

Capacity transformation of environmental health cadres through the PILAH (integrated guide for waste management) program

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Abstract. Waste management remains a major challenge in Bonto Perak Village due to the community's low level of knowledge and skills in sorting and processing household waste. Environmental health cadres were selected as intervention targets because of their strategic role as agents of change at the community level. Within the Theory of Planned Behavior framework, positive attitudes and strong behavioral intentions are the primary determinants of actual behavior, while increased knowledge serves as a foundation for strengthening both aspects. Objective To evaluate the effectiveness of the PILAH (Integrative Waste Management Guidelines for Waste Management) program in strengthening cadres' capacity through participatory education. Methods: A quasi-experimental study with a one-group pretest–posttest design was conducted among 18 cadres from different neighborhoods. The intervention included interactive education sessions, distribution of the PILAH handbook, and composting practice. Data were analyzed using the Wilcoxon signed-rank test. Knowledge scores significantly improved after the intervention ($p=0.008$). Behavioral intention increased from 83.3% to 100% in the “good” category, though not statistically significant ($p=0.083$). Attitudes remained consistently positive, with all cadres in the “good” category before and after the intervention ($p=1.000$). The PILAH program effectively enhanced cadres' knowledge and strengthened their behavioral intentions, despite the latter not reaching statistical significance, while maintaining consistently positive attitudes. The program is recommended for replication in other communities with continuous support to ensure sustainable waste management practices.

1 Introduction

The problem of household waste management remains a strategic issue in Indonesia, where based on data from the National Waste Management Information System (SIPSN) of the Ministry of Environment and Forestry in 2024, waste generation was recorded at 34.63 million tons per year, with only 40.08% (13.88 million tons) being successfully managed while 59.92% (20.75 million tons) were not managed properly, waste recovery efforts only reached 1.13% (390 thousand tons), and handling through TPA Control/Sanitary Landfill amounted to 8.50 million tons and TPA Open Dumping still reached 6.75 million tons (Ministry of Environment and Forestry of the Republic of Indonesia, 2024). This condition

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shows that most of the waste in Indonesia still ends up in Final Disposal Sites (TPA) or Temporary Disposal Sites (TPS) without going through a sustainable management process (I Made Dicky Taruna Wijaya et al., 2022). This has an impact on increasing the risk of environmental pollution, blockage of drainage channels which can trigger flooding, the spread of disease vectors, and a decline in the quality of public health (Saxena et al., 2025).

Bonto Perak Village, as one of the densely populated areas, is not free from waste management issues, where the practice of mixing all types of waste, both organic and inorganic, is still a community habit due to limited knowledge and skills in sorting and processing household waste, and this problem also reflects a broader phenomenon in Pangkep Regency, where waste production reaches around 100 tons per day or 36,500 tons per year, while community-based management facilities such as the Rahmawati Main Waste Bank are only able to accommodate 370 kg per month or around 13 kg per day, so this significant disparity shows that the local collection and management system is still very limited (Pangkajene and Kepulauan Regency, 2022).

In this context, environmental health cadres play a strategic role as drivers of change because they are able to bridge health workers with the community and ensure the implementation of waste management practices at the household level (Peng et al., 2024). Within the Theory of Planned Behavior (TPB) framework, changes in cadre behavior are influenced by attitudes toward behavior, subjective norms, and perceived behavioral control, which form intentions as the main predictors of actual behavior. Therefore, strengthening knowledge is a crucial aspect in supporting the formation of positive attitudes and consistent behavioral intentions (Ahmad Kholid, 2020). This means that increasing community capacity must begin by strengthening these factors through environmental health cadres to form new, consistent behaviors (Pourhaji et al., 2020).

Facing complex waste management issues at the community level, strategies are needed that are not only informative but also participatory, emphasizing capacity building for cadres through interactive education, practical mentoring, and the provision of easy-to-implement guidelines, so that they can become agents of change in educating and mobilizing the community (Jaipakdee et al., 2025). To address these issues, the PILAH (Integrative Waste Management Guide) Program was developed, based on cadre participation (Afnan et al., 2025). This program is designed with an interactive educational approach, distribution of practical guidebooks, and composting practices (Bachmann et al., 2025; Rahmaniah et al., 2024). Through this method, cadres not only gain additional insight but also strengthen positive attitudes and practical skills that can be applied and disseminated back to the community (Xu et al., 2025).

This study aims to evaluate the effectiveness of the PILAH Program in improving the capacity of environmental health cadres in Bonto Perak Village through changes in knowledge, attitudes, and behavioral intentions. This can enrich the literature on the effectiveness of cadre-based interventions in waste management, while providing a conceptual basis for developing environmental health promotion strategies in various community contexts (Nurfatimah Yusuf et al., 2024). The results of this study also have the potential to become a reference for local governments in formulating more structured, measurable, and sustainable community participation-based waste management policies, while contributing to the development of innovative participatory education approaches to strengthen pro-environmental behavior and reduce pollution risks (Saxena et al., 2025). Thus, this study is expected to provide empirical evidence regarding the benefits of the program and serve as a basis for developing similar intervention models in other regions to strengthen environmental health promotion strategies and sustainable waste management (Nurfatimah Yusuf et al., 2024). In addition, this study can support the achievement of the sustainable development agenda, especially in the aspects of environmental health and community-based waste management.

2 Methods

This study was a quasi-experimental quantitative study using a one-group pretest–posttest design. It aimed to evaluate the effectiveness of the PILAH (Integrative Waste Management Guidelines) Program in improving the capacity of environmental health cadres (Loso Judijanto et al., 2025).

In this study, respondents were first assessed through a pretest, then given the PILAH Program intervention, and then a posttest was administered using the same instrument. Differences between pretest and posttest results were analyzed to determine the effect of the intervention (Okamoto et al., 2020). This study was conducted in July 2024 in Bonto Perak Village, Makassar City. The independent variable in this study was the PILAH Program intervention, while the dependent variables included the knowledge, attitudes, and behavioral intentions of environmental health cadres regarding household waste management (Ageng Saepudin Kanda et al., 2024).

The study population was all environmental health cadres in Bonto Perak Village, using a purposive sampling technique. Based on the inclusion criteria, 18 cadres were selected as research respondents. The inclusion criteria included: (1) active cadres for at least 1 year, (2) domiciled in the research area, and (3) willing to participate in all research activities. The exclusion criteria were cadres who were not present during the intervention or did not complete the questionnaire.

The research instrument used was a standardized questionnaire consisting of three sections: (1) knowledge of the basic concepts of household waste management, (2) cadre attitudes toward waste management behavior, and (3) cadre behavioral intentions for implementing and disseminating waste management practices. Prior to use, the questionnaire underwent a validity test using Pearson Product Moment correlation. The calculated r value ranged from 0.432 to 0.756, with an r table ($n=30$; $\alpha=0.05$) of 0.361, thus declaring all items valid. Reliability testing was performed using Cronbach's Alpha, with a result of 0.872 (>0.70), indicating the reliability of this research instrument. The research data were analyzed using SPSS software. Univariate analysis was performed to describe respondent characteristics and the distribution of knowledge, attitude, and behavioral intention scores. Furthermore, the Wilcoxon Signed Rank Test was used to determine whether there were significant differences between the pretest and posttest results. The significance level was set at a p -value <0.05 .

3 Results and Discussion

Respondent Characteristics This study involved 18 environmental health cadres in Bonto Perak Village. Respondent characteristics are shown in the following table:

Table 1 Respondent characteristics

Characteristics	Category	Z	%
Age	<30 years	4	22,2%
	30–40 years	9	50,0%
	>40 years	5	27,8%
Education	Junior High School	2	11,1%
	Senior High School	10	55,6%
	College	6	33,3%
Time as a cadre	<3 years	7	38,9%
	≥ 3 years	11	61,1%

The majority of respondents were of productive age (30–40 years old) with a high school education and having been a cadre for more than three years. Productive age is the period when a person has optimal cognitive and physical capacity to absorb new information and play an active role in community activities. Secondary education provides a sufficient foundation for understanding educational materials, while more than three years of experience as a cadre familiarizes respondents with fulfilling social roles in the community. This facilitates acceptance of the PILAH Program and increases the effectiveness of the intervention.

Table 2 Effectiveness of the PILAH program on respondents' knowledge, attitudes, and behavioral intentions

Variable	Kategori	Pretest Z (%)	Posttest Z (%)	p-value
Knowledge	Good	4 (22,2)	9 (50,0)	0,008*)
	Enough	12 (66,7)	9 (50,0)	
	Not enough	2 (11,1)	0 (0,0)	
Attitudes	Good	18 (100)	18 (100)	1,000
	Enough	0 (0,0)	0 (0,0)	
	Not enough	0 (0,0)	0 (0,0)	
Behavioral Intentions	Good	15 (83,3)	18 (100)	0,083
	Enough	3 (16,7)	0 (0,0)	
	Not enough	0 (0,0)	0 (0,0)	

*) $p < 0.05$ is considered significant

Cadre Knowledge

Cadre knowledge increased significantly after the intervention ($p=0.008$). Before the program, the majority of cadres were only in the adequate category (66.7%), but after the intervention, this increased to 50% in the good category, with the elimination of the poor category. This improvement indicates that interactive outreach, the use of the PILAH Guidebook, and hands-on composting practice proved effective as learning media, as they enabled cadres to understand concepts more deeply, internalize waste sorting and processing procedures, and develop practical skills that could be directly applied in the field, compared to conventional one-way lecture methods. With an increased understanding of the 3R concept, waste sorting, and organic waste processing, cadres became more prepared and confident in educating the community appropriately, thus maximizing the potential for behavioral change in household waste management and sustaining it (Tasnim et al., 2024).

Cadre Attitudes

There was no significant difference in cadre attitudes ($p=1.000$) because all respondents had a positive attitude from the start (100%). This means that cadres were already aware of the importance of household waste management before the program was implemented. This is consistent with Green's theory that attitudes are influenced by pre-existing values, experiences, and social environments. Although there was no statistical increase, this positive attitude constitutes important social capital that supports the program's acceptance in the community. Cadre attitudes often remain unchanged due to the influence of long-standing social values.

Cadre Behavior Intentions

The results showed an increase in the proportion of cadres with good behavior intentions, from 83.3% in the pretest to 100% in the posttest. The Wilcoxon test yielded a $p=0.083$, indicating statistical insignificance ($p>0.05$). This was because the majority of cadres (83.3%) were already in the good category from the start, resulting in only three cadres who improved from the fair to the good category. The relatively small change in the number of cadres meant the difference was not strong enough to generate statistical significance. However, in practice, this change was significant, as after the intervention, all cadres (100%) were in the good category. This indicates that the PILAH Program successfully strengthened cadres' commitment to implementing and disseminating household waste management practices, in accordance with the Theory of Planned Behavior, which emphasizes that intention is the primary predictor of actual behavior. With increased cadre commitment, it is hoped that program implementation in the community will be more optimal, although the statistical test results are not significant.

Implications of the PILAH Program

The results of the study indicate that the PILAH Program significantly increased cadre knowledge and strengthened their behavioral plans, although this was not statistically significant. Meanwhile, cadre attitudes were already in the good category from the outset and showed no change. The implications of these findings are:

3.1 Strengthening Cadre Capacity

Improving cadre knowledge demonstrates that participatory education and the use of the PILAH Guidebook are effective strategies for strengthening the capacity of environmental health cadres.

3.2 Practical Behavioral Commitment

Although statistically insignificant, the practical change in behavior plans, which reached 100% in the good category, indicates that cadres have a strong commitment to implementing waste management in the community.

3.3 Attitude as Social Capital

The cadres' consistently positive attitudes are a social asset that needs to be utilized, so that interventions focus more on improving practical skills and program sustainability.

3.4 Program Replication

The PILAH Program can serve as a model for interventions in other regions, particularly with an emphasis on participatory education, hands-on practice (such as composting), and support for waste management infrastructure.

3.5 Community-Based Waste Management

The implementation of the PILAH Program confirms that successful waste management is determined not only by technical aspects, but also by structured management at the community level. This includes sorting mechanisms at the household level, strengthening collection systems, optimizing waste banks, and utilizing organic waste for composting. With trained cadres, the waste management process can run more

systematically, integrated with village apparatus, and has the potential to create sustainable economic and environmental value.

Thus, the PILAH Program has implications for strengthening cadres as agents of change in the community, and for sustainability, it requires government support, supporting facilities, and regular mentoring. Integration with waste management policies at the sub-district and city levels is also crucial to ensure the program aligns with applicable regulations, gains legitimacy, and has broader reach.

In addition to emphasizing the habit of separating organic and inorganic waste from the household as a first step towards a sustainable waste management system, the PILAH Program also builds collective community awareness of the risks of environmental pollution caused by improper waste management, thereby encouraging sustainable behavior. Furthermore, economic-based incentive policies are needed, such as support for strengthening waste banks, providing awards for households or neighborhood associations (RT) that are active in waste management, and waste levy reduction schemes to encourage consistent community participation and create added value from waste management practices.

4 Conclusion

This study shows that the PILAH (Integrative Waste Management Guide) Program is effective in significantly increasing the knowledge of environmental health cadres and strengthening behavioral plans, although not statistically significant, with cadre attitudes that have consistently been in the good category from the beginning. This finding confirms that the program has achieved its objectives as explained in the introduction, namely increasing the capacity of cadres as agents of behavior change in household waste management. The practical implication of this study is that the PILAH Program can be used as a model for community-based interventions that can be replicated in other areas. Further research is recommended to monitor changes in cadre behavior in the long term, integrate infrastructure support, and evaluate the sustainability of cadre-based waste management practices at the broader community level.

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