Mitigating Environmental Threats: An Intervention Study on Household Waste Management in Pasirkaliki Village

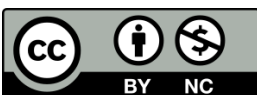**Tati Ruhmawati, Uyu Wahyudin, Sardin Sardin, Amar Sharaf Eldin Khair, & Yanti Shantini**

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ABSTRACT

The lack of awareness regarding the management of household waste, particularly hazardous and toxic waste, poses a significant threat to environmental pollution. This lack of awareness is exacerbated by the accumulation and mixing of such waste with other categories of household waste. This study aims to mitigate the impact of household waste through an assistance mechanism designed to alter waste management behavior. Employing a quasi-experimental method, the research was conducted within the community of Pasirkaliki Village, North Cimahi. The study revealed significant changes in both the knowledge and behavior of the community towards waste management. Post- intervention, there was a notable increase of 16.6% in the community's knowledge compared to pre- intervention measurements. Furthermore, individuals who initially exhibited poor knowledge of waste types showed a remarkable 55.6% increase in understanding. The enhanced knowledge positively correlated with changes in behavior, evidenced by the increased community agreement on sorting waste based on its categories. This behavioral change was attributed to the intervention, supported by a p-value of 0.002. The results underscore the effectiveness of the assistance provided, which involved identifying community tendencies and employing direct involvement to enable individuals to experience the benefits firsthand through education.

Introduction

The increase in household activities resulting from cultural and lifestyle developments contributes to the generation of waste that poses environmental risks. Data from Sistem Informasi Pengelolaan Sampah (the Waste Management Information System) (2021) indicates that hazardous and toxic waste (B3) comprise 2% of the total household waste, accounting for 40.9%. While this percentage may seem small in terms of quantity, the

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handling of such waste presents significant hazards due to the absence of control and systems for household waste management. Unlike hazardous waste generated by industries, household hazardous waste lacks proper management mechanisms, leading to a higher risk of accumulation. Prasetyaningrum et al. (2017) identified that the potential for landfilling household hazardous waste stems from the community's low awareness and knowledge regarding waste categorization, often treating hazardous waste the same as organic waste. Neglecting efforts to raise awareness of waste categories and establish effective management practices can mitigate the hazardous potential of household waste.

Numerous studies have addressed household waste management from various perspectives. Past research has primarily focused on facilitating technical solutions to address waste management challenges, overlooking the potential for behavioral change through experimental approaches. Researchers tend to adopt two main tendencies when examining household waste management. Firstly, there is a focus on technical waste management mechanisms, emphasizing processes such as waste reduction, utilization, and recycling, which are imparted to the community (Kgs et al., 2021). Additionally, researchers often prioritize cultivating sorting skills to enhance technical waste management practices (Humairo et al., 2022). Secondly, there is an emphasis on waste management assistance mechanisms. According to Gatta et al. (2022), mentoring programs have been found to foster community creativity and innovation in waste management, leading to potential economic improvements. Unfortunately, efforts to change the behavior of communities with negligent waste management habits have been overlooked, as researchers concentrate more on mentoring processes and the development of waste management techniques.

This study aims to address the gaps identified by previous researchers by placing a stronger emphasis on the assistance process to implement social engineering and foster new knowledge and behaviors. The behavioral engineering process targets the Pasirkaliki village community in North Cimahi. Data from the Cimahi City Environmental Agency indicates that household waste generation in Cimahi City amounts to 273 tons per day, making this area a suitable subject for study. To accomplish this objective, the research seeks to address two main issues. Firstly, it seeks to examine the waste management behaviors of the Pasirkaliki Village community to establish a suitable assistance model. Secondly, the research aims to measure behavior change as an assessment tool for the effectiveness of the applied assistance model. Both issues are addressed to evaluate the assistance mechanism's efficacy in implementing social engineering to instigate behavioral changes in the waste management process.

This study diverges from the notion that inducing lasting changes in community behavior necessitates a change mechanism capable of fostering self-regulation through the cultivation of praxis awareness. Praxis awareness can only be fostered by reshaping discursive conceptions through a model that comprehends the ramifications of hazards and benefits derived from proper waste management practices (McGannon & Smith, 2015). Recognizing the specific advantages and disadvantages within society significantly influences the process of behavioral change. This assertion is corroborated by Noora

Jansson (2013), who posits that particular and pragmatic assumptions play a pivotal role in promoting behavioral changes within society. Leveraging the particular dimension, such as community participation directly involved in waste management processes, underscores the efficacy of knowledge dissemination regarding the importance of waste segregation to mitigate environmental harm.

Literature review

Waste Management System

The pressing need for effective waste management across various countries is a critical concern intertwined with the surge in population density (Nartey & Nyarko, 2020). Every human activity generates waste, leading to the accumulation of waste heaps that pose significant threats to environmental integrity, subsequently impacting public health (K. S. Boateng et al., 2019). Typically, the onus of addressing these challenges falls on governmental bodies tasked with regulating, minimizing, and managing waste, while community involvement tends to remain passive, often resulting in inefficient waste management processes (Lissah et al., 2021). Brotosusilo and Nabila (2020) underscore the necessity of active community engagement in shaping waste management policies through individual initiatives. Moreover, the informal sector's participation in waste management is increasingly acknowledged as a pivotal element within the broader waste management framework (Indrosaptono & Syahbana, 2017; Poletto et al., 2016).

There's a growing emphasis on adopting circular waste management strategies that consider the entire waste system within its context (Viva et al., 2020). Integrated organic waste management systems, encompassing decentralized collection, recycling, and composting, are being advocated as effective means to manage urban waste while fostering socioecological transformation (Yates & Gutberlet, 2011). Furthermore, Agarwal et al. (2021) propose a decentralized approach that prioritizes the reuse and recycling of organic waste for urban agriculture as a sustainable solution for urban waste management. Implementing the 3R concept (Reduce, Reuse, Recycle) at the household level is acknowledged as a crucial element in an efficient waste management strategy (Ridayati & Yunastiawan, 2021).

Variables Enhancing Community Engagement in Waste Management

The community's involvement in waste management is often hindered by a lack of awareness regarding the significance of proper waste management practices. Adogu et al. (2015) underscored the importance of enhancing knowledge levels as a means to foster community commitment to effective waste management processes. Similarly, Lema et al. (2019) discovered similar results while examining communities in Ethiopia. Through a questionnaire-based approach, their study highlighted the pivotal role of knowledge in shaping community engagement towards improved waste management. Research conducted in Phnom Penh, Cambodia, further corroborates these findings,

demonstrating that increased knowledge contributes to heightened community participation in effectively managing waste within urban settings (Seng et al., 2010).

Researchers have identified a correlation between increased community participation in waste management and enhanced knowledge levels. Changes in knowledge often lead to the adoption of new practices aimed at reducing and effectively managing household waste. Handayani et al. (2024) demonstrated the link between knowledge transformation and behavioral changes in waste management, highlighting how heightened awareness can improve waste management practices. Similarly, Nguyen et al. (2024) observed similar outcomes in their study investigating students' attitudes and behaviors towards plastic waste management. Their research revealed that increased knowledge about waste and its associated hazards spurred greater involvement and proactive behaviors in waste management practices.

Drivers of Transformation in Waste Management Knowledge and Behavior

Increased awareness of the importance of waste management often stems from enhanced knowledge, leading to behavioral changes. Boateng et al. (2016) proposed an educational intervention mechanism for Ghanaian communities, aiming to induce long-term behavioral changes in waste management practices, an approach also supported by Saseanu et al. (2019). Education plays a pivotal role in fostering sustainable waste management techniques in urban areas. Tailored educational initiatives, community involvement, and timely interventions within educational institutions are essential in promoting proper waste management practices among citizens. By prioritizing education and awareness, urban communities can strive towards efficient waste management systems, thereby fostering a cleaner and healthier environment. Educational campaigns and awareness programs hold the potential to empower citizens to adopt sustainable waste management methods, consequently reducing improper waste disposal and mitigating associated environmental and health risks (Yukalang et al., 2018).

Behavioral changes in interventions can also be achieved through shaping social transformation via social engineering mechanisms. This approach was exemplified by Yukalang et al. (2018), who illustrated the Thai government's direct interventions aimed at enhancing local infrastructure and operational capabilities. Similarly, Narethong (2020) explored the significance of environmental governance frameworks in influencing waste management policies and practices in urban settings. Beyond government interventions involving regulations and infrastructure, behavior modification can also be facilitated through the increased adoption of technology. El-Saadony et al. (2023) outlined the potential of blockchain-enabled systems for smart waste management, offering a promising avenue to enhance efficiency and transparency in waste management processes. Urban areas can enhance waste management practices by leveraging technologies such as blockchain and the Internet of Things (IoT), which enable the optimization of waste collection, tracking, and recycling operations, thus fostering more sustainable waste management practices.

Research Methods

This research belongs to the quasi-experimental research category, which is characterized by a pre- and post-intervention research design that uses only one group without a control group. The research objective was to find out more about the knowledge and attitudes of the respondents in sorting the household household hazardous waste they produce. From August to November 2022, the research was conducted in RW 06, Pasirkaliki Village, North Cimahi. The population of this study consisted of 18 heads of families or 18 families representing RW 06, all members of the population were studied. Respondents in the study were determined based on the criteria of being willing to take part in the research and not having separated the household hazardous waste they produced. Data collection techniques using a questionnaire sheet. Respondents' knowledge and attitudes about household hazardous waste segregation were measured before and after the intervention in the form of education and assistance. The collected data is being analyzed. To find out the differences in respondents' knowledge before and after the intervention, data were analyzed using the dependent t test.

Results

The Perception and Actions of the Pasirkaliki Village Community in North Cimahi Regarding Household Hazardous Waste: Before intervention

Government Regulation No. 81/2012 mandates the implementation of waste management practices, requiring household and similar waste to undergo sorting based on specific categories. The regulation outlines five distinct types of waste, including hazardous and toxic waste (B3), easily decomposable waste, recyclable waste, and others. This categorization system is designed to streamline waste handling procedures. Consequently, facilities within a given area must be equipped with the necessary infrastructure to facilitate waste sorting in accordance with government regulations. However, in Pasirkaliki Village, the absence of diverse trash bins, as mandated by the regulation, indicates a lack of public awareness regarding proper waste management protocols.

The limited awareness among the residents of Pasirkaliki Village, North Cimahi, regarding household waste management can be evidenced by two key indicators. Firstly, there is a notable lack of knowledge concerning waste management practices. Data reveals that a significant portion of the community lacks understanding of household waste segregation, as illustrated by Table 1. Specifically, 66.7% of respondents are unfamiliar with the necessity of sorting organic and non-organic waste, indicating a deficiency in knowledge.

No.	Category	Before Intervention	
		F	**%**
1	Excellent	0	0
2	Very good	1	5.6
3	Good	5	27.7
4	Bad	12	66.7
5	Very bad	0	0

Table 1. Respondents' knowledge of household hazardous waste segregation before the intervention. *Source:* Own work authors'.

This deficiency underscores the overall low level of awareness among the Pasirkaliki village community regarding household waste management.

Secondly, examining behavior provides further insight into the community's awareness of household waste management. There exists a correlation between the community's limited knowledge and its behavior in waste handling. Data illustrates a pessimistic stance among community members (as depicted in Table 2) regarding the advantages of household waste segregation. The majority (66.7%) expressed disagreement with the benefits of such segregation, while 27.7% harbored doubts about its efficacy.

No.	Category	Before Intervention	
		F	**%**
1	Strongly agree	0	0
2	Agree	1	5.6
3	Doubtful	5	27.7
4	Do not agree	12	66.7
5	Strongly disagree	0	0

Table 2. Respondents' Attitude of household hazardous waste segregation before the intervention. *Source:* Own work authors'.

This skepticism toward waste segregation underscores a lack of recognition among community members regarding the importance of proper household waste management practices.

Empowerment process through intervention mechanism: reshaping the perception and behavior of Pasirkaliki Village community, North Cimahi

To address behavior change in household waste management within Pasirkaliki Village, two approaches were employed. Firstly, observation was utilized. This method involved conducting a field-note-based mapping exercise to identify the underlying issues

contributing to the community's low awareness of waste management. The observations highlighted three primary factors contributing to waste management challenges in the area: ingrained habits of indiscriminate garbage disposal, lack of awareness regarding different types of household waste, and inadequate waste disposal infrastructure. Notably, the absence of segregation- friendly waste bins perpetuates the habit of disposing of both organic and non- organic waste together. Consequently, waste is collected indiscriminately, using carts that accommodate all waste categories. Additionally, there is a general lack of understanding regarding the various types of waste generated from household activities, hindering efforts to introduce additional waste bins.

Secondly, socialization and assistance were employed. This involved imparting knowledge through socialization mechanisms while simultaneously implementing tangible actions to cultivate waste disposal habits. Community members were educated about the different types of household waste and were directly involved in the sorting process using provided separate bins. Recyclable waste was separated for appropriate processing. Additionally, the socialization process aimed to raise awareness about the environmental impact of various types of waste. Introducing waste types alongside their environmental consequences was achieved through informal methods, emphasizing personal experiences to highlight the repercussions of disregarding waste segregation. This approach aimed to transform sorting actions into a sustainable behavioral change.

The intervention mechanism aims to facilitate sustainable change by ensuring proper waste management practices. This process involves a structured approach that considers the flow of waste management (refer to Figure 1).
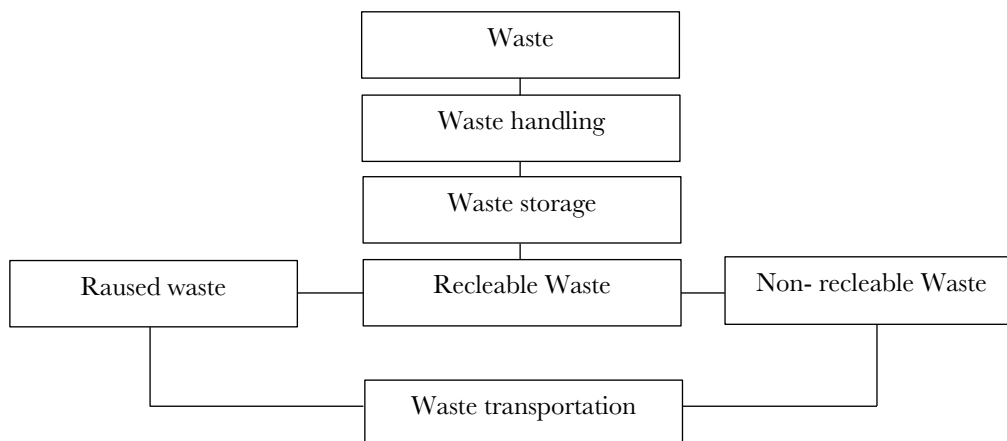

Figure 1. A flow chart for intervention.

Through this intervention, actions are implemented in tandem with cultivating knowledge about waste categorization, directly engaging the Pasirkaliki village community.

Respondents' Attitudes about Household Hazardous Waste Segregation

Simultaneous implementation of socialization and intervention processes has led to a notable improvement in community awareness regarding waste categories, consequently influencing changes in waste disposal behavior. This assertion is supported by the observed increase in knowledge and behavioral changes among the Pasirkaliki Village community in North Cimahi following the intervention. Data reveals a significant enhancement in community knowledge concerning household waste categories (refer to Table 3).

No.	Category	Before Intervention	
		F	**%**
1	Excellent	0	0
2	Very good	4	22.2
3	Good	12	66.7
4	Bad	2	11.1
5	Very bad	0	0

Table 3. Respondents' knowledge of household hazardous waste segregation after the intervention. *Source:* Own work authors'.

Notably, the proportion of individuals categorized as having excellent knowledge increased by 16.6% post-intervention compared to pre-intervention measurements. Moreover, there was a notable 55.6% increase in understanding among individuals who initially demonstrated poor knowledge of waste types.

Increased knowledge is positively associated with changes in the sorting behavior of the Pasirkaliki village community regarding household waste. Table 2 illustrates that prior to the intervention, 12 respondents (66.7%) did not agree to sort household hazardous waste. Following the intervention (refer to Table 4), there was a notable shift in attitude, with 14 respondents (66.7%) agreeing and an additional 4 respondents (22.2%) strongly agreeing to sort their household hazardous waste.

No.	Category	Before Intervention	
		F	**%**
1	Strongly agree	4	22.2
2	Agree	14	77.8
3	Doubtful	0	0
4	Do not agree	0	0
5	Strongly disagree	0	0

Table 4. Respondents' Attitude of household hazardous waste segregation before the intervention. *Source:* Own work authors'.

The results of the dependent t-test conducted at a significance level of 5% yielded a p-value of 0.002, indicating a significant change in participants' understanding before and after the intervention.

Discussion

The significant behavioral shifts observed within the community of Pasirkaliki Village, North Cimahi, underscore the efficacy of intervention strategies aimed at concurrently developing cognitive and psychomotor capacities. These interventions are designed to enhance the community's ability to manage waste effectively. The augmented understanding of waste classification, coupled with the practice of sorting household waste, exemplifies this capacity-building process. Notably, the rise in affirmative responses, particularly strong agreement with waste segregation, from 0% to 22.2%, reflects heightened awareness regarding the importance of waste management fostered through socialization and intervention efforts. Community members have come to recognize the benefits of segregating organic and non-organic waste into separate bins. Furthermore, the calculated p-value of 0.002 instills confidence that the observed changes are indeed attributed to the intervention measures implemented within the Pasirkaliki Village community, North Cimahi.

Efforts to enhance the community's quality of life, as part of an empowerment mechanism facilitated through socialization, demonstrate that interventions conducted in conjunction with knowledge dissemination are operating effectively. Knowledge serves as a potent tool capable of compelling individuals to reconsider their beliefs and values, thereby leading to behavioral changes (Alsop et al., 2006, p. 235). When knowledge cultivation is integrated with direct engagement methods, it diminishes the resistance to change typically associated with preference formation, as argued by Steven Lukes (2002). The efficacy of knowledge in influencing actions has also been highlighted by Luh Devanitas et al. (2020) and Yudhistirani et al. (2015) as a means to instigate behavioral shifts. The concurrent implementation of these two mechanisms proves pivotal in shaping behavioral changes regarding waste management within the Pasirkaliki village community, North Cimahi, which previously disposed of waste without segregation.

The daily behaviors shaped by individuals' habits in response to household waste represent complex actions deeply ingrained in their praxis consciousness. According to Giddens (1993, p. 218), changes in these habitual behaviors, often unquestioned in their validity, necessitate alterations in cognitive structures. This transformation occurs through the involvement of agents who serve as facilitators, sensitizing individuals to their habits through factual interventions. Clegg (1989) refers to this direct intervention, which involves the community as the subject of empowerment, as delegating authority, thereby empowering delegates. This model not only fosters community independence but also contributes to sustainable change (Hoerniasih, 2019). The intervention model, which integrates community involvement with knowledge cultivation, proves to be an effective

empowerment mechanism for individuals accustomed to actions that disregard established rules.

Researchers often overlook interventions aimed at addressing habits of neglect towards household waste management, despite their potential to harm the environment and jeopardize public health. Instead, research tends to prioritize aspects of socialization and skill-building with economic value. Socialization mechanisms typically emphasize technical knowledge related to waste reduction, utilization, and recycling (Humairo et al., 2022; Kgs et al., 2021), while overlooking comprehensive understanding of waste types like the Bergama type and independent implementation. Similarly, the assistance mechanism in recycling processes often focuses solely on economic value (Gatta et al., 2022), neglecting broader behavioral changes. This trend is prone to incidental alterations rather than sustainable change. The study underscores the importance of fostering demand for sustainable change through the acquisition of knowledge and delegation of authority, prompting individuals to internally reassess the significance of proper waste management.

The transformations observed within each individual in the Pasirkaliki Village community, North Cimahi, have played a crucial role in reshaping the perception that proper waste management is not merely a request, but a necessity. Intervention strategies aimed at enhancing knowledge acquisition are fundamental in advocating for sustainable waste management practices across various community levels within the region. Tailored knowledge dissemination initiatives, coupled with active community participation and timely interventions from diverse stakeholders, are pivotal in fostering proper waste management behaviors among residents. By prioritizing knowledge and awareness, communities can work towards establishing efficient waste management systems, thereby fostering a cleaner and healthier environment.

Conclusion

Enhancing the regulation of household waste management processes mandated by the government, particularly in communities where effective management practices are lacking, can be achieved through socialization and assistance mechanisms. This study highlights the efficacy of these approaches in augmenting community awareness regarding government-issued regulations. Significant improvements were observed, evidenced by enhanced knowledge and adoption of proper waste management behaviors. Prior to the intervention, 66.7% of respondents exhibited poor knowledge. Post-intervention, this figure decreased to only 11.1%, with a corresponding increase in respondents categorized as having good (66.7%) and very good (22.2%) knowledge levels. Following education and assistance, all respondents displayed a positive attitude, expressing agreement to sort their household waste. Through education and guidance, communities can be empowered to bolster their knowledge and comprehension of household waste sorting practices.

This study employed quasi-experimental research to assess fundamental shifts in community behavior and knowledge, evaluating changes before and after the intervention. Significant alterations were evident, supported by t-tests yielding noteworthy p-values. However, the assessment overlooked skill formation for waste reuse within the reused and recyclable waste categories. This research limitation echoes findings from previous studies, highlighting the need for future investigations into the impact of recycling knowledge on behavioral responses to household waste. Exploring this aspect further could provide valuable insights for future research endeavors.

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Author's declaration
We declare that manuscript has been prepared, written and approved to submit to this journal by us.

Author's contributions and responsibilities
We are Tati Ruhmawati (Author 1) and other authors (Uyu Wahyudin, Sardin, Amar Sharaf Eldin Khair, Elih Sudiapermana, Yanti Shantini, and Asep Saepudin) hereby declare that the manuscript has been prepared, written, read, and approved for submission to this journal by us. All sources used in the research and writing are fully acknowledged, and all quotes are properly identified based on the research data we have conducted. a contributed to designing the research design and developing the theoretical framework; b developed instruments; collected and analyzed data; and c analyzed and discussed, and all authors agreed to submit this article.

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