



Integrated Solid Waste Management for Closed Community: An Experiment on Jahangirnagar University Campus

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Abstract – This study examines community participation in integrated solid waste management (ISWM) at Jahangirnagar University in Bangladesh. The university faces significant challenges in waste management, with negative social, environmental and economic consequences. The goal is to identify barriers to community involvement in ISWM and provide recommendations for enhancing engagement. The research uses a mixed-methods approach, surveying 397 respondents using cluster random sampling from the university's population of 20,000. Data collection methods include interviews, observations, focus groups, and document analysis. The findings highlight obstacles to community participation, such as limited community empowerment, mobilization, organization, and resource coordination. Household waste segregation is practiced by only 30% of respondents. However, 74% of participants express willingness to oversee door-to-door waste collection and dispose of waste at designated points, influenced by socioeconomic factors. Non-compliance with ISWM regulations is observed in 26% of respondents, and 12% lack sufficient knowledge about ISWM, indicating a need for improved organization and coordination. Additionally, some university authorities rely on outdated methods, resulting in weak enforcement of environmental regulations. Ineffective policies exacerbate the situation, failing to align with the market economy. The study recommends fostering cooperation between university authorities and the community, revising and enforcing regulations, and emphasizing waste generators' responsibility for proper disposal. Addressing these challenges can significantly improve solid waste management and environmental outcomes at Jahangirnagar University.

Keywords – ISWM, Closed Community, Community Participation, Jahangirnagar University

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1. Introduction

Bangladesh faces a significant solid waste issue, worsened by inaction. Jahangirnagar University, renowned for its green campus housing over 15,000 people in 464 apartments, 16 student halls, a medical facility, two administrative buildings, four institutes, and 34 departments, suffers from a lack of proper waste management. Waste is often scattered in open areas, combined with animal excrement, causing flooding, disease vectors breeding, and illness transmission [1]. Direct discharge of pollutants into surface water harms the campus environment and its aesthetics. Improper solid waste management is also linked to global warming. Thus, establishing an organized solid waste management plan at Jahangirnagar University is crucial to preserve environmental quality and recreational value [2].

Integrated Solid Waste Management (ISWM) encompasses diverse activities for managing waste generated by human activities, which can harm the environment and ecosystems. Proper management is essential to limit environmental damage and conserve

resources. ISWM is a crucial aspect of sustainable development worldwide, with strong global emphasis. Public involvement is a sociological approach that engages people at the local level to improve living conditions. It requires different degrees of participation, financial contributions, and social commitment at various project stages [3].

In today's world, active participation in society is vital due to factors like government's inefficiency in addressing issues, including solid waste management. Community engagement empowers residents to decide on matters that impact their daily lives, like waste management, leading to improved productivity and effectiveness. Community-based integrated solid waste management is seen as a sustainable long-term solution [4].

Population growth and industrialization endanger the urban environment and strain natural resources, hindering equitable and sustainable development. Poor solid waste management contributes to environmental degradation in many developing country cities. In nations like Bangladesh, government institutions struggle to handle the rising waste,

resulting in uncollected waste accumulation on roads and public spaces [5].

Jahangirnagar University is the sole residential university in Bangladesh, housing all its students, totaling around 20,000 individuals (18,000 students). The university includes 16 hostels, eight for male and eight for female students, along with residential units for faculty and staff. These accommodations and dormitories are the main sources of daily solid waste generation. Moreover, the university's 24/7 Medical Centre generates medical waste. Along the Dhaka-Aricha Highway, commercial areas have developed organically, adding to waste production [6].

The study area lacks a proper solid waste policy, leading to challenges in waste management for residents. Improper disposal causes foul odors and blocked drains, worsening the living environment. Jahangirnagar University's formal waste management system is inadequate, with limited authorized vehicles, community involvement, and funding. The study aims to assess community participation in ISWM at the university and explore willingness to pay for improved waste management services, addressing public health and environmental implications [7]. Community participation in integrated solid waste management is a valuable solution for efficient waste management at Jahangirnagar University. This research focuses on the university's campus as a case study to analyze the current waste management framework, assess the role of the community (students, teachers, staff, and visitors) in waste management, and provide recommendations for improvement. Successful implementation of community involvement in waste management has shown positive environmental outcomes in various countries.

2. Aim and Objectives

This research at Jahangirnagar University investigates community involvement in integrated solid waste management, aiming to identify factors influencing participation and assess behavioral practices related to waste management in the study area. The study seeks to explore the existing waste management framework, the community's role (students, teachers, and workers), and the challenges hindering current participation. Additionally, the research offers recommendations to enhance community involvement and improve solid waste management effectively. This article presents a social data analysis, shedding light on community engagement in ISWM within a closed residential educational environment.

3. Concept of ISWM

A holistic approach to sustainable solid waste management encompasses all aspects of waste management, including waste generation, segregation, transportation, processing, treatment, recycling, and disposal, with a focus on maximizing the value of resource utilization [8]. To ensure efficient waste management processes, it is crucial to adapt the principles of ISWM to be flexible in design,

adaptable to changing needs, and responsive to social, economic, and environmental requirements that may vary across different locations and over time. To maintain consistency in the quality and quantity of recycled and reclaimed materials (such as compost and energy), promote diverse disposal options, and take advantage of economies of scale, large-scale organization of ISWM systems is necessary [9].

Some of the major features of ISWM can be listed as follows:

- In order to optimize synergetic advantages in storage, processing, care & disposal, a systematic approach to all waste sources.
- Increase the likelihood of resource recovery at all stages, from generation through ultimate disposal.
- Assist all parties in attaining their objectives, from waste generators through waste management and service suppliers.
- Facilitate the perception of goods and materials in the life cycle; thereby, encouraging greater quality of resource use.
- Integrate various response features such as technological, administrative, financial, regulation, etc.
- Greater local ownership & accountability/participation by an approach to consultation.

Following figure illustrate the ISWM concept:

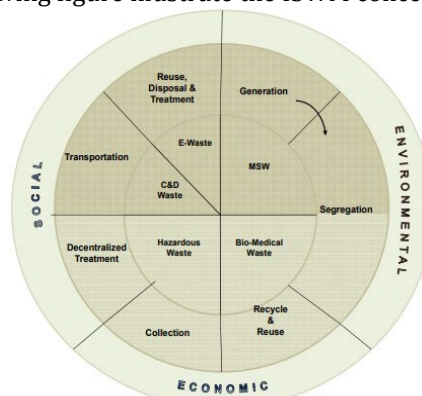


Figure 1. Concept of ISWM [9].

3.1. Concept of Community Participation on ISWM

Public participation empowers individuals to influence decisions in democratic governance. It allows those affected by decisions to have a say and promotes engagement, consensus-building, education, and information dissemination [10]. "Community" can refer to a city's entire population, a part of the city, or a social group within an area, forming the basis of its organization and leadership [11].

This study focuses on a specific area within Jahangirnagar University, where the administration collaborates with different groups. The community's uniqueness arises from the university's closed residential facilities. Effective solid waste management requires the community's active involvement, based on mutual understanding and agreement. Public participation is crucial for decision-making, especially in environmental issues, land

use planning, large construction projects, and solid waste management. Organized participation ensures people's right to live in a healthy environment, free of solid waste [12].

3.2. Effective Community Participation

Certain variables influence successful community participation in integrated solid waste management. Empowering communities is crucial for effective implementation of such programs. The conceptual framework below addresses knowledge gaps identified in the introduction, issue description, and literature review. The figure illustrates assumed connections in centralized waste management, aiming to maximize productivity and efficiency. Stronger links between groups lead to more localized efforts. Diverse connections are vital for productive and efficient integrated waste management, enhancing community involvement in comprehensive programs in a market-driven environment [13].

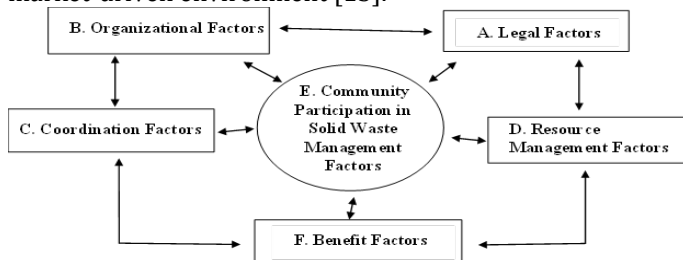


Figure 2. Conceptual Framework: Effective Community Participation in ISWM [14].

The conceptual framework highlights six important aspects that can enhance community participation in integrated solid waste management. Firstly, effective regulations are essential to supervise institutional behavior and define stakeholder duties, responsibilities, and rights in ISWM transactions. However, the impact of regulations and standards on community involvement depends on the social and economic conditions and cultural attitudes.

Secondly, community-based organizations (CBOs) play a crucial role in organizing public participation in waste management initiatives, facilitating communication and collaboration with other stakeholders. Clear arrangements, empowerment, and dispute resolution mechanisms are vital for successful community engagement. Thirdly, sufficient communication and networking between stakeholders and waste regulatory authorities are necessary for coordinated solid waste management projects involving CBOs and partnerships. Fourthly, resource factors such as finance, human resources, land, information, and transportation are critical for effective waste management. Utilizing cost-effective technology for waste reduction and revenue generation, along with community empowerment, motivates active participation. Fifthly, community participation in the solid waste management system allows local groups to leverage capital and cooperation with other stakeholders, enabling better planning, decision-making, and project evaluation. Innovative technologies further optimize profitability and benefit vulnerable communities [15].

Lastly, community participation in integrated waste management has dual benefits. At the community level, wages and assets generated by CBOs from solid waste can incentivize residents to pay waste collection costs, while segregating recyclable waste generates revenue for educational institutions. At the government level, cost savings from waste management can alleviate restricted allocations. A visually appealing environment with fresh air fosters social interaction and improves urban living quality and safety [16].

4. Reviews of Theories and Models

The institutional economic theory was utilized as the main leading theory in this study, with a few associated theories and ideas supporting it. The application of institutional economic theory in this study has three reasons. To begin with, it is an important concept of urban planning and management to coordinate service activities across groups, thus reducing disputes [17]. Second, the study concentrated on the importance of transactions in solid waste management, but it disregarded CBOs' intergraded involvement in solid waste collection programs. Thirdly, this exception may be that community engagement in institutional solid waste management which have residential facilities would increase under institutional economic conditions.

4.1. Institutional Economic Theory (IET)

According to North (1990), structures in society, seen from an economic perspective, are the rules that shape human interaction. These human-created limitations define institutions, encompassing individuals, households, and organizations with varying behaviors. Fair transactions are governed by standards and regulations, which the state is responsible for upholding [14]. The hypothesis posits that people's personalities are molded by society, impacting their political, economic, and social connections. This influences their behavior and worldview. Individuals consciously work to improve their living conditions, emphasizing the importance of interaction with others to create complete "institutions" [14].

Institutions influence trade and development costs, impacting the output of individuals, groups, organizations, governments, or economies. Evaluating institutional success standards is essential to grasp their impact on organizational performance. According to North's theory, institutions, encompassing both formal and informal laws, trade through company hierarchies to minimize transaction costs. Another assumption is bounded rationality, emphasizing openness and information sharing in Institutional Economic Theory [18]. IET is structured on three other theories which are as following-

4.2. Organizational Theory

Organizational Theory describes how individuals, groups, and subgroups interact to achieve a common goal. It explores the impact of social interactions and behavior

within an organization, as well as the organization's effect on the market environment, political, legal, and cultural issues. An organization is a group of individuals working together to achieve a shared goal [14].

The principle now integrates environmental restrictions such as technology, operation, income, choice, service, and performance. These factors combine to create prospective capital, enabling entrepreneurs to maximize social, economic, and political prospects. These variables are essential for successful community involvement in purposeful practices and driving institutional progress and economic performance [18]. The term "organization" has evolved from its original commercial meaning to include public and voluntary institutions in a top-down and closed structure. These organizations can form partnerships to improve service delivery. The aim of this study was to establish community participation with key stakeholders to achieve coordinated waste management in the study area [14].

4.3. Collective Action Theory

In 1965, Mancur Olson first published the collective action theory [19]. He claimed that it is impossible to work successfully with any group of citizens trying to deliver a public benefit. Humans are rational creatures, according to this idea. They should actively participate in social development initiatives and pool resources to achieve a shared objective [20].

The desire of individuals to participate in the supply and preservation of a common good is not always the same. For a mutual interest, they may collaborate or act uncaringly. Many disputed factors between "cooperation optimists" and "cooperation pessimists" influence this [21]. "Collective action" and "cooperation" are interchangeable terms. Optimists believe that collaboration for the group's shared benefit will naturally occur. This optimism stems from orthodox group theories in the 1950s, asserting that a common purpose motivates individuals to engage in activities that affect their lives. Collective action in public interest activities, like public elections and charity organizations, has been studied, but poor attendance is often observed due to the "free ride" problem [14].

The Collective Action Theory, combined with Institutional Economic Theory, was applied in a study of collective action in solid waste management at Jahangirnagar University's formal settlements. This approach emphasizes coordinated and collaborative actions using common-pool capital or property to efficiently deliver public benefit and utility services.

4.4. Existing Laws and Policies Dealing with Management of Solid Waste

Bangladesh has implemented numerous environmental regulations to address severe environmental issues. Currently, there are over 200 location-specific laws in effect,

covering various aspects, including soil and water usage, toxic waste, noise pollution, hazardous chemicals, solid waste disposal, forest preservation, wildlife protection, mineral resources, coastal management, industry, ecological well-being, and hygiene. Prior to 1995, there was no comprehensive legislation defining "waste" in Bangladesh. Although the Environment Conservation Act of 1995 provides a relatively acceptable definition, a comprehensive legislative framework for waste management is still lacking. However, the country does have several area-specific laws governing waste disposal [22].

5. Study Area

Jahangirnagar University was established in 1970 by the Pakistani government as a project, with the first Vice-Chancellor appointed in 1970. It was officially opened on January 12, 1971, and later renamed Jahangirnagar University by the Jahangirnagar University Act, 1973, after Bangladesh gained independence. The campus covers 697.56 acres of land, located 32 kilometers west of the city and bordered to the north by the National Monument. The area has a natural inclination towards plant growth due to its location in the south section of the Madhupur tract. The campus is spread across several moujas, including Solia, Dakshin crok, Boro oalia, Gerua, Uttor crok, and Shen oalia, featuring red soil, red ceramic constructions, and natural scenic views.

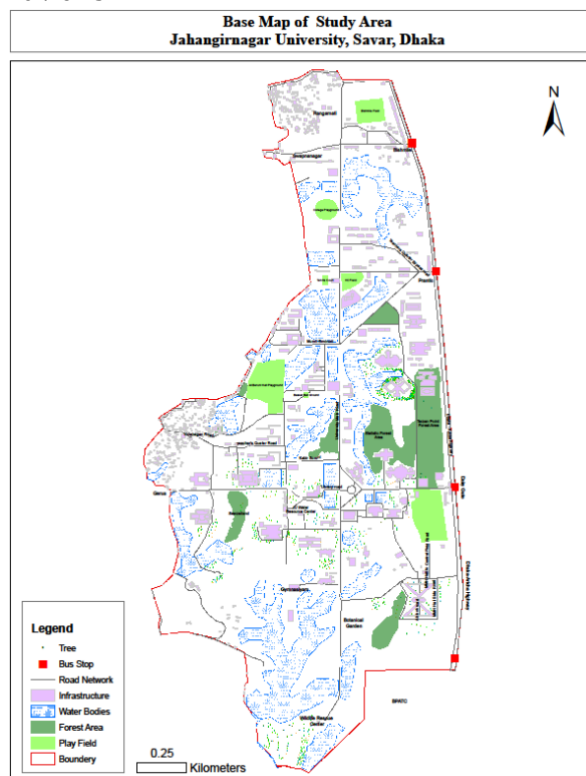


Figure 3. Study Area Map.

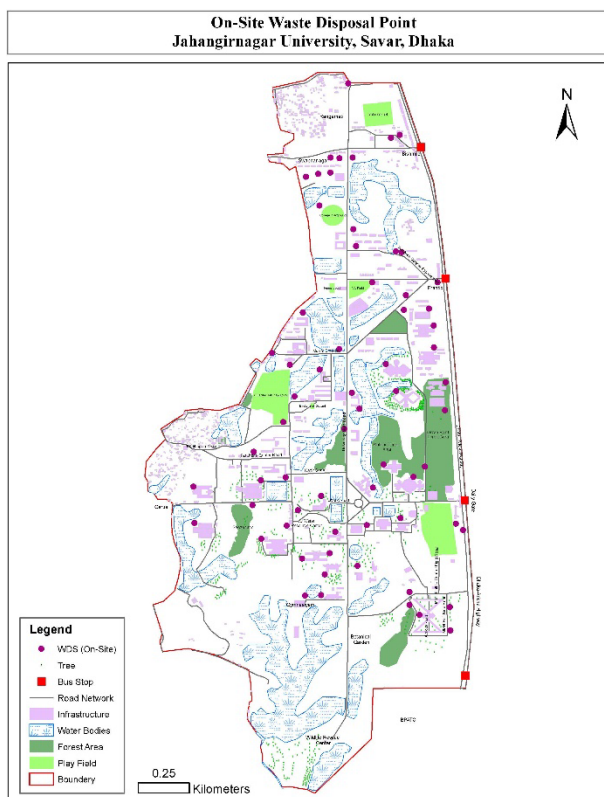


Figure 4. Waste Dumping Zone (On-Site).

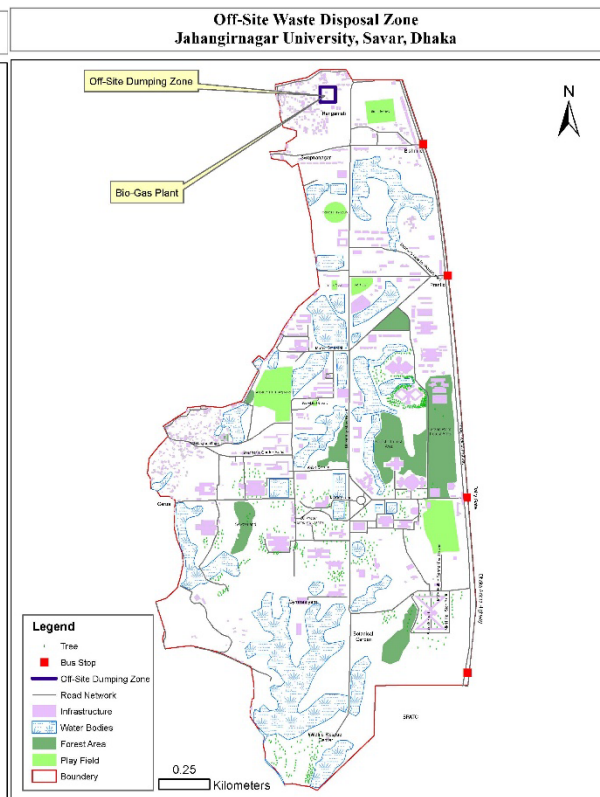


Figure 5. Waste Dumping Zone (Off-Site).

Table 1. Stakeholders in the management of solid waste.

Categories	Stakeholders
Primary	Students, teachers, university-based volunteer groups, canteen operators, and tourists
Secondary	Members of teachers' and staff quarters' families; shopkeepers on and around the university campus
Tertiary	Researchers; Volunteers as development activists; Savar Municipality; Non-Governmental Organizations (NGOs) and Community Based Organizations (CBOs) involved in waste management;

The campus's geography, with its gentle slopes and flat areas, offers a visually pleasing landscape that attracts thousands of winter birds every year, popularizing bird-watching among visitors, students, and staff. The campus's natural beauty also draws tourists to the area. The campus is adorned with several lakes of varying topography and rainwater catchment areas that serve as storage during the rainy season. The soil on this deltaic landform is a type of ancient alluvium known as latte rite, with a reddish-yellow hue due to its high degree of oxidization [6].

Jahangirnagar University's eastern side is significantly higher than the western side, while the majority of the area is susceptible to flooding, except for the east. The undulating terrain offers a diverse view of the entire campus, which was designed with this land pattern in mind. Both on-site and off-site waste disposal systems are employed, with off-site disposal accounting for a smaller portion of the total waste. The Estate Office dumps solid waste, particularly kitchen waste, at a single dumping location on the northern boundary of the university in a neighborhood called "Rangamati." On-site disposal points are also used, with 65 waste disposal points (WDS) available, and burning disposal

methods used regularly or infrequently, as per the Estate Office [23].

5.1. Stakeholders on the Community of Study Area

In Integrated Sustainable Waste Management, all stakeholders within a community have a crucial role to play in addressing waste issues. Main stakeholders in urban areas include households, community leaders, waste collectors, university authorities, and micro and small enterprises. Similarly, Jahangirnagar University has three types of stakeholders involved in solid waste management, as outlined in the Table 1.

6. Methodology

Method is a comprehensive concept that pertains to the process of acquiring knowledge. It involves making deliberate decisions, such as selecting data collection techniques and determining individual-level strategies, including sample size and whether to conduct face-to-face interviews or not [24]. The technique involves organizing scattered ideas and thoughts for analysis, and a methodology encompasses multiple stages of data or information

processing. A structured workflow helps to identify the best items and achieve the report's goals. This report also maintains a systematic approach for accomplishing dissertation work effectively. Completing any task requires various procedures and methods for different phases, such as data collection and step-by-step instructions. The approach for papers, projects, theses, or dissertations also involves these phases [6].

This study has four objectives, including analyzing variables such as waste generation, collection, disposal, management methods, worker engagement, equipment cost, and behavioral practices. Both qualitative and quantitative approaches were employed for data collection and processing. The research used a mixed method approach to explore and describe metrics, utilizing exploratory descriptive and phenomenological methodologies to investigate the current solid waste management system's phenomena, difficulties, and effects on the environment and public health in the studied area. Jahangirnagar University was chosen as the study area due to its unique status as the only residential public university in the country, providing both educational and residential features. This research is the first of its kind to be conducted within the campus community. To facilitate data collection, the study area was classified into five categories: administrative buildings, other residential buildings, residential halls, other social gathering areas, and academic buildings [25].

6.1. Data Sampling Method

Sampling is the process of selecting units from a population of interest (for example, individuals or organizations) so that we can apply our results to the entire population by analyzing the sample. [26]. To ensure accuracy, scalability, and representativeness of the entire population, the sample size selection for this study used a stratified random sampling method. The sampling unit was divided into administrative, residential, and social gathering areas on the university campus. This approach considered budgetary and time constraints for surveying the community within the study area.

Stratified random sampling is a statistical method used to sample subgroups within a larger population. This approach is advantageous when subpopulations differ and allows for the division of individuals into homogeneous groups, known as strata [27]. Stratified random sampling involves assigning individuals in a population to mutually exclusive and collectively exhaustive strata. Ordinary random sampling is used within each stratum to increase accuracy and reduce sampling error. This method can provide a more accurate weighted mean than the population's arithmetic mean, and is often conducted through interviews with responsible authorities. Stratification can result in lower estimation errors if the standard deviation of measurements within strata is lower in the research area [28].

The campus population is estimated to be over 2000 individuals, with regular and weekend students comprising the majority. The research area for this study consists of individuals who produce solid waste, with a sample size of 393 divided into four strata based on population homogeneity. The exact number of daily visitors to the campus is unknown, but the estate office estimates an average of 350 to 420 per day. To ensure proportionate participation, a total survey of 397 respondents will be conducted. The institution has 755 faculty members and 1700 staff members, but not all reside on campus.

6.2. Data Analysis

This study used both qualitative and quantitative approaches to collect and evaluate data from primary and secondary sources, including open-ended and closed-ended questions during interviews with personnel experienced in solid waste management. The study area's existing solid waste management system was reviewed by examining published and unpublished documents. Primary data were collected through a stratified random sampling method, including questionnaire surveys and in-depth interviews with communities actively involved in solid waste generation and management. The collected data was analyzed using a mixed method approach, including content analysis for qualitative data and statistical tools such as MS Word, MS Excel, SPSS, and ArcGIS for quantitative analysis. The study aims to provide guidance for creating a proper solid waste management system and offer lessons for future research in this field.

6.3. Existing Scenario of Waste Management System of Jahangirnagar University

The study area consists of various land-uses that significantly impact waste generation, with residential units and student hostels being the primary contributors. Commercial areas, particularly hotels, also generate a significant amount of waste. Academic units, administrative offices, and communal areas also produce daily waste. Organic waste accounts for the majority of the waste generated, with food waste being the primary component. The Estate Office manages only a small portion of the total waste generated daily, with limited contributions to the waste management system. On-site and off-site disposal methods are employed, but off-site disposal covers a smaller proportion of the total waste. Jahangirnagar University faces a shortage of manpower and equipment for proper solid waste management, highlighting the urgent need for an improved waste management system.

The Estate Office has identified 65 waste disposal points (WDS) for on-site disposal, where burning disposal methods are occasionally or regularly used. Most waste disposal sites are located in areas other than the lakefront lowland and open spaces around the hall/residential units [23].

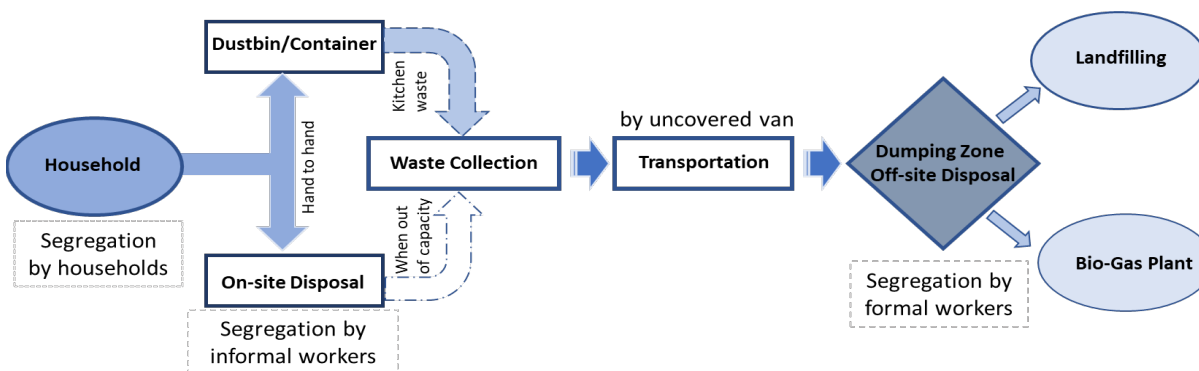


Figure 6. Existing waste management system.

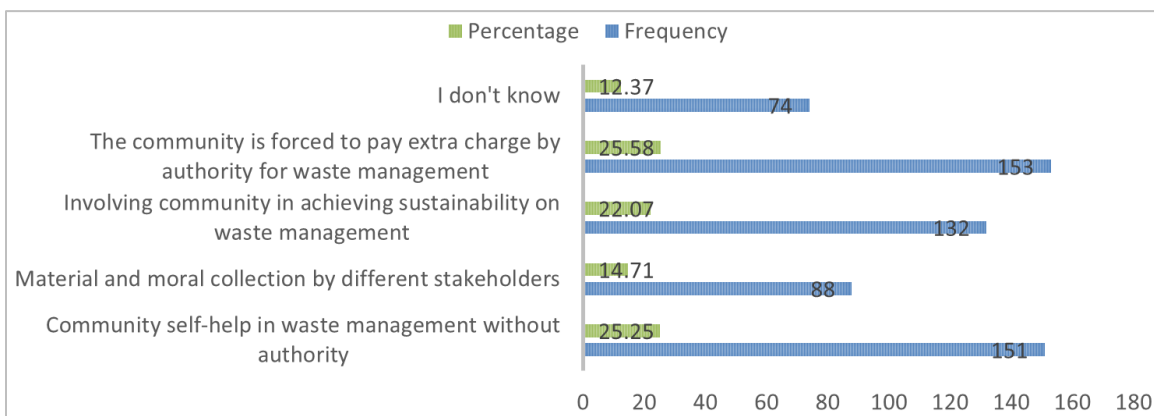


Figure 7. Meaning of community participation on ISWM according to respondent.

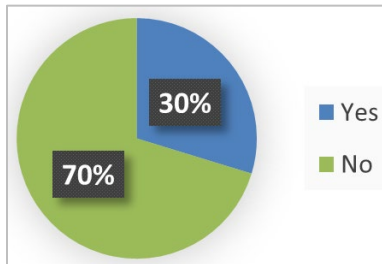


Figure 8. Waste segregation practice by respondents.

Table 2. Understanding on ISWM figure according to the responder type.

Statement	Respondent Type				Total
	Student	Teacher	Staff	Visitors	
I understand very well	66	10	8	0	84
I understand well	149	4	14	2	169
My understand is not well	76	2	4	4	86
I do not understand	46	0	6	1	53
Others/ No Response	5	0	0	0	5
Total	342	16	32	7	397

Table 3. Respondent gender wise waste segregation practice.

Gender	Waste Segregation		Total
	Yes	No	
Male	60 (50%)	146 (53%)	206 (52%)
Female	61 (50%)	130 (47%)	191 (48%)
Total	121 (100%)	276 (100%)	397 (100%)

The study area has only one landfill site located in the northern part of the campus known as "Rangamati." The Estate Office collects kitchen waste and segregates the organic waste for gas production while the rest is directly thrown into the landfill. However, a significant amount of waste is not handled properly, leading to negative environmental and health impacts. The absence of a waste management policy poses a significant challenge for the university authority in effectively managing waste.

While waste segregation is not mandatory, some members of the community segregate waste at different stages. Teachers and residential staff segregate waste in their homes for economic benefits, while informal laborers engage in recycling solid waste for their livelihood. The Estate Office collects kitchen waste separately for biogas production, but other waste types are also present due to a lack of community involvement. The workers separate kitchen waste from other waste types for the biogas plant, while the rest is dumped at the landfill.

7. Results and Discussion

7.1. Community Participation on ISWM

The Estate Office claims to follow an integrated approach to manage the solid waste of the campus, incorporating the fundamental elements outlined in the theoretical framework and regularly supervising and coordinating the integration process. However, survey data analysis reveals that the effectiveness of various fundamental elements of Integrated Solid Waste Management (ISWM) is not satisfactory. Focus Group Discussion (FGD) findings indicate that the Estate Office does not fulfill the responsibility of supervision and cooperation, and their waste management activities have been limited due to the current COVID situation. Further analysis will examine the level of community participation in the existing solid waste management system.

7.1.1. Respondent Understanding on ISWM

When participants were asked what they know about the integrated solid waste management at Jahangirnagar University, the responses were as follows in Table 3. In this statement, from descriptive statistics the mean value is 3.59 found. Hence, it means that the majority of respondent do not understand well about the term of ISWM. The understanding on ISWM figure according to the responder type is highlighted by following Table 2.

To justify if understanding on ISWM has relation with respondent's typology, a chi-square test was conducted. The assumption was that there is no relationship between respondent's typology and understanding on ISWM. An independence with $\alpha = .05$ was used. The chi-square test was statistically significant at .05 level. $\chi^2 (1, N=397) = 26.384$. Significance value was .009 which is smaller than $\alpha = .05$ - meaning that the above assumption is not correct. There is relationship between respondent typology and understanding on ISWM. The above finding contradicts the

idea of community participation. Community participation in the ISWM concept depends on their knowledge about it.

7.1.2. Meaning of Community Participation in Relation to Solid Waste Management by Respondent

When asked where they learned about community involvement in connection to solid waste management at Jahangirnagar University, participants responded as follows Figure 7. As can be seen from the Figure 7, the second and third statements are true in the case of community participation. However, just 36 (22+14) percent of those polled were able to correctly answer the question. The others all provided incorrect responses. 12 percent of those polled had no idea what this is. In addition, 25.25 percent of the respondents gave a response that has nothing to do with the fundamental idea of ISWM. This demonstrates that the majority of respondents in the research area had a hazy understanding of community involvement. That has a negative effect on their participation of integrated solid waste management. The concept of community participation is contradicted by the above findings. The knowledge of the community participation concept is required for community involvement.

7.1.3. Waste Segregation Practice by Respondents

Respondents were asked if they segregate solid waste at their house that are reflected in the following pie diagram. As can be seen here, 30 percent say that they practice waste segregation and 70 percent don't practice waste segregation. That ratio is very negligible in terms of community participation.

Findings from FGD and secondary data analysis also follow a pattern similar to above. The majority of respondents do not segregate waste, owing to a lack of understanding and awareness about the issue. The TF's concept of community participation is contradicted by the above findings. Waste segregation is also important in the source reduction mentioned in ISWM, which was not seen by most of the respondents in this study area.

7.1.4. Waste Segregation Practice by Respondents Gender

The waste segregation figure according to the responders' gender is highlighted in the following Table 3. To justify if waste segregation has relation with respondents' gender, a chi-square test was conducted. The assumption was that there is no relationship between respondents' gender and waste segregation practice. An independence with $\alpha = .05$ was used. The chi-square test was statistically significant at .05 level. $\chi^2 (1, N=397) = .370$. Significance value was .543 which is greater than $\alpha = .05$ - meaning that the above assumption is correct.

According to data from FGD, female respondents are more involved in other household chores than male respondents. Student halls also have a tendency for female to cook more than female. So naturally female should have

practiced more waste segregation specially than male. But it was not seen in the above analysis.

7.1.5. Waste Segregation Practice by Respondents Type

The waste segregation figure according to the responders' type is highlighted in Table 4. To justify if waste segregation practice has relation with respondents' typology, a chi-square test was conducted. The assumption was that there is no relationship between respondents' typology and waste segregation practice. An independence with $\alpha = .05$ was used. The chi-square test was statistically significant at .05 level. $\chi^2 (1, N=397) = 30.144$. Significance value was .0001 which is smaller than $\alpha = .05$ - meaning that the above assumption is not correct. There is a relationship between respondent typology and waste segregation practice.

The matter can be clearly understood with the help of the following bar diagram. Waste segregation practices are more prevalent among teachers and staff than among student and visitor groups. Talking to them, two reasons have been found in Figure 9. The first is the housemaid that basically does this work in the homes of teachers and employees - which the student or visitor group does not have. The housemaid is economically benefited by selling a portion of the segregated waste. Which makes him/her interested in waste segregation. Many teachers and staff also sows plants next to their homes using biodegradable waste as fertilizer. This is the second reason teachers and employees practice waste segregation. That opportunity is not available to the resident students on campus.

The above finding contradicts the idea of community participation. According to ISWM Concept, all stakeholders in the community should have an attitude of participation which is not seen here except teachers and employe. People work in groups for a shared goal where they can benefit themselves, according to organizational theory and collective action theory. Because university authorities have not been able to establish a common goal in solid waste management that empowers them to benefit on an individual level, the above image is observed in the Figure 9.

7.1.6. Reasons for Not Segregating Waste

Respondents were asked why they do not segregate waste. The diagram below represents their answer. Majority of the respondent stated that it is not their responsibility i.e. 50% (138). Being a resident of an autonomous institution, most of the respondents feel that segregation is not their responsibility. Because there is no direction or obligation for them to do waste segregation. Respondents have no idea about the alternative use of segregated waste or their economic importance, so they do not realize the importance of segregation. Although some respondents are interested, segregation is not practiced for them due to lack of adequate equipment for segregation.

The above finding contradicts the concept of community participation on waste segregation. According to ISWM Concept, Necessary steps should be taken to provide

the necessary equipment, direction and encouragement to all for segregation. Which was not seen in the above discussion.

7.2. House Sweeping and Cleaning

7.2.1. Cleaning and Sweeping Work

Respondents were asked who does the house cleaning and sweeping work. 68 percent said that it is the university employed labors, 17 percent said that it is the domestic helpers and 15 percent said that they do it themselves. The cleaning practice of one's own home is negligible which indicates poor participation from the aspects of community participation.

Findings from FGD and KII also follow a pattern similar to above. Respondents are less involved in-house cleaning, one of the main reasons being lack of awareness and laziness. They can also do this because they do not know how to benefit them.

The above finding contradicts the concept of community participation. According to organizational theory and collective action theory, People work in groups for a common purpose where they have the opportunity to benefit themselves. University authority have not been able to demonstrate a collective purpose in solid waste management so that they themselves can be beneficiaries on an individual level, which is why the Figure 11 is seen in the case of community participation on ISWM.

7.2.2. House Sweeping, Cleaning and Waste Collection Time

72% of the respondents are cleaning and sweeping their house in the morning. Whereas 15% of does it at least once per week. And 15% of the total respondent have no specific order to do this. Findings from FGD also follow a pattern like above. Although residential units are regularly cleaned and waste collected, this work is not done regularly in some common public places. The above finding confirms the concept of ISWM.

7.2.3. Respondents Attitude When Waste Collection Vehicle Does Not Come

The following table shows the descriptive analysis on the attitude towards household solid waste when the authority vehicle does not come at right time. In the first statement, the mean is 3.59. Hence, it means that the majority of respondent are disagree with this statement. The mean of the second statement is 3.06. Accordingly, most students are disagreeing with this statement. The third statement concerns the disposal of solid waste in an open area away from the main route. Here the mean is 2.90 that means that most of the respondent are agree with this statement. Most students reported disagree with the statement of dumping solid waste in the existing sewerage system as is seen in the mean of 3.97. In the fifth statement, the mean is 2.67. Hence, it means that the majority of respondent disagree with this statement. As shown by the mean of 1.84, most students agree or strongly agree with the

statement of digging a trench around the home and burning it. This analysis shows how the community will solve any problem related to waste management and how they will behave. From the values of descriptive analysis, their behavior can be said to be satisfactory. Findings from FGD and KII also follow a pattern like above. Community participation is a behavioral practice that depends on many factors. Finding out how the respondents would behave in each situation here shows that most have chosen the right statement. Where it is seen that the respondents have agreed in three statements and disagree in the other three.

The above finding confirms the concept of Institutional Economic Theory (IET). According to IET, People have socially defined personalities. The idea also promotes the perception or development of political, economic, and social relationships with others to understand and analyze the world and methods of functioning in it. People are continuously engaged in reflecting on their lives and consciously attempting to improve their living situations over the course of their lives. An image of which we can see from the Table 5.

Table 4. Respondent type wise waste segregation practice.

Respondent Type	Waste Segregation		Total
	Yes	No	
Student	92 (76.03%)	250 (90.58%)	342 (86.14%)
Teacher	14 (11.57%)	2 (0.72%)	16 (4.03%)
Employee	14 (11.57%)	18 (6.52%)	32 (8.06%)
Visitors	1 (0.83%)	6 (2.17%)	7 (1.76%)
Total	121 (100%)	276 (100%)	397 (100%)

Table 5. Analysis of Respondent Attitude When Authority Vehicle Did Not Come.

Statement	N	Minimum	Maximum	Mean	Std. Deviation
I keep the waste at home until the collector come.	397	1	5	3.59	1.479
I burn it in the back of my home.	397	1	5	3.06	.946
I dump it on open space, which is far from main road.	397	1	5	2.90	.913
I dump it in the existing sewerage system.	397	1	5	3.97	1.148
I dump it at the adjacent low land.	397	1	5	2.67	1.058
I dig a hole around the house and burn it.	397	1	5	1.84	1.207

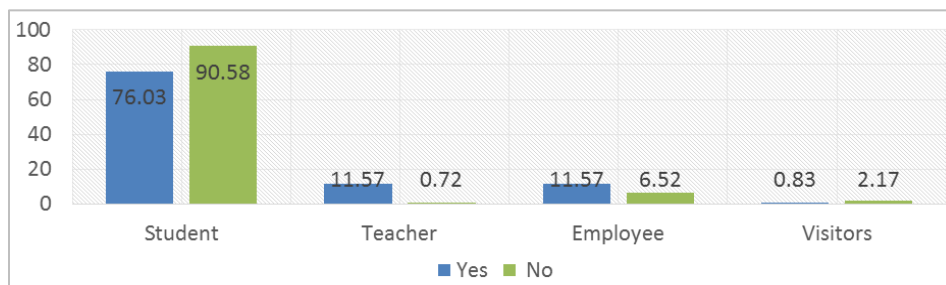


Figure 9. Waste segregation practice by respondents' type.

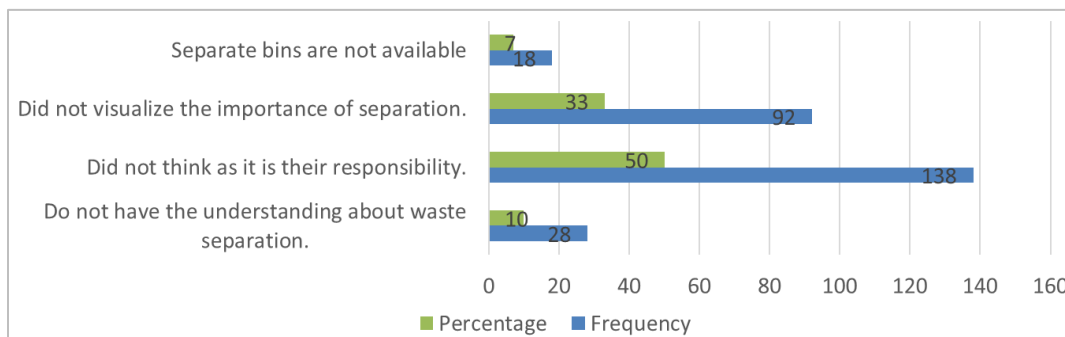


Figure 10. Reasons not to segregate waste.

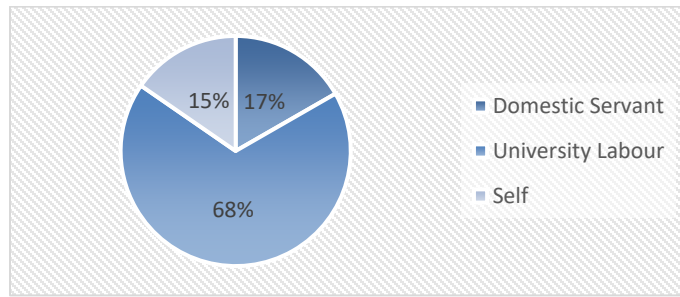


Figure 11. Those who do the cleaning and sweeping work.

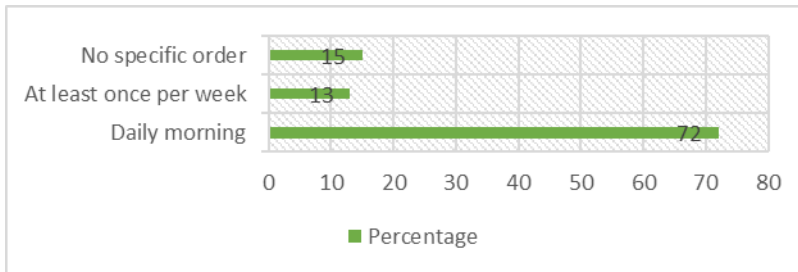


Figure 12. House Sweeping, Cleaning and Waste Collection Time.

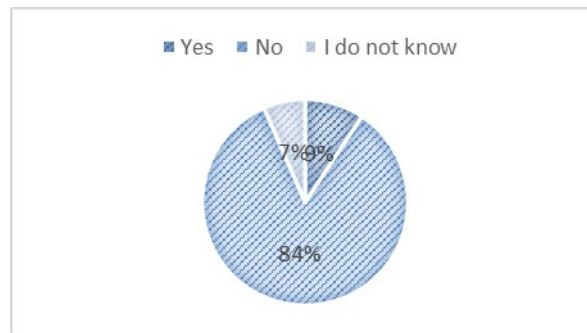


Figure 13. Micro or small enterprises for door-to-door waste collection.

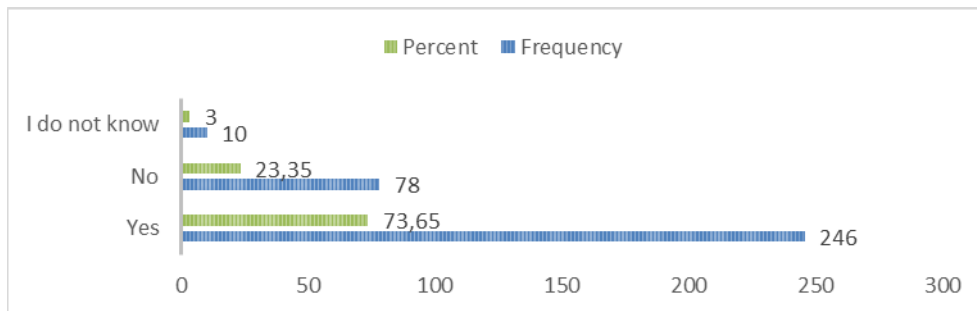


Figure 14. Respondent willingness when micro or small enterprises were absent.

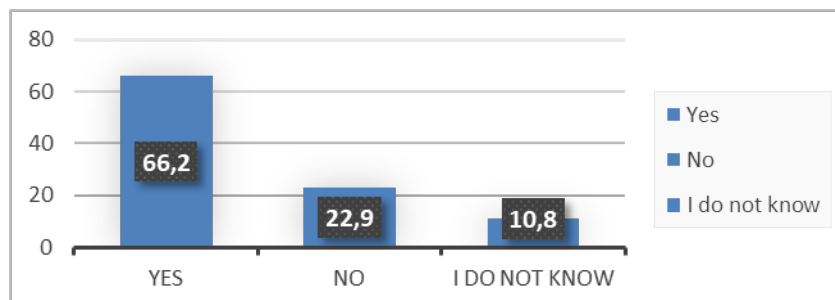


Figure 15. Willingness to pay for the waste collection services.

7.2.4. Micro or Small Enterprises for Door-to-door Waste Collection

Respondents were asked whether they needed micro or small businesses for door-to-door waste collection, as seen in the pie chart below. 84% answered they don't need such a facility, 9% said they need, and 9% stated they had no clue what these facilities are. A further analysis on the respondent's response category reveals that 84% of them don't feel the need of micro or small enterprises of which 87% are students, 5% are faculties, 8% are staff and 0.3% are visitors. Among 9% of the respondents feeling need of micro or small enterprises 84% are students, 3% are teachers, and 13% are visitors. In total 7% sad that they do not know the answer.

To justify if necessity of micro or small enterprises has relation with respondents' typology, a chi-square test was conducted. The assumption was that there is no relationship between respondents' typology and willingness of necessity of micro or small enterprises. An independence with $\alpha = .05$ was used. The chi-square test was statistically significant at .05 level. $\chi^2 (1, N=397) = 76.862$. Significance value was .0001 which is smaller than $\alpha = .05$ - meaning that the above assumption is not correct. There is a relationship between respondent typology and felling of necessity of micro or small enterprises.

The reason why the respondent of the study is doesn't think micro or small enterprise for door-to-door waste collection is necessary is that it will increase waste management costs. Small or micro enterprises are not needed if university authority is more responsible according to respondents of the study area. According to the Estate Office, there is no micro or small enterprise in the study area for waste collection. However, it has been learned that some of the waste from settlements along the boundary of the campus has been collected in the informal way by the outside small enterprise. People in areas where the presence of the authority is less may be forced to do so.

The above finding contradicts of the concept of Institutional Economic Theory (IET). The supply and demand of a service are related to each other. If there are more than one service provider, then there is a competition between them which helps to increase the quality of service. The preceding debate demonstrates that only the authority provides waste management services in a centralized way in the study area, and the inhabitants do not want any new people to come in to offer this service. Which is a big obstacle in improving the quality of service.

Those who said they don't need micro or small enterprise were asked if in the absence of such an arrangement, will they oversee door-to-door waste collection and dispose their waste at the nearest collection point or whether the distance between their home and the waste collection point will benefit them in this regard. The Figure 14 represents the respondent's attitude in this regard.

This analysis displays that about 74% (246) of the respondents shows their willingness where 23% (78) of the

respondent don't think they can contribute in this case within the study area. And 13% (10) of the total respondents are unaware of this. It can be seen here that the majority of respondents are taking the issue positively and even if there is no micro or small enterprise, their participation shows an attitude to solve this problem.

To justify if respondent willingness when micro or small enterprises were absent has relation with respondents' typology, a chi-square test was conducted. The assumption was that there is no relationship between respondents' typology and willingness of necessity of micro or small enterprises. An independence with $\alpha = .05$ was used. The chi-square test was statistically significant at .05 level. $\chi^2 (1, N=397) = 11.222$. Significance value was .082 which is greater than $\alpha = .05$ - meaning that the above assumption is correct. There is no relationship between respondent typology and respondent willingness when micro or small enterprises were absent. Findings from FGD also follow a pattern similar to above. The above finding confirms the concept of community participation on ISWM. In the absence of micro or small enterprises, the willingness of majority respondents to do their own thing can have a positive effect on community participation.

7.2.5. Willingness to Pay for the Waste Collection Service

Respondents were asked whether they would be prepared to pay for waste pickup in order to improve waste management. Sixty-six percent indicated they want to pay for waste collection, twenty-three percent said they don't want to pay, and eleven percent said they haven't made up their minds yet. A further analysis on the respondent's response category reveals that 68% of them are willing to pay for waste collection service of which 85% are students, 6% are faculties, 8% are employee and 1% are visitors. Among 23% of the unwilling respondents, 95% are students, 2% are employees and 3% are visitors. In total, 11% sad that they do not know the answer.

To justify if willingness to pay for waste collection has relation with respondents' typology, a chi-square test was conducted. The assumption was that there is no relationship between respondents' typology and willingness to pay for waste collection. An independence with $\alpha = .05$ was used. The chi-square test was statistically significant at .05 level. $\chi^2 (1, N=397) = 23.977$. Significance value was .008 which is smaller than $\alpha = .05$ - meaning that the above assumption is not correct. There is a relationship between respondent typology and respondent willingness for waste collection to improve solid waste management system.

Findings from FGD also follow a pattern like Table 7. According to FGD, the community sense that has grown among teachers and staff due to living together for a long time has led them to pay in the waste collection which is comparatively less in the other two groups. The above finding confirms the concept of community participation on ISWM. The willingness of pay for waste collection can have a positive effect on community participation.

7.3. Rules and Regulations Followed by the Respondents

Respondents were asked if they follow the rules and regulation to improve waste management. 62% said that they follow rules and regulation, 26% respondent don't follow rules and regulation related to integrated solid waste management and 12% respondent don't have enough knowledge about this. In terms of participation, a good sign from the community is compliance with rules and regulation.

A further analysis on the respondent's response category reveals that 62% of them are following rules and regulation of solid waste management of which 84% are students, 6% are faculties, 8% are employee and 2% are visitors. Among 26% of the not following respondents, 95% are students, 1% are faculties and 3% are employees. In total, 12% sad that they do not know about the rules and regulation related to ISWM.

To justify if following of rules and regulation have relationship with respondents' typology, a chi-square test was conducted. The assumption was that there is no relationship between respondents' typology and following of rules and regulation. An independence with $\alpha = .05$ was used. The chi-square test was statistically significant at .05 level. $\chi^2 (1, N=397) = 17.9$. Significance value was .006 which is smaller than $\alpha = .05$ - meaning that the above assumption is not correct. There is a relationship between respondent typology and following of rules and regulation.

Findings from FGD also follow Table 8. According to FGD, the community sense that has grown among teachers and staff due to living together for a long time has led them to follow the rules and regulation of waste management.

The above finding confirms the concept of legal factors of community participation. Such kinds of legal factors influence community to participate on ISWM. According to IET, legal issues also help to provide shape of initialized human behavior. The rules and regulation followed by the respondents can have a positive effect on community participation.

7.4. Multiple Regression Analysis for Community Participation

Community participation in solid waste management depends on behavioral practice. Jahangirnagar University is not like all other residential areas. The opportunities for their participation in the system created by the authority in waste management system are limited. Because of the decision-making process of the authority on ISWM, there is less opportunity for the final community to participate on decision making. The connection between community involvement and different possible variables was investigated using multiple regression analysis. The model summary is the first table of interest (Table 9). This table shows the R, R square, adjusted R square, and standard error of the estimate, all of which may be used to assess how well a regression model fits the data: The descriptive data and analytical findings are shown in Table 9. In this case, a score of .061 shows a high degree of prediction.

As can be observed, each respondent type is positively and substantially associated with the criteria. The R square value is 0.081, suggesting that independent factors explain 8.1 percent of the variability of the dependent variable (Table 10).

The F-ratio in the ANOVA (Table 11) model shows that the independent variables predicted the dependent variable with statistical significance, $F (7, 326) = 4.106, p (.0001) < .05$ (i.e., the regression model is a good fit of the data).

Regression coefficients (Table 11), reveals that amongst the independent variables' segregation practice, cleaning and sweeping practice, lack of responsibility of micro or small enterprises are significant. But understanding about ISWM, necessities of micro or small enterprises, willingness to pay and rules and regulation followed is not significant.

Table 6. Necessity of micro or small enterprises according to respondent type.

Respondent Type	Necessity of Micro or Small Enterprises			Total
	Yes	No	I do not know	
Student	31 (84%)	291 (87%)	20 (77%)	342 (86.14%)
Teacher	1 (3%)	15 (5%)	0	16 (4.03%)
Staff	5 (13%)	27 (8%)	0	32 (8.06%)
Visitors	0	1 (0.3%)	6 (23%)	7 (1.76%)
Total	37 (100%)	334 (100%)	26 (100%)	397

Table 7. Respondent type wise willingness to pay for waste collection.

Statement	Respondent Type				Total
	Student	Teacher	Employee	Visitors	
Yes	223 (85%)	16 (6%)	22 (8%)	2 (1%)	263 (100%)
No	86 (95%)	0	2 (2%)	3 (3%)	91 (100%)
I do not know	33 (77%)	0	8 (19%)	2 (4%)	43 (100%)
Total	342 (86.14%)	16 (4.03%)	32 (8.06%)	7 (1.76%)	397 (100%)

Table 8. Respondent type wise willingness to pay for waste collection.

Respondent Type	Rules and Regulations Followed			Total
	Yes	No	I do not know	
Student	208 (84%)	95 (93%)	39 (80%)	342 (86%)
Teacher	15 (6%)	1 (1%)	0	16 (4%)
Staff	19 (8%)	6 (6%)	7 (14%)	32 (8%)
Visitors	4 (2%)	0	3 (6%)	7 (2%)
Total	246 (100%)	102 (100%)	49 (100%)	397 (100%)

Table 9. Model Summary of Multiple Regression Analysis of Community Participation.

Model Summary ^b				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.285 ^a	0.081	0.061	0.567

a. Predictors: (Constant), Rules & Regulations followed, Segregation Practice, Necessity of micro or small enterprises, Cleaning & Sweeping practice, Responsibility absence of Micro or small enterprises, understanding about ISWM, Willingness to pay.

b. Dependent Variable: Respondent Type

Table 10. ANOVA of Multiple Regression Analysis of Community Participation.

ANOVA ^a						
Model	Sum of Squares	df	Mean Square	F	Sig.	
1	Regression	9.228	7	1.318	4.106	.000 ^b
	Residual	104.679	326	0.321		
	Total	113.907	333			

a. Dependent Variable: Respondent Type

b. Predictors: (Constant), Rules & Regulations followed, Segregation Practice, Necessity of micro or small enterprises, Cleaning & Sweeping practice, Responsibility absence of Micro or small enterprises, understanding about ISWM, Willingness to pay.

Table 11. Coefficients of Multiple Regression Analysis of Community Participation.

Coefficients ^a								
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	β			Lower Bound	Upper Bound
		1	(Constant)	2.773			0.840	
	Understanding about ISWM	-0.048	0.032	-0.081	1.504	0.134	-0.111	0.015
	Segregation practice	-0.188	0.071	-0.146	2.662	0.008	-0.327	-0.049
	Cleaning & sweeping practice	-0.208	0.058	-0.192	3.567	0.000	-0.322	-0.093
	Necessity of micro or small enterprises	-0.469	0.405	-0.062	1.160	0.247	-1.265	0.327
	Lack of responsibility of micro or small enterprises	0.093	0.041	0.122	2.255	0.025	0.012	0.173
	Willingness to pay	0.027	0.050	0.032	0.545	0.586	-0.072	0.127
	Rules & Regulations followed	0.045	0.048	0.052	0.926	0.355	-0.050	0.140

a. Dependent Variable: Respondent Type

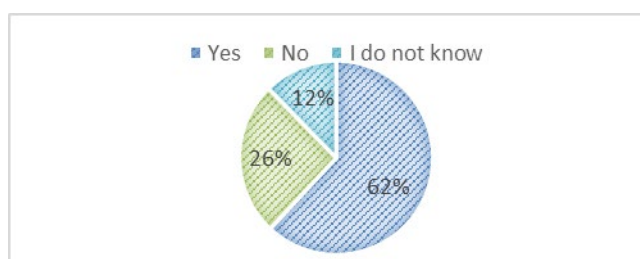


Figure 16. Rules and regulations followed by the respondent.

8. Discussion

In the Jahangirnagar University research on solid waste management, female respondents accounted for 48.11% of the total, with students comprising the majority of respondents at 86%. Teachers and workers were found to participate in solid waste management more than other categories. However, most respondents did not implement waste segregation at the home level, with 70% not practicing it. The lack of community involvement in waste management is contrary to the concept of community engagement. Most respondents did not see the need for micro or small businesses to collect solid waste at the home level, with concerns over increased costs. The role of Community Based Organizations (CBOs) in solid waste management was found to be minimal, despite the Sustainable Development Goals stressing the importance of private sector involvement in waste management [29].

The study found that 74% of respondents were willing to oversee door-to-door waste collection and dispose of their waste at the nearest collection point, with willingness to pay influenced by socioeconomic factors. Teacher and staff involvement in waste management was found to be higher than other categories, confirming the concept of community participation in ISWM. However, 26% of respondents do not follow the rules and regulations for integrated solid waste management, and 12% do not have enough knowledge about it, revealing a lack of sufficient organization and coordination. Legal issues and regulations can have a positive impact on community involvement in waste management, according to the study's findings. Regression coefficients showed that among the independent variables, segregation practice, cleaning and sweeping practice, and lack of responsibility of micro or small enterprises were significant, while understanding of ISWM was not significant. The decision-making process of the authority on ISWM limits the opportunity for the final community to participate in decision-making [30].

9. Conclusion

The research revealed that effective community involvement in solid waste management in the study area has not yet been achieved. This is due to a lack of commitment from the authorities to implement the plan, and the government and many people not adhering to existing standards and rules. The university administration has also shown a lack of attention in enforcing existing rules and standards. The lack of effective management and

coordination has led to health and environmental hazards in the area. Recycling and separation of waste, suitable solid waste treatment facilities, and implementation of an appropriate solid waste disposal system are essential. The government, NGOs, CBOs, and micro or small businesses should be given a chance to create energy from waste and increase community participation in waste management.

Community-based education and awareness are essential to promote sustainable waste management practices. A green force of community members should be formed to act as a supervisory body and instill a sense of community spirit among members. The public should be educated on solid waste management rules and regulations, and penalties for non-compliance should be imposed. Participatory strategies for raising awareness, changing behaviors, and promoting social mobility and integrity should be implemented. Policies and guidelines for solid waste management should be developed and adopted by all stakeholders at the micro level to ensure uniform waste segregation, transportation, treatment, and disposal procedures.

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