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Community participation in municipal solid waste management: Special reference to Gampaha municipality

H.A. Dimani Tharuka Hapuarachchi *

Department of Social Statistics, University of Kelaniya, Sri Lanka.

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Abstract

Effective management of municipal solid waste is a pressing issue for numerous developing countries, including Sri Lanka. Despite efforts to implement eco-friendly waste disposal methods, many nations struggle with open landfills and unregulated dumping, causing detrimental effects on both public health and the environment. This study delves into the impact of community participation on solid waste management, with Sri Lanka serving as a case study. Urbanization and shifting consumption patterns exacerbate the challenges surrounding solid waste management. In Sri Lanka's urban areas, the absence of adequate waste management mechanisms emphasizes the necessity for active community involvement. Identifying the types and sources of solid waste is crucial for devising efficient waste management strategies. Concepts like the 3R approach (reduce, reuse, recycle) and composting play pivotal roles in sustainable waste management. Employing logistic regression analysis, the study assesses how community participation influences solid waste management. Results indicate that community involvement positively affects waste reduction, recycling, and composting efforts. However, while a considerable portion of the community actively engages in waste reduction, participation in waste reuse and recycling is limited. This highlights the significance of promoting the 3R concept and enhancing community involvement in waste management endeavors. Overall, the study underscores the instrumental role of community participation in achieving sustainable municipal solid waste management. Recommendations include prioritizing the 3R approach, investing in composting initiatives, and fostering greater community engagement in waste management practices. By adopting these strategies, municipalities can effectively address solid waste challenges while promoting environmental sustainability and public health.

Keywords: Solid waste management; Community participation; Ordinal logistic regression; Waste reduction; 3R concept

1. Introduction

Municipal solid waste management poses a significant challenge for numerous countries, particularly those in the developing world [1]. Despite the existence of some environmentally friendly waste disposal methods in a handful of nations, many developing countries still struggle to effectively manage solid waste, often resorting to open landfills or dumping in unregulated areas, which can have detrimental effects on public health and the environment [1]. As highlighted by Shabani (2015), municipal solid waste has become a pressing issue for urban management, exacerbated by the rapid growth of urban populations and their consumption patterns [2]. Economic prosperity and increased urbanization further complicate waste generation and management, making it an increasingly complex challenge for the future [2].

In many countries, including Sri Lanka, urban solid waste management has emerged as a significant concern, with open landfills contributing to groundwater pollution and posing risks to public health and the environment [1]. Pinnawala (2016) emphasizes the lack of proper mechanisms for managing solid waste in urban areas, with citizens often assuming

* Corresponding author: H.A. Dimani Tharuka Hapuarachchi

that waste management is solely the responsibility of local authorities [3]. However, Pinnawala (2016) argues that waste management is a shared responsibility, requiring active participation from the community for sustainable solutions to be implemented effectively in Sri Lanka [3].

2. Literature Review

2.1. Solid waste and municipal solid waste

Solid waste refers to discarded materials in a solid state that is deemed useless and unwanted, stemming from various societal activities [4]. These materials originate from manufacturing processes or post-use waste generated in domestic or commercial settings [4]. Categorized into several types, solid waste includes municipal, hazardous, industrial, agricultural, and biomedical waste [5]. The convergence of population growth and evolving living conditions has led to the proliferation of diverse solid waste types [5]. With global production reaching a staggering 2.01 billion tonnes annually, of which a concerning 33% is inadequately managed [6]. On average, each person generates 0.74 kg of waste per day worldwide, with variations across regions [6]. Projections suggest a surge to 5 billion tons of solid waste by 2050, driven by population growth, with a notable correlation between waste generation and income level [6]. High-income countries are anticipated to witness a 19% rise in per capita waste production by 2050, while low- and middle-income nations may experience a 40% or greater increase [6].

In the Sri Lankan context, solid waste comprises food waste, kitchen scraps, garden waste, paper, cardboard, plastics (both hard and soft), glass, metals, textiles, rubber, ceramics, and hazardous materials like batteries, fluorescent bulbs, and volatile substances (State Ministry of Provincial Councils and Local Government Affairs, 2024) [7]. Major sources of solid waste include households, commercial establishments, businesses, markets, factories, public areas, and highways [7].

2.2. Municipal solid waste management

Solid waste management involves the collection, treatment, and disposal of materials that have reached the end of their useful life [8]. Inadequate handling of municipal solid waste can lead to unsanitary conditions, environmental pollution, and the transmission of vector-borne diseases like plague through rodents and insects [8]. It's now widely recognized that managing municipal solid waste is not just a duty but a responsibility.

One method of managing municipal solid waste is through open burning, where materials such as wood, plastic, textiles, rubber, and waste oil are incinerated [9]. However, this practice, including burning in landfills, contributes significantly to air pollution in developing countries due to particulate matter emissions [9]. Exposure to these emissions can lead to various health issues, including respiratory and cardiovascular problems, adverse birth outcomes, and cancer [10]. The Global Burden of Disease study estimates that outdoor particulate pollution is the fifth leading cause of premature death in India, resulting in 695,000 premature deaths [10].

Another effective approach to managing municipal solid waste is composting, despite common misconceptions about its complexity and inconvenience [11]. Composting, which involves the decomposition of food and organic matter without pesticides or artificial fertilizers, is a straightforward and valuable process [11]. Various composting methods and technologies, such as the compost pile, pit, bin, and three-bin methods, are available for efficient waste management. Additionally, the 3R concept—Reduce, Reuse, and Recycle—is crucial in solid waste management [12]. This concept has evolved, with the introduction of the 5R concept, which includes the stages of Recover and Disposal [13]. These principles provide a structured approach to managing solid waste effectively.

2.3. Community participation in municipal solid waste management

Community participation plays a pivotal role in solid waste management, as highlighted by Gotame (2012) [14]. It is integral to ensuring the continuous operation of solid waste management systems. Tasks such as segregating garbage into special bins or bags, storing waste properly, and delivering it to designated disposal sites are responsibilities that fall upon the community [14]. Indeed, community involvement is often deemed more crucial than other municipal services. Gotame (2012) defines community management as the process wherein community members or their representatives determine what actions to take and how to execute them [14]. This involvement spans various local interventions, including educating and raising awareness about proper hygiene practices, implementing cost recovery initiatives, undertaking resource recovery efforts, and participating in advisory, administrative, and managerial roles [15]. At its core, community participation entails providing segregated waste to collectors and ensuring timely waste disposal [15].

Thus, it is evident from the literature that sustainable urban solid waste management relies heavily on the contributions of the community. Consequently, the objective of this study is to assess the impact of community participation on municipal solid waste management.

3. Materials and Methods

The target population of this study comprises all household units within Gampaha Municipality, totaling 16,658 units as per the Gampaha Municipality Budget Document (2021). A simple random sampling method, specifically the Hpbasa method, was employed to select a sample of 100 household units from this population. Primary data was collected for the study, focusing on understanding the impact of public participation on municipal solid waste management. Data collection involved administering questionnaires to the selected 100 household units within Gampaha Municipality.

Descriptive statistical techniques and ordinal logistic regression analysis were utilized for data analysis. In the logistic regression model, solid waste reduction, solid waste reuse, solid waste recycling, and solid waste composting were treated as independent variables, represented by binary variables indicating "yes" or "no." The dependent variable, community participation, was measured using Likert scales ranging from "strongly disagree" to "strongly agree."

4. Results and Discussion

4.1. Descriptive Statistics

The community must recognize that solid waste management is a shared responsibility, as it primarily stems from community activities. Understanding the level of knowledge among study respondents regarding solid waste management is essential in this context. According to the survey findings, 42% of respondents demonstrate sufficient knowledge about solid waste management. They acknowledge that solid waste is a product of human activities and recognize their role in its management. Moreover, they consistently support and collaborate with municipal efforts in solid waste management. Additionally, 51% of respondents possess a fair level of knowledge, and understanding that solid waste poses various challenges. However, 7% of respondents lack awareness regarding the necessity of solid waste management.

59% of the community has made a full contribution to reducing solid waste, while 24% have made a moderate contribution. Additionally, the study clarified that approximately 17% of the community does not make any contribution towards solid waste reduction efforts. Only a simple 14% of the community has been involved in the reuse of solid waste, as indicated by the study. On average, approximately 27% of the community has contributed moderately to solid waste reuse, while a staggering 59% have not participated in this aspect. This highlights a significant disparity, showing that although a substantial 84% of the community has actively contributed to reducing solid waste, only half of that percentage has been involved in its reuse.

An ordinary 14% of the community has been involved in contributing to the reuse of solid waste, as per the findings of this study. On average, approximately 27% of the community has made a moderate contribution to solid waste reuse, while a significant majority, accounting for 59%, has not participated in this endeavour. This underscores a notable imbalance: while a substantial 84% of the community has actively contributed to reducing solid waste, only half of that figure has engaged in its reuse.

Moreover, none of the communities have directly contributed to solid waste recycling, reflecting a 0% participation rate in this aspect. This further highlights the disparity: despite the majority of the community participating in solid waste reduction, only half have contributed to solid waste reuse, and none have been directly involved in recycling. Instead, 23% have made a moderate contribution to recycling, while a considerable 77% have not participated at all. This suggests a slow pace of community participation in solid waste recycling, as revealed by the study.

From the data provided, it is evident that while a significant portion of the community has actively participated in reducing solid waste, their engagement in reusing and recycling solid waste has been notably lower. This indicates a limited adoption of the 3R concept within the Gampaha Municipality. Consequently, the insufficient implementation of the 3R concept may be contributing to the increase in solid waste generation.

Another strategy for managing solid waste at the household level is composting. The graph below illustrates the community's contribution to composting, based on the sample survey conducted in this study.

4.2. Impact of Community Participation on Municipal Solid Waste Management

The primary aim of this study is to investigate the impact of community participation on municipal solid waste management. Logistic regression analysis was employed to achieve this objective. To ensure the validity of the results, it is imperative to satisfy certain assumptions. The first hypothesis pertains to the proportion odds hypothesis.

Table 1 Test of Parallel lines

Test of Parallel Lines ^a				
Model	-2 Log Likelihood	Chi-Square	Df	Sig.
Null Hypothesis	39.187			
General	35.714	3.473	7	0.838

Source: Survey data, 2023

According to the table above, the mean value (p-value) is 0.838, which is greater than 0.05, which confirms that the slope does not change in this study, and the ordinal logistic regression model can be used for this purpose.

Table 2 Pseudo R-Square

Pseudo R-Square	
Cox and Snell	0.304
Nagelkerke	0.402
McFadden	0.257

Source: Survey data, 2023

According to Table 2, the Cox and Snell measurements are reported as 0.304, with Nagelkerke’s adjusted value at 0.402. These positive values indicate an increasing probability of community participation in municipal solid waste management, suggesting that both the outcome variable and each predictor variable are contributing to this likelihood. The relatively similar values of Cox and Snell measures and Nagelkerke's adjusted value indicate a reasonably good effect size.

The second hypothesis concerns multicollinearity. The Tolerance value is high ($0.6 > 0.1$), and the Variance Inflation Factor (VIF) is low ($1.67 < 10$), satisfying the assumption of no multicollinearity in the model.

The third assumption involves checking whether the observed data aligns well with the developed model. The goodness of fit test yields a significance value of 0.998, which exceeds 0.05. Consequently, it can be inferred that the observed data are in good agreement with the fitted model. This study aims to explore the impact of community participation on waste management. The Model Fitting Information test indicates a Chi-square value of 36.195 with a Significance value of 0.000, which is below 0.05. This suggests a significant effect of community participation on municipal solid waste management. Given that all assumptions are satisfied, it confirms the suitability of using the ordinal logistic regression model for this study.

Table 3 demonstrates that reducing solid waste positively influences community participation in municipal solid waste management. With all other variables held constant, an increase of one unit in solid waste reduction corresponds to a 1.363 increase in the log odds of community participation in waste management. The odds ratio ($\exp = 1.24$) is 3.4556. Additionally, the significance value being less than 0.05 implies that community participation significantly affects solid waste reduction, further affirming its positive impact.

According to Table 3, solid waste reuse exhibits a negative effect on the presence of community participation in municipal solid waste management. Holding all other variables constant, a one-unit increase in solid waste reuse decreases the log odds of community participation by 1.85, with an odds ratio of 6.3598. Additionally, the significance level ($p\text{-value} = 0.005$) indicates that community participation significantly influences solid waste reuse. Conversely, solid waste recycling demonstrates a positive effect on community participation in municipal solid waste management. With all other variables held constant, a one-unit increase in solid waste recycling corresponds to a 1.78 increase in the log odds of community participation, with an odds ratio of 5.9298. The significance level ($p\text{-value} = 0.012$) confirms that

community participation significantly affects solid waste recycling. Similarly, composting shows a positive effect on community participation in municipal solid waste management. Holding all other variables constant, a one-unit increase in solid waste composting increases the log odds of community participation by 1.02, with an odds ratio of 2.7731. The significance level (p -value = 0.000) indicates that community participation significantly influences solid waste composting.

Table 3 Parameter Estimates

		Estimate	Std. Error	Wald	df	Sig.
Threshold	Disagree	-2.337	1.089	4.607	1	0.032
	Neutral	4.025	0.865	21.626	1	0.000
Location	Reduce solid waste	1.240	0.621	3.983	1	0.046
	Reuse solid waste	-1.853	0.661	7.866	1	0.005
	Recycling solid waste	1.781	0.705	6.381	1	0.012
	Compost	1.016	0.276	13.528	1	0.000

Source: Survey data, 2023

Overall, community participation has a notable impact on municipal solid waste management, with predominantly positive effects. This confirms the study's objective, illustrating that community involvement in waste management is indeed beneficial.

5. Conclusion and Suggestions

When examining the impact of community participation on municipal solid waste management in Sri Lanka, it's evident that community involvement is moderate and generally has a positive effect on waste management practices. Community participation contributes positively to various solid waste management methods, including waste reduction, recycling, and composting. The active involvement of communities in these practices is directly linked to achieving sustainable waste management goals, fostering a cleaner environment, and improving public health.

Several researchers have emphasized the necessity and significance of adopting alternative approaches to address the significant solid waste generated by countries facing rapid and unsustainable urbanization. Conventional methods of waste collection, transportation, and disposal have proven to be both costly and unsustainable. Therefore, municipalities need to prioritize the adoption of the 3R concept (reduce, reuse, recycle) and invest in composting initiatives alongside traditional waste management methods. This approach not only offers a sustainable solution to waste management challenges but also creates opportunities for job creation, thus addressing issues of unemployment in urban areas. Additionally, incorporating compost derived from municipal biodegradable waste into urban agriculture practices can promote sustainable urban agriculture and serve as an alternative fertilizer, further contributing to environmental sustainability and food security.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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