Assessing Waste Disposal and Recycling Behavior in Public Spaces: Habits, Barriers, Incentives, and Digital Solutions

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DOI: https://dx.doi.org/10.47772/IJRISS.2026.10200594

Received: 17 January 2026; Accepted: 22 January 2026; Published: 21 March 2026

ABSTRACT

The ongoing production of waste globally poses serious environmental concerns, particularly in developing countries such as the Philippines. Despite national legislation like the Ecological Solid Waste Management Act (RA 9003) and local programs in Cabagan, Isabela, sustaining active public engagement in recycling remains difficult. This study, titled Assessing Waste Disposal and Recycling Behavior in Public Spaces: Habits, Barriers, Incentives, and Digital Solutions, examined waste behaviors, common barriers, and potential incentives among 345 participants, including vendors, drivers, students, teachers, and government employees.

A descriptive research design was employed using a structured survey questionnaire. Findings revealed that the use of public recycling bins was generally low, and plastic was the most frequently disposed waste type. Women reported better waste segregation practices than men, though the difference was not statistically significant. The two primary obstacles identified were the lack of accessible recycling bins and limited incentives. Proposed solutions included providing more visible and well-maintained bins and introducing reward-based initiatives.

Participants also expressed strong support for digital solutions to improve waste management. The most preferred were reward-based mobile applications and QR code tracking systems, followed by smart bins with sensors, AI-based waste sorting, and digital awareness campaigns. Monetary rewards were considered the strongest motivator, although non-monetary rewards were also valued.

The study concludes that improved infrastructure, combined with digital innovations, can enhance efficiency, increase participation, and promote sustainable waste management in public areas.

Keywords: Waste management, recycling behavior, public spaces, sustainable practices, digital solutions

INTRODUCTION

The continuous growth of the global population has greatly increased waste generation, creating environmental challenges such as floods, global warming, and other natural disasters linked to improper waste disposal. Waste management is further complicated by external factors that influence individual behaviors and practices (Phulwani et al., 2021). In the Philippines, this issue is especially urgent. According to Balita (2024), daily waste production in the country reached approximately 59.24 thousand tons in 2022, reflecting an alarming upward trend.

To address these challenges, various organizations and governments have introduced initiatives to improve waste disposal, particularly in public spaces. Traditional approaches such as the 3Rs (Reduce, Reuse, Recycle) continue to promote segregation and conversion of waste into useful products. Programs like waste-to-reward systems are also being implemented to motivate individuals through incentives. In addition, the Ecological Solid Waste Management Act (Republic Act No. 9003), enacted in 2001, aims to reduce waste through institutionalized reuse, recycling, and reduction strategies.

At the local level, Cabagan, Isabela has implemented programs such as the CABAGAN BASUHEROES PROGRAM, which includes initiatives like Palit Single-Use Plastic Store (exchange of plastics for cash), Single-Use Plastic Engagement Rewards (educating and rewarding students with school supplies for plastic collection), and the Trash-to-Crafts-to-Cash Project (transforming waste into marketable crafts). These programs have proven effective in reducing waste and encouraging community participation.

Despite these efforts, sustaining active participation remains a major challenge. Factors such as attitudes, habits, and behavioral practices influence whether individuals properly dispose of waste in designated bins. This indicates the need to explore additional strategies that can strengthen participation and accountability such as the integration of digital and IT-based solutions offers new opportunities to enhance efficiency, motivate public participation, and sustain recycling practices.

The study, "Assessing Waste Disposal and Recycling Behavior in Public Spaces: Habits, Barriers, Incentives, and Digital Solutions," aims to examine the social behaviors, attitudes, and practices of individuals in waste management, particularly in the public places at Cabagan. It also seeks to evaluate the effectiveness of current waste management programs and assess how the integration of digital tools can encourage stronger and more consistent recycling participation in public spaces.

Statement of Objectives

This study aimed to assess waste disposal and recycling behaviors in public spaces and determine the factors, incentives, and digital solutions that influence community participation.

Specifically, it aims to:

1. Determine the waste disposal and recycling habits of the individuals in public spaces

2. Determine the key issues and barriers that hinder effective recycling practices in public spaces

3. Determine the factors influencing the use of recycling bins

4. Assess the perception on the use of incentives and rewards on respondents' likelihood to participate in material recycling.

5. Find out the differences in respondents' waste disposal and recycling habits in public spaces based on sex

6. Determine respondents' views on using technology to improve waste management and encourage recycling participation

METHODS

This study employed a descriptive research design, with a survey questionnaire as the primary tool to assess waste disposal and recycling habits in public spaces. The questionnaire focused on behaviors, perceived barriers, and attitudes toward incentives and rewards, as well as perceptions of how incentives might encourage recycling. Data collection took place over a two-month period in key public areas such as parks, markets, and universities.

The study involved the following respondents: 30 vendors from Cabagan Square Park and the local market, 105 customers from the market and Square Park, 15 personnel from the Cabagan Local Government Unit (LGU), 30 tricycle drivers, five staff members from the Municipal Environment and Natural Resources Office (MENRO), 20 faculty and 140 students from Isabela State University–Cabagan Campus (ISUC), enrolled in the second semester of SY 2024–2025.

The study was carried out in key public areas such as parks, markets, and universities in Cabagan, Isabela. A pre-test of the questionnaire was conducted with senior faculty researchers to ensure content validity and reliability. Questionnaires were distributed and retrieved personally. Collected data were analyzed using ranking, and percentage.

Likewise, a t-test was utilized to determine the significant difference between male and female responses with regard to their habits or practices in waste Segregation in Public Spaces.

RESULTS AND DISCUSSION

a. Waste Disposal and Recycling Habits

This section shows the results of the data gathered form 345 respondents to determine the waste disposal and recycling habits of the individuals in public space. It is divided into four tables.

Table 1 presents the data on the frequency of recycling bin usage in public spaces in Cabagan. The results indicate that the majority of respondents rarely use recycling bins, with 32% (ranked 1) comprising 73 females and 38 males. This low usage corresponds with the proponents' observations of scattered waste in areas such as Cabagan Square Park, markets, and school surroundings.

Meanwhile, 27% (ranked 2) of respondents—51 females and 43 males—reported using recycling bins on a weekly basis. Notably, 12% of the respondents (25 males and 16 females) indicated that they never use recycling bins in public spaces. Although this is the fourth most frequent response out of five, it remains concerningly high and suggests the need for improved waste management practices and increased public awareness.

Table 1. Frequency of Recycling Bin Use in Public Spaces

Frequency of Recycling Bin Use				
Description	**Sex**	**No. of Respondents**	**Rank**	**Percentage**
Daily	Male	30	3	22%
	Female	47		
Weekly	Male	43	2	27%
	Female	51		
Monthly	Male	8	5	6%
	Female	14		
Rarely	Male	38	1	32%
	Female	73		
Never	Male	25	4	12%
	Female	16		
Total Respondents		**345**		

Table 2 presents the respondents' waste segregation practices, focusing on individuals aged 18 to 25, as this age group had the highest response rate to the survey. The data show that males had a mean score of 2.71, indicating they sometimes separate recyclables from non-recyclables when disposing of waste. Field observations in public spaces revealed that labeled segregation bins are often unavailable. Even when such bins are present, people frequently misuse them, discarding mixed waste in bins designated for recyclables, suggesting poor adherence to proper segregation practices. Upon examining the contents of these bins, the researchers found that waste was typically mixed, further confirming low compliance.

In contrast, females had a higher mean score of 3.44, indicating they often practice waste segregation, especially in public spaces. This group likely includes students and faculty members who are in settings where labeled bins and waste segregation systems are both available and actively promoted.

Table 2. Waste Segregation Practice of Respondents in Public Spaces

Waste Segregation Practice						
	Male (n = 80)			**Female (n = 80)**		
Response	Frequency	Weight	Score	Frequency	Weight	Score
Always	11	5	55	15	5	75
Often	15	4	60	18	4	72
Sometimes	29	3	87	34	3	102
Rarely	20	2	10	13	2	26
Never	5	1	5	0	1	0
Total	**80**		**217**	**80**		**275**
Weighted Mean	**2.71**			**3.44**		

Table 3 presents data on whether respondents use recycling bins when available in public spaces. The results show that a majority—89% of respondents (ranked 1), including 186 females and 121 males—reported that they use recycling bins when available. Interestingly, 6% (ranked 2) indicated that they are *not aware* of the presence of recycling bins in public areas. Additionally, 5% admitted they had not noticed such bins at all. This lack of awareness may be attributed to the limited number and visibility of recycling bins in public spaces, highlighting a gap in infrastructure and signage, hence Recycling bin design has been shown to be important in guiding and changing waste management practices [1].

Table 3. Usage of Bins in Public Places

Availability-Based Bin Usage				
Description	**Sex**	**No. of Respondents**	**Rank**	**Percentage**
Yes	Male Female	121 186	1	89%
No	Male Female	12 6	3	5%
I am Not aware of recycling bins in public	Male Female	11 9	2	6%
Total Respondents		**345**		

The types of waste most commonly disposed of in public spaces by respondents is shown in Table 4. Notably, plastic is the most frequently discarded material, reported by 61% of respondents (ranked 1), consisting of 126 females and 85 males. Paper ranks second, with 24% of respondents (58 females and 25 males) indicating it as a common waste type. The least reported waste type is organic waste, accounting for only 1% of the total responses.

Table 4. Commonly Disposed Waste in Public Spaces

Commonly Disposed Waste in Public Spaces				
Description	**Sex**	**No. of Respondents**	**Rank**	**Percentage**
Paper	Male Female	25 58	2	24%
Plastic	Male Female	85 126	1	61%
Glass	Male Female	9 17	3	8%
Organic waste	Male Female	1 4	5	1%
Bakal	Male	7	4	6%
	Female	13		
Total Respondents		**345**		

Barriers to Recycling and Solutions

This section shows data on the key issues and barriers that hinder effective recycling practices in public spaces.

The identified barriers to recycling in public spaces among the respondents is shown in Table 5. The top-ranked barrier, cited by 30% of respondents, is the lack of accessible recycling bins. The second most reported barrier, at 26%, is the absence of clear incentives or rewards for recycling. Providing such incentives may encourage individuals to dispose of their waste properly and practice effective waste segregation. This statement also supported by [2] which stated that economic inducement was more effective than social mobilization in promoting waste separation. This could support not only the waste management efforts of the Cabagan LGU and MENRO but also contribute positively to environmental sustainability. The third-ranked barrier, reported by 20% of respondents, is the lack of proper waste segregation bins, which aligns with earlier findings in previous tables highlighting the limited availability of appropriately labeled bins.

Table 5. Barriers to Recycling Waste in Public Spaces

Barriers to Recycling Waste in Public Spaces				
Description	**Sex**	**No.of Respondents**	**Rank**	**Percentage**
Lack of accessible recycling bins	Male Female	45 58	1	30%

Lack of awareness about recycling	Male Female	19 33	4	15%
No clear incentives or rewards for recycling	Male Female	32 55	2	26%
Lack of proper waste segregation bins	Male Female	21 47	3	20%
Cleanliness or poor maintenance of recycling bin	Male Female	13 15	5	8%
Social indifference or lack of peer influence	Male Female	2 5	6	2%
Total Number of Respondents		**345**		

Table 6 presents the respondents' suggestions for overcoming barriers to recycling in public spaces. The most commonly recommended solution is the provision of more accessible and well-maintained recycling bins, suggested by 33% of respondents, including 74 females and 38 males. Ranked second is increased incentives or rewards for recycling, recommended by 31% of respondents (68 females and 37 males). These suggestions indicate that respondents believe proper waste disposal and recycling behavior can be encouraged through better infrastructure [3] and motivational rewards [4]. The least recommended strategy, with only 9% of responses, is the implementation of public awareness campaigns to promote recycling. This may be due to the ongoing efforts of local government units (LGUs) and barangays, which already conduct regular campaigns and programs on waste management and weekly waste collection.

Table 6. Respondents Suggestion to Overcome Recycling Barriers

Strategies to Overcome Recycling Barriers in Public Spaces				
Description	**Sex**	**No. of Respondents**	**Rank**	**Percentage**
More accessible and well-maintained recycling bins	Male Female	38 74	1	33%
Clear signage and instructions for proper recycling	Male Female	28 36	3	19%
Increased incentives or rewards for recycling	Male Female	37 68	2	31%
Public awareness campaigns to encourage recycling	Male Female	12 17	5	9%
Stronger enforcement and penalties for improper waste disposal	Male Female	12 23	4	10%
Total Respondents		**345**		

Factors Influencing the Use of Recycling Bins

This section shows the data on the factors influencing the use of recycling bins Table 7 presents data on the respondents' perceived level of difficulty in finding recycling bins in public spaces. About 49% of respondents, including 104 females and 66 males, indicated a *neutral* stance on the ease of locating recycling bins. The second most common response, at 20%, was that it is *easy* to find recycling bins, particularly in the public market. However, based on the proponents' observations, while bins may be present, they are not designated for different types of waste, leading to improper waste disposal and a lack of segregation. The least selected response was *very difficult*, reported by 6% of respondents. This may be due to the practice of vendors using plastic bags as makeshift waste containers, which are not appropriate for sorting different types of waste

Table 7. Difficulty Level in Finding Recycling Bins in Public Spaces

Difficulty Level in Finding Recycling Bins in Public Spaces				
Description	**Sex**	**No. of Respondents**	**Rank**	**Percentage**
Very difficult	Male Female	10 10	5	6%
Difficult	Male Female	33 26	3	17%
Neutral	Male Female	66 104	1	49%
Easy	Male Female	24 46	2	20%
Very easy	Male Female	11 15	4	8%
Total Respondents		**345**		

Table 8 presents data on the different aspects that influence the decision of respondents to use a recycle bin in public spaces. Out of the 345 total respondents, 20% (41 females and 28 males) indicated that the availability of incentives (e.g., rewards, discounts) rated as rank 1 has a big impact on motivating individuals in public spaces in terms of recycling waste in the bin. The second rank is accessibility and visibility of recycle bins, with 19% of respondents (42 female and 31 male) 1% away from rank 1. This response indicated that even though there is an unavailability of incentives for throwing waste in public, individuals are also motivated to dispose of their waste in recycle bins as long as the bin is accessible and visible in the public spaces[5]. While environmental awareness, which has 10%, is the least factor influencing individuals to use the recycle bins, this response proved that even if individuals don't have enough knowledge of the effect of improper use of recycle bins in the environment, they also have the initiative to dispose of waste in the appropriate recycle bin.

Table 8. Factors Influencing Respondents Decision to Use a Recycling Bin in Public Spaces

Factors Influencing Respondents Decision to Use a Recycling Bin in Public Spaces				
Description	**Sex**	**No. of Respondents**	**Rank**	**Percentage**
Availability of incentives (e.g rewards, discount)	Male	28	1	20%

	Female	41		
Accessibility and visibility of recycling bins	Male Female	31 42	2	19%
Environmental awarenes	Male Female	12 23	5	10%
Cleanliness and organization of the recycling bins	Male Female	13 44	3	17%
Social influence (seeing other recycle)	Male Female	21 33	4	16%
Convenience	Male Female	20 37	3	17%
Total Respondents		**345**		

Effectiveness of Incentives

This section shows the perception on the use of incentives and rewards on respondents' likelihood to participate in material recycling.

Table 9 presents the respondent's willingness to recycle when there is a reward or incentive. 52 % comprising 81 males and 100 females believed that rewards or incentives motivate individuals to recycle waste in public spaces; this is an important insight that helps different Local Government Units (LGUs) to adopt recycling with rewards or incentives programs. 33% of the respondents responded *maybe*, which indicates that some individuals have the initiative to dispose of their waste in recycling bins with or without incentives. While the lowest response is 14 percent, this individual believed that properly using recycling bins in public spaces is not all about incentives or rewards that they will receive; this may be due to the practice of LGU Cabagan in maintaining cleanliness and orderliness of the Municipality.

Table 9. Likelihood of the Recycling with Rewards or Incentives

Likelihood of Recycling with Rewards or Incentives				
Description	**Sex**	**No. of Respondents**	**Rank**	**Percentage**
Yes	Male Female	81 100	1	52%
No	Male Female	18 31	3	14%
Maybe	Male Female	45 70	2	33%
Total Respondents		**345**		

Table 10 presents the respondents' most preferred incentives that would encourage individuals to recycle waste in public spaces. The option monetary rewards (e.g., discounts, cash) received the highest number of responses, with 41 males and 40 females, with 23% of the total, which is ranked as number 1. This indicates that the motivator of males and females to recycle waste in public spaces is either monetary cash or a discount. The second highest number of responses, which have 20% comprising 30 males and 38 females, is option-free products or services. This response proved that even non-monetary benefits, as long as there are incentives, can encourage individuals to recycle waste in public spaces. While the option of public recognition, which has 8% responses, and vouchers or gift cards with 7% responses are the least, it shows that individuals need some incentives that help them to survive rather than incentives for individual recognition.

Table 10. Types of Incentives that would Encourage Recycling in Public Spaces

Types of Incentives that would Encourage Recycling in Public Spaces				
Description	**Sex**	**No. Of Respondents**	**Rank**	**Percentage**
Monetary rewards (e.g., discounts, cash)	Male Female	41 40	1	23%
Vouchers or gift cards	Male Female	15 8	5	7%
Points that can be exchanged for rewards	Male Female	14 22	3	10%
Public recognition (e.g., certificates, names on a leaderboard)	Male Female	16 11	4	8%
Free products or services	Male Female	30 38	2	20%
Total Respondents		**235**		

Differences in respondents' waste disposal and recycling habits in public spaces based on sex

Table 11 show a t-test for two independent samples (male and female) assuming equal variances was conducted to determine whether there is a statistically significant difference between male and female responses with regard to their habits or practices in waste Segregation in Public Spaces

The table shows that the mean for male variable is 43.4 and mean value for female is 55. Therefore, the calculated t-statistic is -0.48. The p-value (two-tailed) is 0.644, which is greater than the significance level of 0.05 This indicates that the difference in means between the two groups is not statistically significant. Therefore, it fails to reject the null hypothesis and conclude that there is no significant difference between the two groups in terms of their responses.

t-Test: Two-Sample Assuming Equal Variances		
	Male	*Female*
Mean	2.7125	3.4375

Variance	1225.3	1691
Observations	5	5
Pooled Variance	1458.15	
Hypothesized Mean Difference	0	
Df	8	
t Stat	-0.480315822	
P(T<=t) one-tail	0.321930845	
t Critical one-tail	1.859548038	
P(T<=t) two-tail	0.643861689	
t Critical two-tail	2.306004135	

Respondents' views on using technology to improve waste management and encourage recycling participation.

Table 12 presents the respondents' views on using technology to improve waste management and encourage recycling participation. The results reveal a strong interest in adopting digital and IT-based solutions to enhance efficiency and engagement in public spaces.

About 41.27% of participants indicated they would be more motivated to dispose of waste properly if reward-based mobile applications or e-wallet incentives were implemented. Meanwhile, 26.38% preferred a QR code tracking system that promotes recycling accountability and provides rewards.

In addition, 15.32% of respondents supported the installation of smart bins with sensor technology, which notify collection teams when bins are full—helping to prevent overflow and maintain public cleanliness. Around 11.49% favored AI-based waste sorting systems for automated segregation, while 5.5% highlighted the effectiveness of digital platforms for education and awareness (such as social media campaigns or mobile notifications) in influencing daily waste disposal habits.

Table 12. Respondents' views on using technology to improve waste management and encourage recycling participation.

Digital/IT Solution	**Rank**	**Percentage**
Reward-based mobile app	1	41.27%
Smart bins with sensors (monitor waste levels, send alerts)	3	15.32%
QR code tracking system (recycling accountability & rewards)	2	26.38%
Digital awareness campaigns (social media, SMS, mobile notifications)	5	5.53%
AI-based waste sorting (automated segregation technology)	4	11.49%

CONCLUSIONS

Based on the results of the study, the following conclusions were drawn:

The data highlight the frequency of recycling bin usage in public spaces in Cabagan. Results indicate that the majority of respondents rarely use recycling bins. Males were found to sometimes separate recyclables from non-recyclables, while females were observed to often engage in waste segregation [6], particularly in public settings. Most respondents reported using recycling bins when available, suggesting that accessibility may influence usage. Interestingly, 6% of respondents (ranked 2) admitted being unaware of the presence of recycling bins in public areas. Notably, plastic was identified as the most commonly discarded material found in these public bins.

The top-ranked barrier to recycling in public spaces is the lack of accessible recycling bins. This was closely followed by the absence of clear incentives or rewards for recycling. As a solution, respondents most commonly recommended the provision of more accessible and well-maintained recycling bins, along with the implementation of increased incentives or rewards to encourage proper recycling practices.

The data on factors influencing the use of recycling bins show that respondents held a neutral stance regarding the ease of locating recycling bins in public spaces. The least selected response indicated that it is very difficult to find recycling bins in these areas. Among the different factors considered, the availability of incentives (e.g., rewards, discounts) was ranked as the most influential, followed by the accessibility and visibility of recycling bins. In contrast, environmental awareness was identified as the least influential factor affecting individuals' decisions to use recycling bins in public spaces

The perception of respondents regarding the use of incentives and rewards for recycling revealed that the majority believe such strategies motivate individuals to participate in material recycling in public spaces. This finding provides valuable insight for Local Government Units (LGUs), suggesting the potential effectiveness of implementing recycling programs that include rewards or incentives. Among the various options, monetary rewards (e.g., discounts, cash) emerged as the most preferred incentive for encouraging individuals to recycle waste in public areas.

The analysis of the differences between male and female respondents' waste disposal and recycling habits in public spaces, based on age, aimed to determine whether there is a statistically significant difference in their practices. The results indicate that the difference in mean responses between males and females is not statistically significant, suggesting that there is no substantial difference between the two groups in terms of their waste segregation behaviors in public spaces.

The study concludes that digital and IT-based solutions can significantly improve waste management efficiency and public participation. Among the options, incentive-driven mobile applications and e-wallet systems emerged as the strongest motivators, followed by QR tracking systems and smart bins with sensor technology. Although AI-based sorting and digital awareness platforms received less support, they still demonstrate potential to strengthen recycling accountability and promote long-term sustainability in public spaces.

Ethical Considerations

The research study was subjected to certain issues. Informed consent letter was prepared and provided to all participants, including vendors, customers from Cabagan Square Park and the local market,personnel from the Cabagan Local Government Unit (LGU), tricycle drivers, staff members from the Municipal Environment and Natural Resources Office (MENRO), faculty and students from Isabela State University–Cabagan Campus (ISUC), enrolled in the second semester of SY 2024–2025.

This transparency helped establish trust and alignment between the research methods and its goals, ensuring that all participants understood the value of their contributions in relation to the broader objective of Recycling Behavior in Public Spaces.

Confidentiality was strictly observed. Survey questionnaires were designed to protect participants' identities—names were optional, and only the researchers had access to the collected data. All responses were treated with strict confidentiality and were used solely for academic purposes within the scope of this research. Furthermore, participants were assured that no physical, psychological, or emotional harm would come to them throughout

the study. By upholding these ethical standards, the study maintained both the integrity of its methodology and the well-being of its participants.

Conflict of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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