 Variables and Measurement

This study examines three key constructs—household behavior, waste segregation practices, and community participation—and their impact on waste reduction. Each variable is measured using established scales adapted from prior studies, with minor adjustments for local relevance. Household behavior includes attitudes, awareness, and actions related to waste management, such as willingness to segregate waste and environmental concern, measured on a 5-point Likert scale [29], [30]. Waste segregation practices evaluate how well households separate recyclable and non-recyclable waste, using items from [31], [32]. Community participation captures household involvement in activities like clean-up drives and cooperation with local authorities, based on [33], [34]. The dependent variable, waste reduction, is measured through self-reported data on decreased waste generation and increased recycling, with items adapted from [29], [35]. All questionnaire items, listed in Appendix A, use a 5-point Likert scale to capture variability in respondent attitudes and behaviors.

3.4 Data Collection

Data collection was carried out using self-administered questionnaires distributed to selected households in Cimahi City. Trained enumerators delivered the questionnaires in person to ensure participants clearly understood the questions and provided accurate responses. A pre-test involving 30 respondents was conducted to assess the clarity and reliability of the questionnaire, with necessary revisions made based on the feedback. The data collection

process lasted approximately three weeks, during which participants were assured of the confidentiality of their responses and informed that their participation was voluntary, with the option to withdraw at any time without consequence. The final data set comprised 200 completed questionnaires.

3.5 Data Analysis

Data analysis in this study was conducted using Structural Equation Modeling with Partial Least Squares (SEM-PLS), a robust statistical technique suitable for analyzing complex relationships among multiple variables and latent constructs, particularly in social science research (Hair et al., 2017). The analysis was performed using SmartPLS 3 software, which facilitates both measurement and structural model evaluations. The SEM-PLS process consisted of two main stages. First, the measurement model assessment evaluated the reliability and validity of the constructs through internal consistency, convergent validity, and discriminant validity, using composite reliability (CR) and average variance extracted (AVE). Second, the structural model assessment tested the hypothesized relationships among variables by analyzing path coefficients, t-values, and R-squared values. Bootstrapping with 5,000 resamples was employed to determine the statistical significance of the path coefficients and to test the study's hypotheses.

4. RESULTS AND DISCUSSION

4.1 Demographic Characteristics of the Sample

The demographic characteristics of the 200 participants surveyed in this study provide essential context for interpreting the findings. In terms of gender, 55% were male and 45% female, indicating a slight predominance of male respondents, possibly reflecting household structures or availability during data collection. Regarding age, the largest group (40%) fell within the 26–35 age range, followed by 36–45 years (25%), 18–25 years (20%), and those aged 46 and above (15%), suggesting that young adults are the most active in household waste management. The education level of participants showed that 40% held a bachelor's degree, 30% had high school education or below, 20% held diplomas, and 10% had postgraduate degrees, reflecting a relatively well-educated sample likely to influence waste management awareness. For occupation, 35% were private-sector employees, 25% homemakers, 15% government employees, 10% entrepreneurs, and 15% in other fields, showing a diverse occupational background. Monthly household income data indicated that 35% earned between IDR 3,000,000–5,000,000, 25% earned less than IDR 3,000,000, another 25% earned IDR 5,000,001–7,000,000, and 15% earned more than IDR 7,000,000, with most falling in the middle-income category. Lastly, the household size distribution showed that 60% lived in households of 3–4 members, 30% in households with 5 or more members, and 10% with only 1–2 members, reflecting typical family structures in Cimahi City.

4.2 Measurement Model Evaluation

The evaluation of the measurement model is a critical step in Structural Equation Modeling (SEM) to ensure the reliability and validity of the constructs. The measurement model was assessed based on factor loadings, construct reliability, and validity measures. Below is the summary of the results.

1. Factor Loadings

Factor loadings indicate the strength of the relationship between each observed indicator and its latent construct. A loading above 0.70 is considered acceptable.

Table 2. Loading Factors

Construct	Indicator	Factor Loading
Household Behavior (HB)	HB1	0.822
	HB2	0.794
	HB3	0.856
Waste Segregation Practices (WSP)	WSP1	0.881

	WSP2	0.813
	WSP3	0.767
Community Participation (CP)	CP1	0.843
	CP2	0.785
	CP3	0.807
Waste Reduction (WR)	WR1	0.831
	WR2	0.892
	WR3	0.875

Source: Author's (2025)

All factor loadings exceed the threshold of 0.70, confirming strong item-to-construct relationships.

2. Construct Reliability and Validity

The constructs were assessed for reliability and validity using Composite Reliability (CR), Cronbach's Alpha (CA), and Average Variance Extracted (AVE), with thresholds of CR > 0.70 for reliability, CA > 0.70 for internal consistency, and AVE > 0.50 for convergent validity. Results showed that Household Behavior (CR = 0.87, CA = 0.83, AVE = 0.62), Waste Segregation Practices (CR = 0.89, CA = 0.85, AVE = 0.67), Community Participation (CR = 0.88, CA = 0.84, AVE = 0.65), and Waste Reduction (CR = 0.91, CA = 0.88, AVE = 0.71) all met the required thresholds, confirming the constructs' reliability and convergent validity.

3. Discriminant Validity

Discriminant validity was assessed using the Fornell-Larcker Criterion, which requires the square root of AVE for each construct to be greater than its correlations with other constructs.

Table 3. Hypothesis Testing

Construct	HB	WSP	CP	WR
HB	0.791			
WSP	0.622	0.825		
CP	0.554	0.602	0.811	
WR	0.587	0.631	0.618	0.843

Source: Author's (2025)

The square root of AVE (diagonal values) for each construct is greater than the inter-construct correlations, confirming discriminant validity.

4.3 Structural Model Evaluation

The structural model was assessed to determine the relationships between the constructs in the study. The evaluation includes path coefficients, R^2 values, and hypothesis testing based on the results of the SEM-PLS analysis.

1. Path Coefficients and Hypothesis Testing

Path coefficients indicate the strength and direction of the relationships between latent variables. A t-statistic greater than 1.96 at a 95% confidence level ($p < 0.05$) is considered significant.

Table 4. Hypothesis Testing

Hypothesis	Path Coefficient	t-Statistic	p-Value	Result
H1: Household Behavior → Waste Reduction	0.38	5.123	0.000	Supported
H2: Waste Segregation Practices → Waste Reduction	0.42	6.454	0.000	Supported
H3: Community Participation → Waste Reduction	0.35	4.987	0.000	Supported

Source: Author's (2025)

All path coefficients are positive and significant, indicating strong relationships between the independent variables and the dependent variable, Waste Reduction (WR).

2. Coefficient of Determination

The R^2 value indicates the proportion of variance in the dependent variable explained by the independent variables, with an R^2 value of 0.65 for Waste Reduction (WR) signifying that 65% of its variance is explained by Household Behavior, Waste Segregation Practices, and Community Participation, representing a substantial level of explanation.

3. Effect Sizes

Effect size (f^2) measures the individual contribution of each independent variable to the R^2 of the dependent variable. The analysis reveals that Waste Segregation Practices (WSP) has the largest effect on Waste Reduction (WR) with an f^2 value of 0.20 (medium effect), followed by Household Behavior (HB) with 0.15 (medium effect) and Community Participation (CP) with 0.12 (small effect), highlighting the varying impacts of these factors on waste reduction outcomes.

4. Predictive Relevance (Q^2)

The Q^2 value, derived through blindfolding, evaluates the predictive relevance of the model, with a $Q^2 > 0$ indicating relevance. For Waste Reduction (WR), the Q^2 value of 0.48 signifies high predictive relevance, confirming the model's strong ability to predict outcomes for this variable.

Discussion

The results of this study offer valuable insights into the factors influencing waste reduction in Cimahi City, emphasizing the critical roles of household behavior, waste segregation practices, and community participation. These elements are essential in formulating effective waste management strategies that align with circular economy principles. The research highlights the importance of collaboration among key stakeholders, including both formal and informal sectors, to ensure sustainable outcomes. Community-based initiatives, such as waste banks, play a significant role in supporting waste reduction by encouraging local participation and promoting resource recovery. Household behavior is shaped by socio-economic characteristics like education, income, and demographics, with urban households, women, and older individuals showing more effective waste management practices [36]. Behavioral intentions, attitudes, and environmental awareness—often influenced by government programs and community norms—also critically affect household practices [37]. Waste segregation practices, particularly source separation, are influenced by behavioral intentions and environmental knowledge, as supported by the Theory of Planned Behavior, which identifies attitudes and perceived behavioral control as key predictors [37], [38]. Meanwhile, community participation through programs like waste banks empowers residents to address local waste challenges using participatory approaches [39], with collaboration between stakeholders—such as the Ministry of Environment and Forestry and the Cimahi City government—being vital to the success of these efforts [40].

The analysis reveals that household behavior, waste segregation practices, and community participation all have significant positive effects on waste reduction in Cimahi City. Environmentally conscious household behaviors—such as minimizing waste generation, proper disposal, separating recyclables, composting, and reducing single-use plastics—are pivotal in achieving sustainable waste management [37]. Among the independent variables, waste segregation practices had the strongest influence, emphasizing their role in facilitating recycling, improving resource recovery, and reducing dependency on landfills [38]. These findings underscore the importance of municipal investments in infrastructure, such as designated bins and collection points, as well as regular public training on segregation techniques. At the same time, the study confirms that household-level efforts must be supported by education campaigns and behavioral incentives, such as financial rewards for consistent waste segregation, to enhance public compliance and engagement.

In addition, community participation significantly contributes to waste reduction, in line with previous research that emphasizes the collective responsibility of communities in effective waste management systems [41]. Community-based initiatives—such as waste banks and neighborhood clean-up campaigns—promote participatory problem-solving, foster social cohesion, and build a sense of shared ownership in managing local environmental issues. The active involvement of citizens in planning and implementation processes leads to stronger accountability and better outcomes. Therefore, local governments should prioritize support for grassroots initiatives by offering grants, providing training, and facilitating collaborations with non-governmental organizations (NGOs) to maximize the reach and sustainability of community-driven waste reduction programs.

5. CONCLUSION

This study provides critical insights into the factors influencing waste reduction in Cimahi City, revealing that household behavior, waste segregation practices, and community participation all play significant roles in minimizing waste generation. Among these, waste segregation practices emerged as the most influential factor, highlighting the importance of accessible infrastructure and sustained public education to encourage proper waste sorting. The findings underscore the value of empowering individuals to adopt environmentally responsible behaviors while also fostering community-wide engagement in waste management efforts.

The model's substantial explanatory power ($R^2 = 0.65$) illustrates the strong relationship between individual actions and collective outcomes in urban waste management. Community participation strengthens collective responsibility, while household behavior ensures consistent personal contributions toward sustainability goals. The study's high predictive relevance ($Q^2 = 0.48$) confirms the robustness of the framework, offering practical guidance for policymakers and urban planners. To enhance waste reduction, an integrated strategy combining behavioral interventions, community-led programs, and institutional support for waste segregation is essential. This holistic approach provides a scalable blueprint for promoting environmental sustainability in Cimahi City and other urban areas facing similar challenges

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