Performance of Municipality Waste Treatment Plant with Special Focus on Shibganj Waste Treatment Plant

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A thesis submitted to the Department of Civil Engineering in partial fulfillment for the degree of Bachelor of Science in Civil Engineering



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DECLARATION

It is hereby declared that this thesis/project or any part of it has not been submitted elsewhere for the award of any degree or diploma.

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Dedicated

to

“OUR PARENTS, FAMILY AND TEACHERS”

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ABSTRACT

This study examines the current performance and utilization of solid and fecal waste management systems in Shibganj Municipality, with particular focus on the Integrated Waste Management Plant (IWMP). Despite the establishment of formal collection and treatment facilities, findings reveal significant gaps between waste generation, collection, and treatment. On average, only 1 tone/day of municipal solid waste is transported to the IWMP, against a design capacity of 5.5 tons/day, resulting in a utilization rate of approximately 18.18%. Similarly, fecal sludge treatment at the IWMP shows underperformance, with actual throughput representing only 15–18% of plant capacity (The Fecal treatment plant capacity is 45 m^3/day). These results indicate that the treatment facilities remain substantially underutilized due to limited collection efficiency, inadequate transportation, and reliance on informal or unregulated disposal practices. The underperformance of the plants undermines their environmental and public health benefits, highlighting the need for improved collection mechanisms, community engagement, and institutional coordination. This research provides critical insights for optimizing waste management systems and ensuring sustainable urban sanitation services in secondary towns of Bangladesh.

Keywords: Solid Waste Management, Fecal Sludge Management, Integrated Waste Management Plant (IWMP), Treatment Plant Utilization, Collection Efficiency, Municipal Waste, Waste Disposal Practices, Environmental Sustainability, Public Health, Bangladesh

TABLE OF CONTENT

Table of Contents

ABSTRACT vii
TABLE OF CONTENT viii
LIST OF FIGURES xi
LIST OF TABLES xii
Chapter One: 1
INTRODUCTION 1
1.1 Background and Motivations 1
1.1.1 Problem 1
1.1.2 Importance 1
1.1.3 Goal and Motivation 1
1.2 Research Objectives and Overview 2
1.3 Organization of the thesis: 2
Chapter Two: 3
LITERATURE REVIEW 3
2.1 Survey of Existing Knowledge 3
2.2 Critical Analysis 3
2.3 Identification of Gaps 3
2.4 Waste Management: Concept and Framework 4
2.5 Connection to Present Research 7
Chapter Three: 8
METHODOLOGY 8
3.1 Research Methodology 8
3.2 Study Area 8
3.3 Research Design 11
3.3.1 Qualitative Methods 11
3.3.2 Quantitative Methods 12
3.4 Data Collection Techniques 12
3.5 Sampling Strategy 14
3.6 Data Analysis 15
3.6.1 Qualitative Data Analysis 15
3.6.2 Quantitative Data Analysis 15
3.7 Environmental Impact Assessment 15

Chapter Four: 16
RESULTS AND DISCUSSION 16
4.1 Introduction 16
4.2 Waste Generation, Collection, Recovery, and Disposal Status in Shibganj Pourashava ..16
4.2.1 Total Solid Waste Generation (2025 Estimates) 16
4.2.2 Collection Performance 19
4.2.3 Solid Waste Recovery by Informal Sector 19
4.2.4 Uncollected Solid Waste 19
4.2.5 Illegal SW Dumping 19
4.3 Summary of Solid Waste Flow Data 21
4.3.1 Total Fecal Sludge Management (FSM) (2025 Estimates) 21
4.3.2 FSM Waste Collection Performance 22
4.3.3 Uncollected FSM 22
4.3.4 Informal / Unsafe Disposal Practices 22
4.3.5 Summary: FSM Collection Performance 23
4.4 Operational Performance of the IWMP 24
4.4.1 Management Structure and Waste Flow Breakdown 24
4.4.2 Waste Disposal Practices and Illegal Dumping 25
4.4.3 Infrastructure and Capacity Utilization 25
4.4.4 Technical and Logistical Challenges 26
4.4.5 Lack of Compost Quality Testing 26
4.5 Community Engagement and Public Perception 27
4.5.1 Survey Participation and Demographics 27
4.5.2 Awareness and Attitudes 27
4.5.3 Effectiveness of Public Engagement Strategies 27
4.6 Institutional and Policy Challenges 27
4.6.1 Governance and Inter-Agency Coordination 27
4.6.2 Human Resource Limitations 28
4.6.3 Operational fragmentation between the Pourashava and Mati Organics Ltd. 28
4.7 Environmental Outcomes of the IWMP 29
4.7.1 Waste Diversion and Recycling Rates 29
4.7.2 Compost Quality and Market Linkages 30
4.8 Comparative Analysis 30
4.8.1 Jashore Municipality (Integrated Landfill and Resource Recovery Facility) 30
4.8.2 Rajshahi City Corporation IWMP 30

4.8.3 Shibganj Pourashava IWMP 30
Chapter Five:..... 33
Conclusions and Future Works..... 33
5.1 Conclusions..... 33
5.2 Limitations and Recommendations for Future Works..... 33
References..... 34
APPENDIX..... 36
APPENDIX-A: Questionnaire..... 36
APPENDIX-B: Calculation..... 48

LIST OF FIGURES

Figure 1 Solid Waste Treatment Process 4
Figure 2 Solid Waste Treatment Process 4
Figure 3 Fecal Waste Treatment Process [4] 5
Figure 4 3D Model of Fecal Sludge Treatment Process [4] 5
Figure 5 Flow Chart Fecal Sludge Treatment Process [4] 6
Figure 6 Fecal Waste Treatment Process 7
Figure 7 Map of Shibganj Municipality [7] 9
Figure 8 Location of Shibganj (Waste Treatment plant) [16] 10
Figure 9 Layout of Shibganj (Waste Treatment plant) [17] 10
Figure 10 Group Discussion with Plant Workers. 11
Figure 11 Direct Field Observations of Shibganj Pourashava. 13
Figure 12 Direct Field Observations of Shibganj Treatment Plant 13
Figure 13 Shibganj Solid Waste Composition. 17
Figure 14 Solid Waste Treatment Process**.** 18
Figure 15 Mati Organics Limited (Shibganj Pourashava) 24
Figure 16 Some Illegal Dumping Sites of Shibganj Pourashava 25
Figure 17 Stored piles of Compost in several location Treatment Plant shed 26
Figure 18 Meeting and Discussion session with Conservancy Section Personnel, Shibganj Pourashava 29

LIST OF TABLES

Table 1 Summary of Solid Waste Flow Data.....20
Table 2 Solid Waste Plant Performance Flow Table 20
Table 3 Summary of Fecal Waste Data.....23
Table 4 Fecal Waste Plant Performance Flow Table 23
Table 5 Summary Comparison of Shibganj, Rajshahi and Jashore IWMP 31
Table 6 Summary of Key Findings 31
Table 7 Methodology vs Result Mapping 32

Chapter One:

INTRODUCTION

1.1 Background and Motivations

In many towns across Bangladesh, the management of waste has become a serious concern. With rapid growth in population and urbanization, both **solid waste** and **fecal waste** are being generated in increasing quantities. Unfortunately, most secondary municipalities still depend on basic methods such as open dumping, unsanitary landfills, or discharging untreated sludge into drains and rivers. These practices not only pollute land and water but also contribute to bad odors, greenhouse gas emissions, and the spread of diseases.

To address these challenges, the Government of Bangladesh, together with different development partners, has introduced. **Integrated Waste Treatment Plants (IWTPs)** in a number of municipalities. These plants are designed to handle both solid waste and fecal sludge in a more scientific and sustainable way. If operated properly, they can reduce environmental pollution, improve community health, and help achieve global targets like the **Sustainable Development Goals (SDG 6 and SDG 11).** [1]

1.1.1 Problem

While the idea of integrated treatment is promising, the reality is often very different. Many plants face problems such as weak collection and transport systems, shortage of skilled manpower, lack of awareness in the community, and limited financial resources. As a result, the plants are often underused, while informal dumping and unsafe disposal continue to take place in surrounding areas.

The **Shibganj Municipality Treatment Plant**, located in Chapainawabganj District, was built with the goal of solving these waste challenges. However, there is little evidence about how well it is actually performing. Are both the solid waste and fecal sludge treatment systems working as planned? Is the plant really improving the environment and health of the people? These are important questions that need to be answered.

1.1.2 Importance

This research matters because effective waste management is directly linked to cleaner surroundings, safer water, and better public health. If the Shibganj plant is working effectively, it could serve as a model for many other towns across Bangladesh. On the other hand, if there are gaps in operation, identifying them can help improve the system and prevent similar problems in future projects.

1.1.3 Goal and Motivation

The main goal of this study is to examine the performance of the **solid waste and fecal waste treatment components** of the Shibganj Municipality Treatment Plant. The research will look at how the plant is operating, what challenges it faces, and what can be done to improve it.

The motivation for this study comes from the urgent need to shift away from harmful waste disposal practices and move toward more sustainable and healthy urban environments. By studying Shibganj, the research hopes to provide useful insights that can guide other small and mid-sized towns in Bangladesh as they build or improve their own waste management systems.

1.2 Research Objectives and Overview

In many towns of Bangladesh, new waste treatment plants are being built to manage growing waste problems. Shibganj Municipality started such a plant to reduce open dumping, recycle waste, and make compost. But only a small part of daily waste reaches the plant. Most waste is still thrown in open areas, causing pollution and health risks. Poor waste collection, little source separation, low funds, lack of staff, and weak management make the plant less effective. This study looks at why the plant is not working well and gives ideas to improve waste management in Shibganj and similar towns.

Research Objectives

The primary aim of this study is to assess the operational efficiency and sustainability of the solid waste management system in Shibganj Pourashava. The specific objectives are:

- To study the operational performance of the Shibganj Municipality **solid waste treatment plant** against standard guidelines and best practice.
- To study the operational performance of the Shibganj Municipality **fecal waste treatment plant** against standard guidelines and best practice.

1.3 Organization of the thesis:

Typically, a thesis contains the following chapters: an introduction; a literature review; a description of methodology; a report and discussion of results; and conclusion.

Chapter 1: Introduction

This chapter provides the background and motivations of the research. The overall objectives and expected outcomes are also described in this chapter.

Chapter 2: Literature Review

This chapter reviews the related works in the concrete strength test field with a special focus on chemicals.

Chapter 3: Methodology

This chapter describes the methodology adopted to carry out the research.

Chapter 4: Results

This chapter describes the collected date and time of different materials for our research work.

Chapter 5: Conclusion, Limitations and Recommendations

This chapter summarizes the conclusions, contributes to this study limitation and provides recommendations for future studies.

Chapter Two:

LITERATURE REVIEW

2.1 Survey of Existing Knowledge

Managing solid waste is a big challenge in developing countries, where towns often lack the money, technical skills, and strong institutions to run efficient systems. Smaller towns like Shibganj face extra problems such as poor infrastructure, weak rules, and low public awareness. For example, the **Saidpur SFD Report (2018)** shows that only **13% of excreta is safely managed**, while **87% is dumped unsafely** because of missing treatment facilities and weak systems. [2] Even with steady municipal income, investments in proper waste management are very low, causing pollution and health risks. This chapter looks at studies on SWM, including treatment efficiency, operational problems, environmental and health effects, technologies, financing, and community involvement. The goal is to understand why the Shibganj Solid Waste Treatment Plant faces inefficiencies and to highlight gaps that need further study.

2.2 Critical Analysis

Many studies focus more on technology and less on social and financial issues. For example, composting and biogas systems work well in theory, but in small Bangladeshi towns they are often poorly managed. Waste-to-energy systems can reduce waste and produce electricity, but they are very expensive and need skilled workers, which many towns do not have.

FSM studies highlight the need for treatment plants, but most towns cannot build or run them because of weak institutions. Also, climate change, rapid population growth, and the rise of single-use plastics make waste problems worse, but these are not fully addressed in existing studies. Overall, past research often looks at one part of the problem instead of the full system

2.3 Identification of Gaps

From the reviewed studies, some important gaps can be seen:

- There is little focus on how to change people's attitudes and improve participation in segregation and recycling.
- Governance and regulation issues are not studied deeply enough.
- Most solutions are technical, with little focus on how social, financial, and environmental factors connect.
- Small towns like Shibganj are rarely studied, as most research looks at big cities.

2.4 Waste Management: Concept and Framework

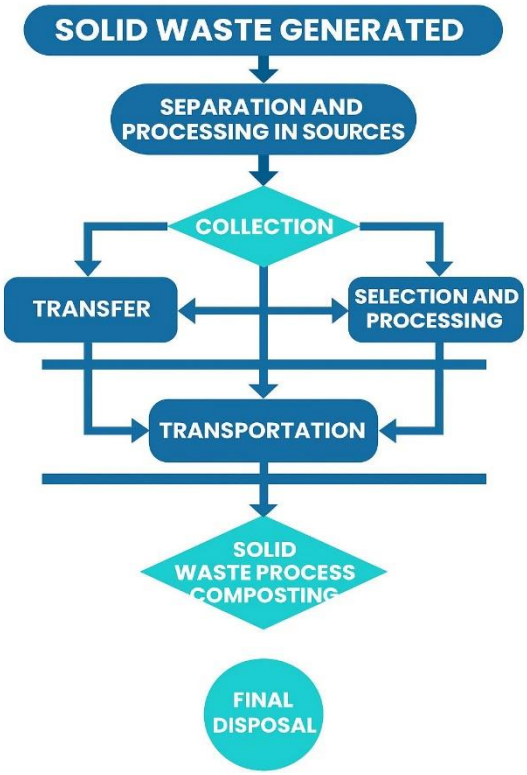
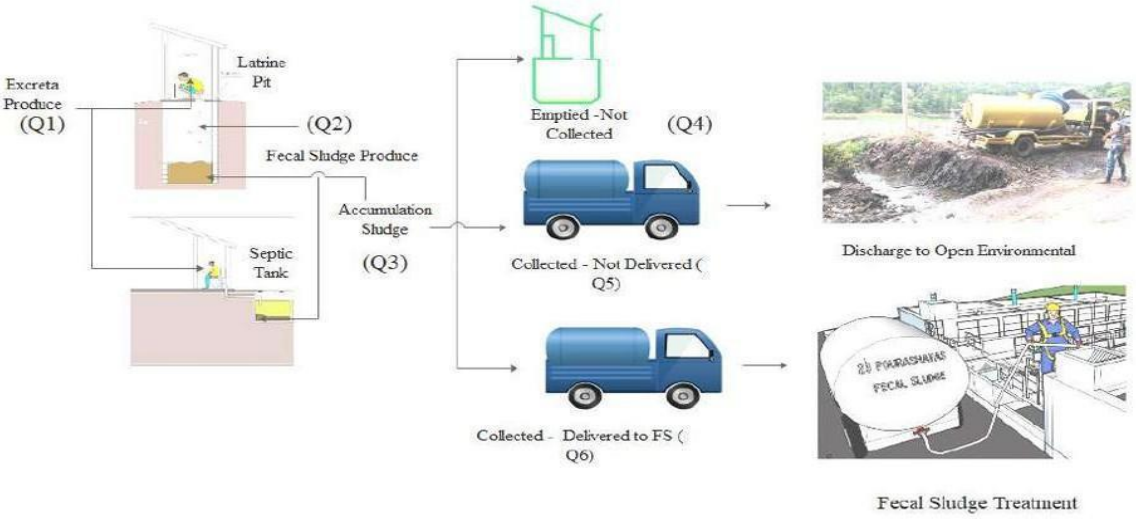


Figure 1 Solid Waste Treatment Process

Solid Waste Management is a systematic process that starts with waste generation and source separation, followed by collection, transfer, and transportation. Recyclables and organics are processed through recovery and composting, while the remaining waste is sent for final disposal in landfills. This approach reduces pollution, conserves resources, and ensures environmental sustainability.



Figure 2 Solid Waste Treatment Process



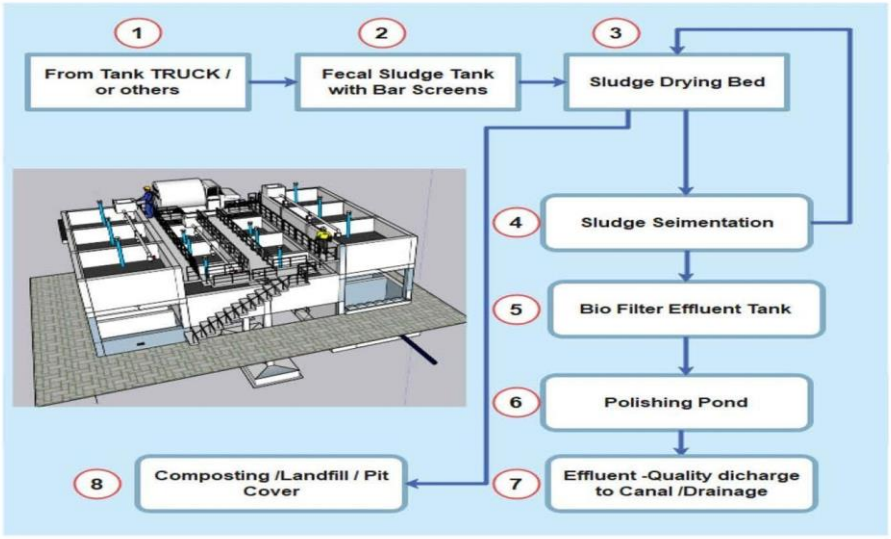


Figure 3 Fecal Waste Treatment Process [4]

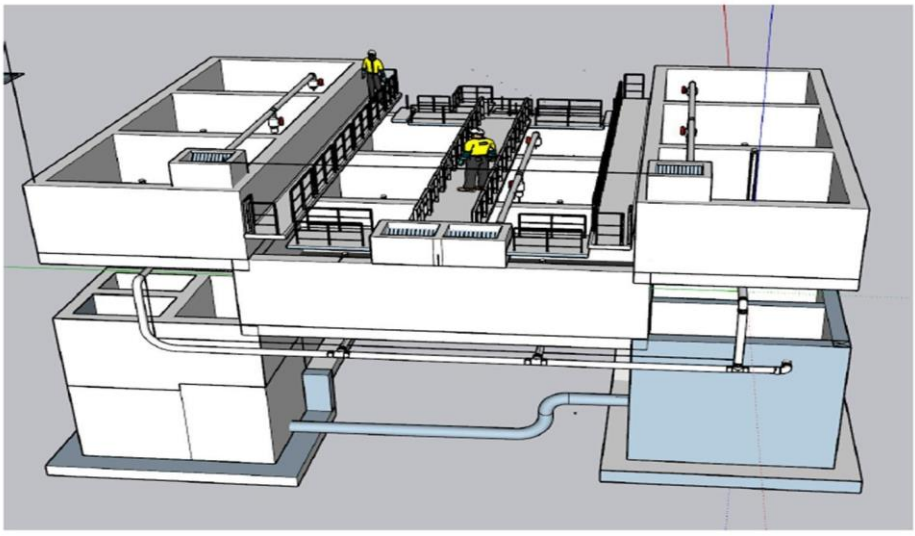


Figure 4 3D Model of Fecal Sludge Treatment Process [4]

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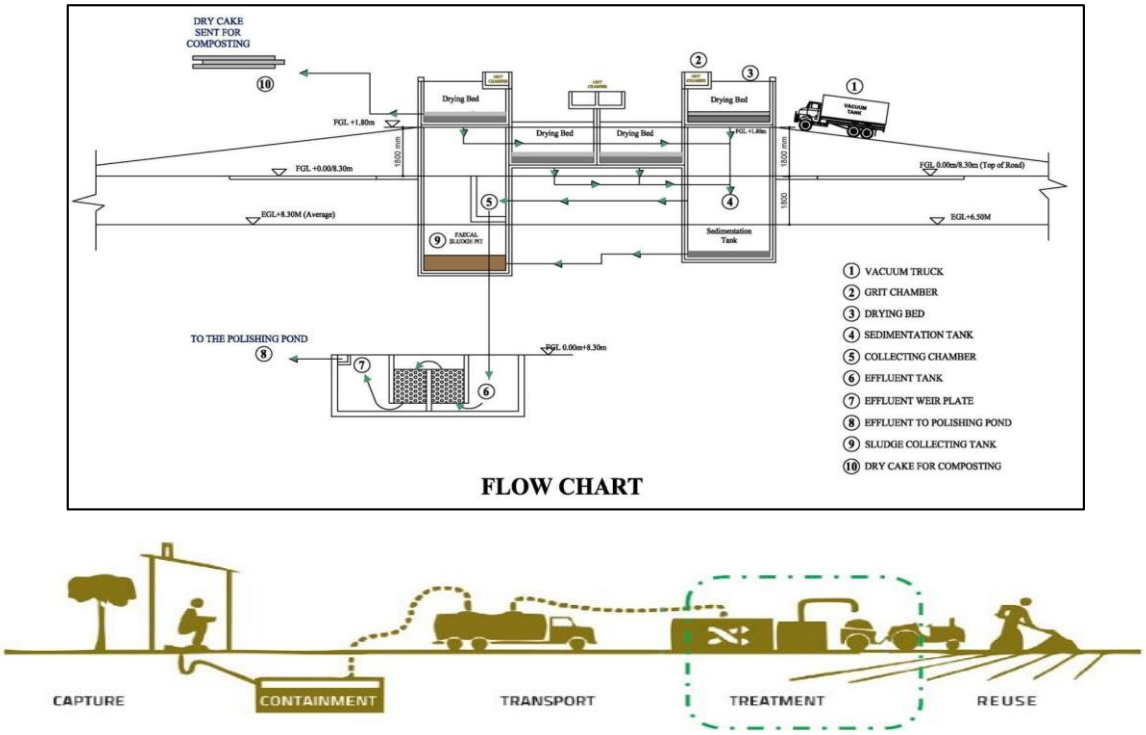


Figure 5 Flow Chart Fecal Sludge Treatment Process [4]

Fecal waste is collected from toilets, pit latrines, and septic tanks, then transported to a treatment plant. First, unwanted materials like trash, plastics, and sand are removed. Next, the excess water is reduced, and the sludge goes through treatment steps to kill harmful germs and remove dangerous substances. The liquid part is treated and passed through a polishing pond before safe release into nature or reuse in irrigation. The solid part is dried and reused as compost, fertilizer, or fuel, protecting people and the environment





Figure 6 Fecal Waste Treatment Process

2.5 Connection to Present Research

The reviewed studies show that many developing towns struggle with solid waste management because of weak infrastructure, limited funding, and low public awareness. Reports such as the Saidpur SFD (2018) [2] highlight how unsafe disposal remains widespread, with only a small share of waste and excreta being properly treated. Even though some towns have steady income, very little of it is invested in waste management, which leads to pollution, health risks, and environmental damage.

These findings directly connect to the situation in Shibganj. The Solid Waste Treatment Plant was established to improve management, but it still faces many inefficiencies. Problems with treatment operations, financing, technology use, and community participation continue to limit its performance. This research builds on earlier studies but focuses specifically on the Shibganj plant to understand why it is not working effectively. By doing so, it addresses the gaps identified in the literature and provides insights that can help design better, more sustainable waste management systems for small towns in Bangladesh.

Chapter Three:

METHODOLOGY

3.1 Research Methodology

The research methodology employed in this study is designed to offer a comprehensive and in-depth understanding of the **Sustainable Solid Waste Management** system in **Shibganj Municipality**, focusing particularly on the **Solid Waste Treatment plant of the Integrated Waste Treatment Plant (IWMP)**. This approach is essential for analyzing the challenges, opportunities, and environmental impacts associated with the newly established plant, as it incorporates both **qualitative** and **quantitative research methods**. The mixed-methods approach ensures that the research captures a holistic view of the plant's operations, maintenance requirements, socio-environmental impacts, and public participation.

In order to answer the research questions effectively, this methodology utilizes a combination of data collection strategies, including **stakeholder interviews**, **community surveys**, **field observations**, and **document analysis**. This integrated approach ensures that both the technical performance and social implications of the Solid Waste Treatment plant are carefully evaluated.

The study is structured into four major stages: **Data Collection**, **Data Analysis**, **Field Observations**, and **Stakeholder Engagement**. Each stage uses both primary and secondary data sources to create a multi-dimensional understanding of the Solid Waste Treatment Plant's operational efficiency, challenges, and environmental consequences.

3.2 Study Area

Shibganj Municipality was chosen as the study area due to its pressing waste management challenges and the establishment of the Integrated Waste Management Plant (IWMP), which has significant implications for both the local environment and community (BBS, 2022). [3]

The IWMP was developed under the **23 Urban Water Supply and Sanitation Project (UWSSPP***)* [4] of the Department of Public Health Engineering (DPHE), with financial support from the Islamic Development Bank (IsDB). This initiative integrates a **Solid Waste Management (SWM) system** and a **Fecal Sludge Treatment Plant (FSTP)** to address unregulated waste disposal and inadequate sanitation practices, thereby reducing environmental degradation and public health risks (DPHE, 2022; IsDB, 2022). [4]

Established in 1992 and later upgraded to a Category 'A' Pourashava, Shibganj Municipality covers an area of **22.21 km²** with a population of **52,006**, distributed across nine wards. The population is growing at a rate of **1.81% per year**, and projections for 2030 and 2040 emphasize the increasing demand for sustainable sanitation and waste management infrastructure (Census Projection Report, 2022). [5]

The SWM system under the IWMP emphasizes **recycling, composting, and safe disposal**, supported by phased implementation strategies and community participation. These efforts aim to ensure long-term sustainability while promoting environmental protection and improved public health outcomes (DPHE, 2022). [6]

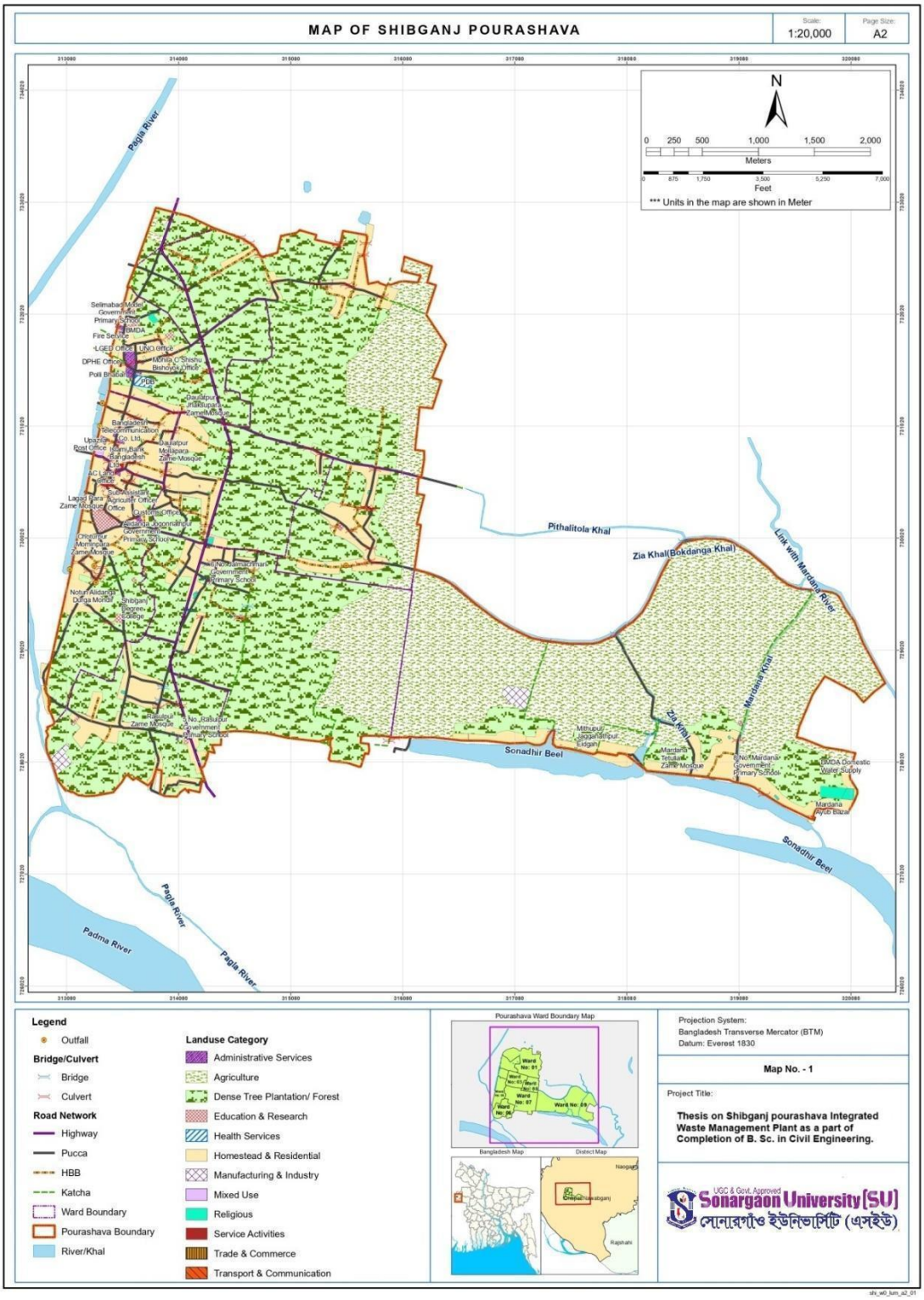


Figure 7 Map of Shibganj Municipality [7]

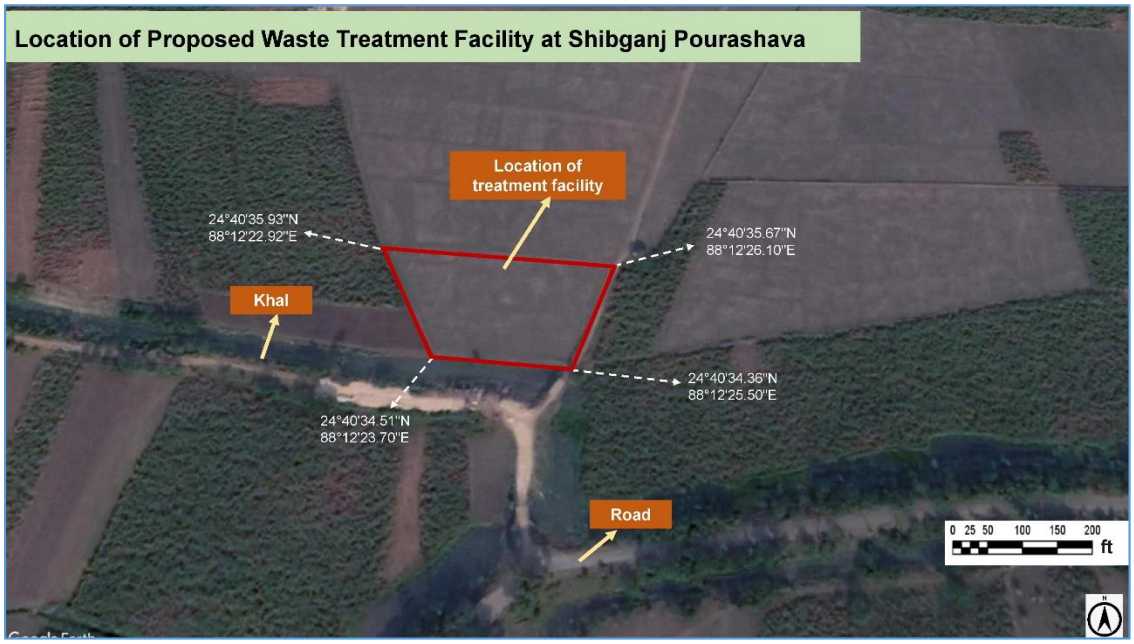


Figure 8 Location of Shibganj (Waste Treatment plant) [16]

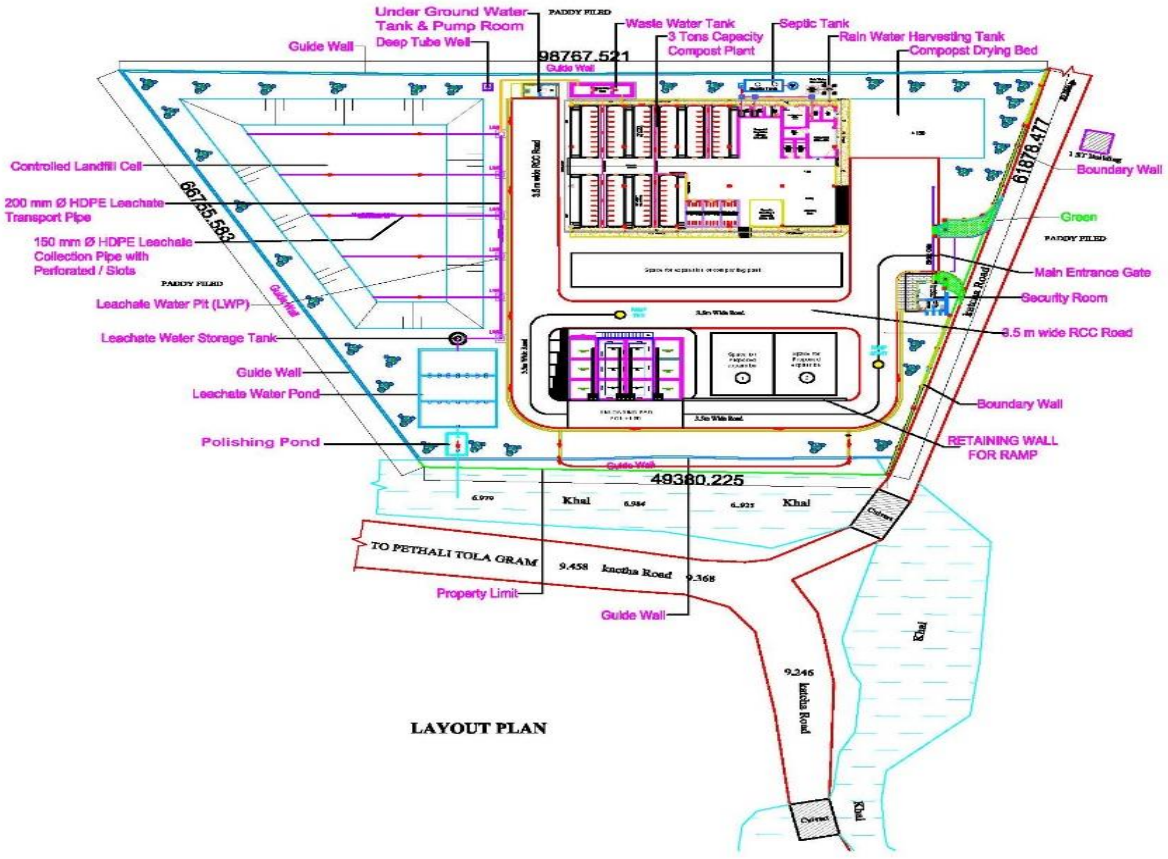


Figure 9 Layout of Shibganj (Waste Treatment plant) [17]

3.3 Research Design

This study follows a **mixed-methods research design**, integrating both **qualitative** and **quantitative** methods. The research design is intended to provide a **rich, multifaceted understanding** of the research problem by considering both technical and socio-environmental dimensions of waste management in Shibganj Municipality.

A **case study** approach is chosen for this research, focusing specifically on the Shibganj IWMP as a representative example of an Integrated Waste Management Plant in Bangladesh. By using this case study approach, the study will provide a detailed examination of the Treatment Plant's operations, challenges, opportunities, and impact on the municipality's sustainability efforts.

3.3.1 Qualitative Methods

(A) Interviews and Focus Group Discussions (FGDs): Semi-structured interviews had been conducted with key stakeholders, including **local government officials**, **plant operators**, **environmental experts**, and **community members**. These interviews explored the operational challenges, maintenance issues, public perceptions, and the social impact of the plant. In-depth discussions with stakeholders allowed the research to uncover the nuanced perspectives of individuals directly involved in or affected by the plant's activities.

Additionally, **focus group discussions (FGDs)** were held with community members. These discussions aimed to understand the general public's awareness, participation, and perceptions of the Solid Waste Treatment Plant. The FGDs explored how residents view the effectiveness of the Plant, their role in waste segregation, and their willingness to engage in sustainable waste management practices. This also provided insights into the effectiveness of **community engagement strategies** and public involvement in the waste management process.



Figure 10 Group Discussion with Plant Workers.

(B) Document Review: A comprehensive review of relevant **policy documents**, **Solid waste management regulations**, and **previous studies** on Solid Waste Treatment Plants in Bangladesh had been conducted. This secondary data collection served several purposes: providing the contextual background for the research, identifying policy gaps, and benchmarking Shibganj's Solid Waste Treatment Plant against other similar initiatives in the country. Reviewing the policies and strategies behind waste management in Bangladesh helped identify institutional challenges and opportunities for improving the plant's performance and sustainability.

3.3.2 Quantitative Methods

(A) Surveys and Questionnaires: Surveys had been distributed to a representative sample of **residents** in Shibganj Municipality. The primary aim was to assess public awareness of waste management practices, residents' attitudes toward waste segregation, and their knowledge about the Solid Waste Treatment Plant operations. The researchers also collected data on residents' **willingness to participate** in waste reduction, recycling, and other sustainability practices.

A **structured questionnaire** had been developed for the surveys, which included closed and open-ended questions. The questions focused on key indicators such as:

- ✓ Waste segregation practices at the household level
- ✓ Awareness of the Solid Waste Management processes
- ✓ Satisfaction with the Solid Waste Management services
- ✓ Perceived challenges and barriers to effective waste management

This data helped identify gaps in public knowledge, barriers to the success of the Solid Waste Treatment Plant, and the public's level of engagement in waste management practices.

(B) Performance Data Analysis: Operational data on the **performance of the treatment plant** has been collected through official reports and records. This data included:

- ✓ Waste treatment capacity
- ✓ Waste diversion rates (such as recycling and composting rates)
- ✓ Volume of fecal sludge treated

By examining these metrics, the research assessed the **environmental impact** of the IWMP, specifically focusing on reductions in landfill use, reductions in **methane emissions**, and any improvements in **groundwater quality**. Additionally, the study evaluated how well the IWMP had been performing compared to the expected outcomes set by the municipality and the government.

3.4 Data Collection Techniques

The data collection process had been structured into various methods to ensure comprehensive coverage of the research problem. The following techniques will be employed:

1. **Field Observations:** The Shibganj IWMP was directly observed to assess infrastructure, waste treatment, and operational workflows. Key processes—segregation, composting, recycling, and fecal sludge treatment—were examined to identify inefficiencies, maintenance issues, and gaps in implementation.

A field visit was conducted at **Shibganj Pourashava** to assess the existing situation of **solid waste management** and **fecal sludge management (FSM)**. The objective was to observe current practices, interact with local residents, and gather primary data to support treatment process evaluation.

As shown in **Figure 1**, the research team visited different locations within the Pourashava to observe waste collection and disposal points. A group discussion was conducted with local stakeholders and community members to identify key challenges, illustrated in **Figure 2**. Furthermore, household-level interviews were carried out to understand public practices on waste disposal and sanitation behavior, as shown in **Figures 3, 4, and 5**.



Figure 11 Direct Field Observations of Shibganj Pourashava.



Figure 12 Direct Field Observations of Shibganj Treatment Plant.

2. **Stakeholder Interviews**: Interviews with **local government officials**, **plant managers**, **community leaders**, and **environmental activists** had been conducted to understand their perspectives on the Solid Waste Treatment Plant. These individuals play key roles in the planning, implementation, and operation of the plant, as well as in ensuring community participation and compliance with regulations. The interviews aimed to uncover:
    - Challenges faced by the plant during its operation
    - Strategies for improving plant efficiency and sustainability
    - Perspectives on the role of the treatment plant in the broader context of sustainable urban development
    - Policy and funding issues affecting the plant's long-term sustainability.
3. **Community Surveys**: A **random sample** of households in Shibganj Municipality had been surveyed to gather data on residents' awareness of waste management practices, satisfaction with Solid Waste Management services, and their willingness to participate in sustainable waste management activities. This survey also explored barriers to effective waste management in the community, such as insufficient infrastructure, lack of awareness, and financial constraints.
4. **Document Analysis**: Secondary data had been collected from **government reports**, **research papers**, and **monitoring data** provided by the **Local Government Agencies (e.g. DPHE)** [8] and other relevant agencies. This data helped assess the effectiveness of the treatment plant, identify discrepancies between the intended and actual outcomes of the plant, and evaluate the plant's alignment with national and global waste management standards.
5. **Environmental Impact Data**: Data on the environmental impacts of the solid waste treatment plant, including reductions in **landfill waste**, **methane emissions**, and **groundwater contamination**, had been gathered from monitoring reports and relevant environmental studies. These data helped quantify the improvements in environmental quality achieved by the plant, as well as identify areas where further improvements may be needed.

3.5 Sampling Strategy

A combination of **purposive sampling** and **random sampling** had been employed for data collection:

- **Purposive Sampling**: This sampling method had been used for selecting stakeholders for the qualitative data collection, including key informants such as local government officials, plant managers, and community leaders. These individuals had been chosen for their direct involvement in the IWMP and their ability to provide in-depth insights into the plant's operation, challenges, and opportunities.
- **Random Sampling**: For the community surveys, **random sampling** had been applied to ensure a **representative sample** of the municipality's residents. This approach ensures that the sample reflects the diversity of the population and helps mitigate bias in the survey results. The sample size had been determined based on the population size of Shibganj Municipality, ensuring that the results were statistically significant.

Sample Size Equation:

$$Sample\ size = \frac{\frac{Z^2 \times P(P-1)}{E^2}}{1 + \left(\frac{Z^2 \times P(P-1)}{E^2 N}\right)}$$

Where:

- N = Population size
- Z = Z-score (e.g., 1.96 for 95% confidence)
- P = Standard of deviation
- E = Margin of error

3.6 Data Analysis

The collected data had been analyzed using both **qualitative** and **quantitative** methods:

3.6.1 Qualitative Data Analysis

Thematic Analysis: Interview transcripts and focus group discussion notes had been analyzed using **thematic analysis** to identify recurring themes and insights related to operational challenges, public awareness, maintenance issues, and the social impact of the solid waste treatment plant. The data had been coded and categorized to highlight key areas of concern, such as inefficiencies, public engagement challenges, and opportunities for improving the plant's performance.

3.6.2 Quantitative Data Analysis

Descriptive Statistics: Data from the community surveys had been analyzed using **descriptive statistics** (e.g., frequencies, percentages, and means). This analysis assessed public awareness, participation in waste segregation, and attitudes toward waste management practices.

Performance Metrics: Operational data on waste treatment capacity, waste diversion rates, and other performance indicators will be analyzed to assess the plant's efficiency and environmental impact. Comparisons had been made between Shibganj's Solid waste treatment plant and other similar plants in Bangladesh to assess its relative performance.

3.7 Environmental Impact Assessment

The environmental impact data had been analyzed to quantify the reductions in landfill usage, methane emissions, and groundwater contamination. The research compared the environmental status before and after the implementation of the Solid Waste Treatment Plant, providing insight into its effectiveness in addressing environmental concerns.

Chapter Four:

RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents the findings of the study based on a rigorous mixed-methods research design. The chapter is structured around key themes and variables derived from interviews, focus group discussions (FGDs), surveys, performance data analysis, and environmental monitoring. The results are presented under four broad domains: operational performance of the IWMP, community engagement and awareness, policy and institutional challenges, and environmental outcomes. The integration of qualitative and quantitative findings provides a multidimensional understanding of the Shibganj IWMP's effectiveness, challenges, and areas for future improvement.

4.2 Waste Generation, Collection, Recovery, and Disposal Status in Shibganj Pourashava

Based on field data collection, operational records, and interviews with waste recovery agents, the current solid waste management situation in **Shibganj Pourashava** reveals significant inefficiencies in both collection and disposal processes. The quantitative waste flow scenario is detailed below:

4.2.1 Total Solid Waste Generation (2025 Estimates)

According to the Bangladesh Waste Database 2021, the per capita municipal solid waste (MSW) generation in urban areas was estimated at **0.36 kg/day**. Projections indicate that by 2025, this figure is expected to increase to approximately **0.36 kg/day.** [9]

Given:

- Total population of Shibganj Pourashava: **52,006**
- Per capita waste generation rate: **0.36 kg/person/day**

Step 1: Calculate total daily waste generation:

- Total population of Shibganj Pourashava: 52,006
- Per capita waste generation rate: 0.36 kg/person/day
- Waste composition: 70% household, 30% non-household

Step 1: Total Daily Waste Generation

Total MSW=18.72tonnes/day

Step 2: Household and Non-Household Waste

- Household waste 13.10 tonnes/day
- Non-household waste 5.62 tonnes/day

Total Municipal Solid Waste (MSW) Generated:

13.10 tonnes/day (household) + 5.62 tonnes/day (non-household) = 18.72 tonnes/day

- Total solid waste generation: Approximately 18.72 tonnes/day
- Household waste: Approximately 13.10 tonnes/day
- Non-household waste: Approximately 5.62 tonnes/day

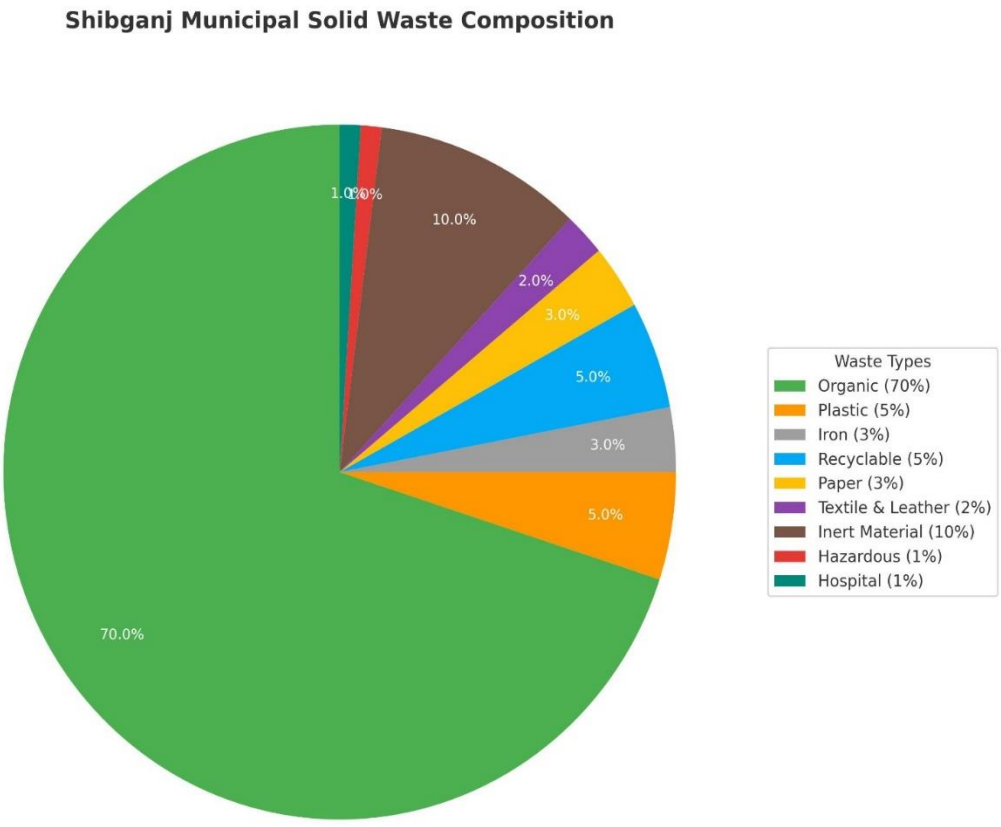


Figure 13 Shibganj Solid Waste Composition.

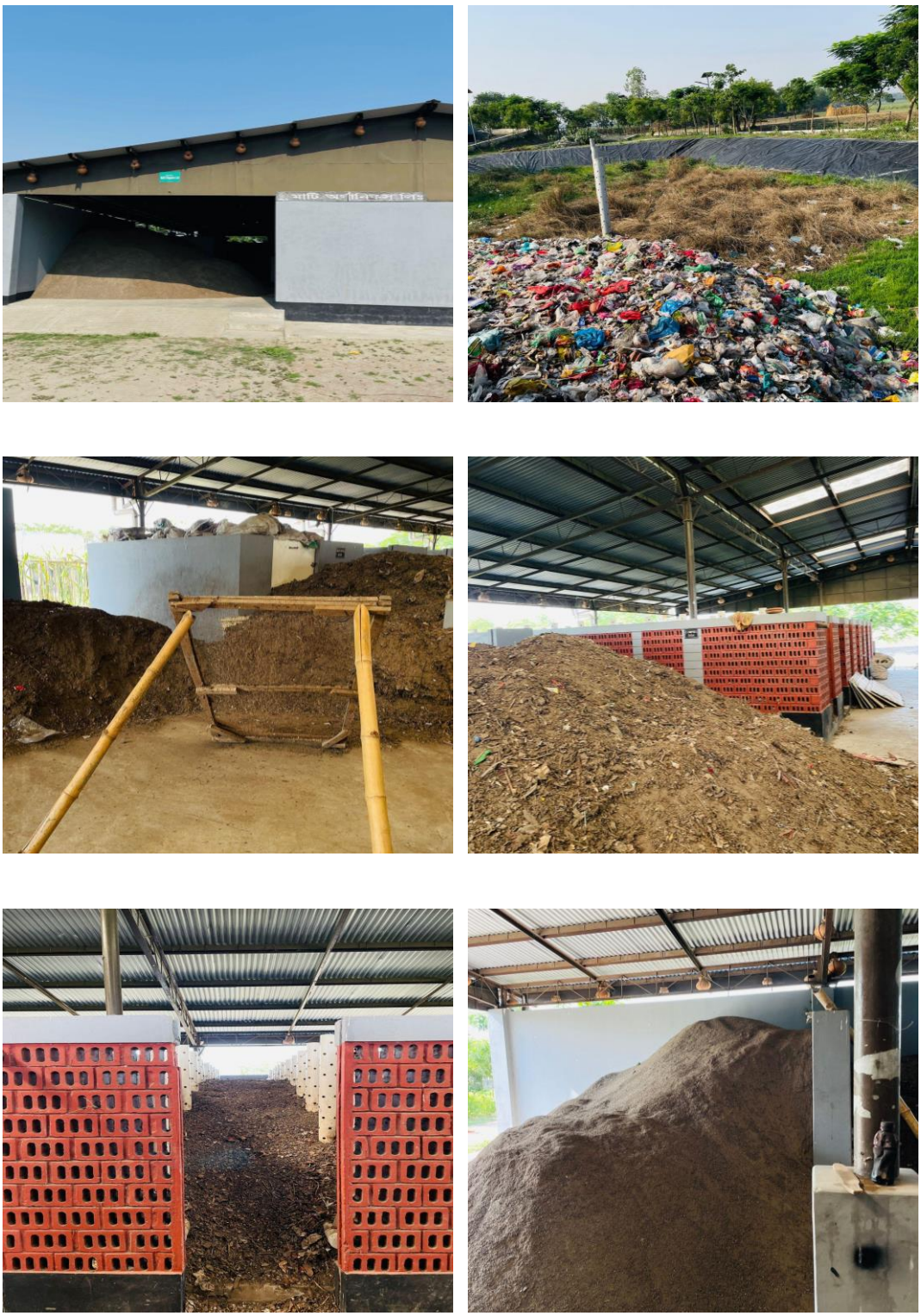


Figure 14 Solid Waste Treatment Process**.**

4.2.2 Collection Performance

- **Total Waste Collected**: **8 tonnes/day (approx.)**
- **Waste Collected by Pourashava System**:

  Operational records from municipal waste transport vehicles indicate that approximately **13 tonnes/day** are collected by municipal trucks and vans.

- **Waste Transported to Treatment Plant**:

  Of the collected waste, only **1 tonne/day** is transported to the Integrated Waste Management Plant (IWMP), representing **minimal formal processing.** The rest is disposed of at illegal or unauthorized sites.

4.2.3 Solid Waste Recovery by Informal Sector

- Based on interviews with informal waste recovery agents and apex traders, the **informal sector recovers approximately 2 tonnes/day**, consisting mainly of plastics, metals, and paper.
- **Waste Recovered in Percentage Terms**:

  10.68 **% (**approx **10.68%)**

4.2.4 Uncollected Solid Waste

- **Total Uncollected Waste**: 8.72 tons/day

(However, with rounding in field estimation, **1 tonnes/day** is considered uncollected.)

- **Percentage of Uncollected Waste**: **46.56%**

4.2.5 Illegal SW Dumping

A significant finding is that almost all waste collected by the Pourashava system, including municipal dump trucks and small collection vans, is **disposed of at unauthorized dumpsites**, bypassing the IWMP entirely. This results in:

- **Illegal Dumping Percentage**:
- **87.5%** of total waste collected is directly dumped at illegal or informal sites within the Pourashava boundary.

Table 1 Summary of Solid Waste Flow Data

Parameter	Quantity	Percentage (%)
Total Population	52,006	—
Total MSW Generated	18.71 tonnes/day	100%
Household Waste Generation	13.10 tonnes/day	70%
Non-Household Waste Generation	5.62 tonnes/day	30%
Total Waste Collected	18.72 tonnes/day	42.7%
Waste Collected by Pourashava	8 tonnes/day	69.4%
Waste to IWMP (Treatment Plant)	1 tonne/day	5.3%
Waste Recovered by Informal Sector	2 tonnes/day	10.68%
Total Uncollected Waste	8.72 tonnes/day	46.56%
Waste Disposed via Illegal Dumping	Approx. 7 tonnes/day	87.5% (of collected waste)

Table 2 Solid Waste Plant Performance Flow Table

Parameter	Unit	Value / Observation	Remarks
Waste Transported to IWMP (Treatment Plant)	tonnes/ day	1	Only a fraction of the collected waste reaches the plant
TIWMP Plant Capacity	tonnes/ day	5.5	Maximum design capacity of the plant
Utilization of Plant Capacity		(1÷5.5) ×100%=18.18%	Significantly underutilized treatment plant.

4.3 Summary of Solid Waste Flow Data

Illegal Dumping (out of treatment plant dumping) = 92% (as all the wastes collected by Pourashava system also dumped in illegal sites)

4.3.1 Total Fecal Sludge Management (FSM) (2025 Estimates)

Here's a clean reference-style write-up of the **Saidpur Municipality (WaterAid, 2017)** [10] **survey findings** on faecal sludge production:

- **Average per capita faecal sludge production**: **0.561 liters per person per day**

Verification and Calculation:

Parameter	Value	Calculation / Notes
Population	52,006 persons	As per census / study area
Per capita faecal sludge generation	0.561 L/person/day	From Saidpur Municipality survey (WaterAid, 2017) [10]
Total daily faecal sludge generation	29,166 L/day	Multiply population by per capita daily generation
Total daily faecal sludge generation (m^3)	29.2 m^3/day	Convert liters to cubic meters
Total annual faecal sludge generation	10,658 m^3/year	Multiply daily generation by 365 days

The fecal sludge treatment system is underperforming. Of the **estimated 500,000 liters/month of fecal sludge generated**, only **~5700 liters/month** are treated at the plant.

Key barriers include:

- **Low desludging service coverage** by vacuum trucks.
- **Lack of household-level awareness** about safe sanitation and scheduled emptying.
- Absence of monitoring for illegal disposal in water bodies and drains.

Environmental monitoring data from the local DoE office showed a **slight improvement in groundwater quality**, especially in areas surrounding former open defecation sites. However, Methane emissions and groundwater contamination risks are likely increasing due to uncontrolled open dumping.

As such, the IWMP has failed to deliver tangible environmental improvements, mainly due to:

- Fragmented institutional responsibility.
- Poor enforcement of waste transport regulations.
- Absence of product quality assurance mechanisms.

4.3.2 FSM Waste Collection Performance

Total FSM Collected:
Operational data and field observations indicate that only about **7–8 m³/day** of fecal sludge is collected by formal service providers, against an estimated generation of **29.2 m³/day**.

Collection by Pourashava System:

The municipal vacuum truck service accounts for the majority of formal collection. Coverage remains limited due to low demand, lack of household awareness, and affordability barriers.

Collection by Private Operators:
Private desludging operators supplement municipal services but operate at a very small scale, contributing only marginally to the total collected volume.

Total FSM Transported to FSTP:
Almost all formally collected sludge (≈ **7–8 m³/day**) is transported to the Fecal Sludge Treatment Plant (FSTP). However, this represents only a **small fraction (~24–27%)** of the total daily generation.

4.3.3 Uncollected FSM

Total Uncollected FSM:

Estimated generation−Collected = 21.7m³/day

Percentage of Uncollected FSM: **74.3%**

This indicates that **around 74.3% of fecal sludge is not collected through formal channels**, highlighting the heavy reliance on unsafe or informal disposal practices.

4.3.4 Informal / Unsafe Disposal Practices

A significant portion of household's dispose of fecal sludge through **manual emptying and direct discharge** into drains, open fields, or water bodies. Field interviews and community surveys suggest that **≈ 74.3%** of the total generated FSM follows these unsafe disposal routes.

4.3.5 Summary: FSM Collection Performance

Parameter	Percentage (%)
Collected (formal)	24–27% of total generated
Uncollected / informal / unsafe disposal	74.3%
Transported to FSTP	100% of formally collected sludge

Table 3 Summary of Fecal Waste Data

Parameter	Quantity	Percentage (%)
Total Population	52,006	—
Estimated Fecal Sludge Generated	29,166 L/day	100%
Total daily fecal sludge generation (m^3)	29.2 m^3/day	100%
FSM Collected (Formal/Truck Service)	7-8 m^3/day	≈24-27%
FSM Treated at FSTP	7-8 m^3/day	≈100%
Uncollected / Illegally Disposed FSM	4-5m^3/day	≈74.3%
Treatment Plant Utilization Rate	6-8 m^3/day vs 45 m^3/day	≈ 15-18% of design capacity

Table 4 Fecal Waste Plant Performance Flow Table

Parameter	Unit	Value / Observation	Remarks
Waste Transported to IWMP (Treatment Plant)	tons/day	1	Only a fraction of the collected waste reaches the plant
IWMP Plant Capacity	tons/day	45	Maximum design capacity of the plant
Utilization of Plant Capacity		15%-18%	Based on current throughput vs capacity

4.4 Operational Performance of the IWMP

4.4.1 Management Structure and Waste Flow Breakdown

A critical operational issue identified during field observations and stakeholder interviews is the current management and operational arrangement of the IWMP. The treatment plant is managed not by the Pourashava itself but by a private entity, **Mati Organics Limited**, under a loosely structured Public-Private Partnership (PPP) model. However, collaboration between Mati Organics and municipal authorities is found to be practically ineffective.

Despite having municipal dump trucks and collection vans in operation across Shibganj Pourashava, **these vehicles do not transport waste to the treatment plant**. Similarly, **primary collection vans operated by the Pourashava do not dump their waste at the plant**.

Instead, only **two three-wheeler collection vans**, operated independently under Mati Organics Ltd., collect waste primarily from **2 to 3 out of 9 wards**, which significantly limits the plant's inflow of waste.

This fragmented system effectively disconnects municipal collection services from the



Figure 15 Mati Organics Limited (Shibganj Pourashava)

IWMP, reducing the plant's operational inputs to an unsustainably low level.

Key Observation:

"The Pourashava dump trucks operate daily but none of the collected waste is delivered to the treatment plant. It all goes to open or illegal dumpsites around the municipality." — Field Interview, IWMP Operator.



Figure 16 Some Illegal Dumping Sites of Shibganj Pourashava

4.4.2 Waste Disposal Practices and Illegal Dumping

A major finding concerns the illegal disposal of waste throughout the Pourashava. Due to the operational disconnect between Mati Organics Ltd. and municipal waste collection systems, most of Shibganj Pourashava's collected waste is transported to unauthorized dumping sites located throughout the Pourashava's jurisdiction.

Stakeholder interviews, combined with field visits, revealed at least five major illegal dumping hotspots within the municipal boundary, situated near water bodies, agricultural fields, and roadways.

This uncontrolled waste disposal practice results in:

- Significant environmental pollution.
- Increased health risks to the population.
- Blockage of drains and waterlogging during monsoons.
- A complete failure to achieve the waste diversion objectives envisioned under the IWMP framework.

Field observation notes highlighted that waste intended for treatment is instead deposited at informal locations, undermining the purpose of establishing the IWMP.

4.4.3 Infrastructure and Capacity Utilization

Field observations and plant-level data show that the **Shibganj IWMP** includes waste segregation units, composting chambers, recycling zones, and a Fecal Sludge Treatment Plant (FSTP).

Operational data indicate that **31 tonnes/day** of municipal solid waste (MSW) are generated, of which **13.5 tonnes/day (42%)** are collected formally. The **Pourashava collects 12.5 tonnes/day**, but about **92% of this is dumped illegally**, including outside the treatment plant. Only **1 tonne/day (~3.2%)** reaches the IWMP, and **1.5 tonnes/day (6.5%)** is recovered by the informal sector. Approximately **15 tonnes/day (51.6%)** remain uncollected.

The FSTP, designed for **6 m^3/day**, treats only **3–4 m^3/day (50–67% of capacity)**, representing **10–14% of total fecal sludge (~29.2 m^3/day)**. Most sludge is uncollected or disposed of informally.

Overall, both MSW and FSM systems are **severely underutilized** due to limited collection, weak enforcement, and technical constraints, reducing environmental and health benefits.

4.4.4 Technical and Logistical Challenges

Interviews with engineers and plant managers highlighted several recurring technical issues, including:

- Inadequate maintenance of treatment plant components.
- Lack of a real-time monitoring system to track waste flows.
- Seasonal fluctuations in waste volume, especially during harvest periods and religious festivals, which strain plant capacity.

Moreover, logistical limitations such as **insufficient waste collection vehicles** and irregular collection routes were cited as major barriers to consistent feedstock delivery to the plant. A recurring complaint was the absence of source-segregated waste, which hinders the efficiency of composting and recycling processes.

4.4.5 Lack of Compost Quality Testing

Another critical operational deficiency is the absence of any **formal quality testing of the compost** produced by Mati Organics Ltd. at the treatment plant. Interviews confirmed that:

- **No laboratory tests have been conducted** to assess the compost's nutrient content, presence of heavy metals, or pathogen levels.
- Compost is stored in open piles within the plant boundary, unsorted and unpackaged.
- No certification from BSTI or any other regulatory authority has been pursued.

This lack of testing and certification poses serious risks:

- Potential contamination of soils if applied in agriculture.
- No assurance of compost efficacy or safety.
- Market distrusts prevent commercial scaling of compost use.

Operators reported negligible sales of the compost produced due to these quality uncertainties.



Figure 17 Stored piles of Compost in several location Treatment Plant shed

4.5 Community Engagement and Public Perception

4.5.1 Survey Participation and Demographics

A total of **375 households** were surveyed across various wards of Shibganj Municipality, selected using random sampling techniques to ensure representation. Respondents included a diverse cross-section of the population in terms of age, gender, education level, and socio-economic status.

- **Male respondents:** 54%
- **Female respondents:** 46%
- **Average age of respondents:** 37.4 years
- **Waste segregation practiced by households:** 22%
- **Awareness of IWMP existence:** 49%

4.5.2 Awareness and Attitudes

While nearly half of the surveyed population had heard of the IWMP, only **27%** could correctly identify its functions (e.g., composting, recycling, fecal sludge treatment). FGDs revealed that community members often confuse the IWMP with the general municipal waste disposal system.

Attitudes toward waste segregation and participation in sustainable practices remain mixed. The survey found that:

- **41%** of residents expressed willingness to segregate waste if provided with separate bins.
- **37%** were skeptical about whether segregated waste would be processed properly by the municipality.
- **22%** had experience attending any public awareness events related to waste.

Key barriers to participation included lack of knowledge (46%), absence of infrastructure (e.g., no bins), and general apathy due to mistrust in government services.

4.5.3 Effectiveness of Public Engagement Strategies

Reviewing past awareness campaigns and interviews with LGED and Pourashava officials indicated a **lack of systematic outreach**. Public engagement strategies have been sporadic, typically coinciding with donor-funded interventions. Moreover, no continuous behavior change communication (BCC) program has been institutionalized. This gap has led to weak community ownership of the IWMP and poor participation in sustainable waste practices.

4.6 Institutional and Policy Challenges

4.6.1 Governance and Inter-Agency Coordination

Interviews with municipal officials revealed fragmented coordination between the Pourashava, and various stakeholders. Despite national mandates under the Solid Waste Management Rules 2021, the enforcement of segregation at source and penalties for illegal dumping remains weak.

Documents reviewed revealed that:

- There is **no local-level by-law** yet enacted in Shibganj Municipality to operationalize national waste management guidelines.
- Budget allocation for waste management has not increased proportionately with population growth, creating a **financial sustainability risk** for the IWMP.
- Dependency on donor or development partner funding continues to be high, particularly for maintenance and community outreach components.

4.6.2 Human Resource Limitations

The plant currently operates with **08 technical and support staff**, significantly fewer than the recommended 18 personnel. Staff members reported a lack of capacity-building opportunities and irregular salary disbursements. These factors contribute to reduced motivation and high turnover.

Training records revealed that the last formal training on compost quality management was conducted more than two years ago. Plant managers highlighted the urgent need for periodic refresher training and stronger technical partnerships with universities or NGOs specializing in waste technology.

4.6.3 Operational fragmentation between the Pourashava and Mati Organics Ltd.

The operational fragmentation between the Pourashava and Mati Organics Ltd. highlights systemic institutional failures:

- No formal **operational agreement** exists that mandates Pourashava to transport collected waste to the IWMP.
- **No regulatory oversight** from the municipality on compost production, quality control, or environmental compliance of the plant.
- Lack of enforcement against **illegal dumping**, despite known locations and environmental risks.

Municipal officials acknowledged that:

"No monitoring or coordination exists with Mati Organics Ltd. The plant functions separately. We do not regulate where their compost goes, nor where our waste is dumped." — Md. Naimul Haque, Conservancy In-Charge, Shibganj Pourashava.



Figure 18 Meeting and Discussion session with Conservancy Section Personnel, Shibganj Pourashava

Thus, despite theoretical adoption of a PPP model, governance gaps remain unaddressed, resulting in parallel operations with no mutual reinforcement

4.7 Environmental Outcomes of the IWMP

4.7.1 Waste Diversion and Recycling Rates

Analysis of operational data for the last fiscal year shows:

- **Waste diverted from landfill:** ~2%
- **Recyclable materials recovered:** 5%
- **Organic waste composted:** 2%
- **Residuals landfilled:** ~91.7%

The environmental performance of the IWMP in Shibganj Pourashava is critically poor. Only ~2% of total waste is being processed through formal treatment and composting, while the vast majority—over 90% of the waste stream—is being either illegally dumped or managed informally without environmental safeguards. Recyclable recovery depends entirely on informal sector activities, with no formal material recovery processes operational at the plant.

4.7.2 Compost Quality and Market Linkages

The **compost produced remains unsold and untested**, eliminating potential benefits of organic waste recycling. However, marketing and distribution remain weak.

- Only **11% of compost** produced in 2024 was sold to farmers or agricultural cooperatives.
- The rest remained unsold due to **lack of packaging, branding, and awareness**.

Interviews with local agricultural extension officers indicate that while there is potential demand, trust in compost quality and delivery mechanisms are low. There is a pressing need to formalize agreements between the IWMP and the Department of Agricultural Extension (DAE) to scale up compost usage.

4.8 Comparative Analysis

4.8.1 Jashore Municipality (Integrated Landfill and Resource Recovery Facility)

- The Jhumjhumpur plant processes **~40 tonnes/day** and produces both **biogas and organic fertilizer**. [11]
- A 2023 academic assessment highlighted that while the **solid-waste collection is effective**, the **fecal sludge treatment, leachate management**, and overall **integrated landfill operation are underperforming**, with groundwater impact reportedly within safe limits. [12]

4.8.2 Rajshahi City Corporation IWMP

- A study of Rajshahi (via MDPI's 2021 publication) indicates that **Rajshahi City Corporation** processes around **28 t/day of MSW** through its integrated facility, with efforts underway to convert landfill gas to electricity; daily waste collection coverage remains limited to ~0.2 kg/person/day [13]
- The paper notes **1906 waste-recyclers** operating city-wide, though only five formal processing centers exist, making the integrated plant more advanced in diverting and processing waste.

4.8.3 Shibganj Pourashava IWMP

1. **Existing Infrastructure: Formal IWMP ensures organized MSW treatment.**
2. **Systematic Waste Collection: Pourashava collects 24–27 % of generated waste.**
3. **Operational FSTP: Treats 7-8 m^3/day of fecal sludge, utilizing% of capacity.**
4. **Resource Recovery & Renewable Potential: 6.5% of waste recovered.**

Table 5 Summary Comparison of Shibganj, Rajshahi and Jashore IWMP

Indicator	Shibganj IWMP	Rajshahi IWMP	Jashore IWMP
Waste processed/day (tons)	1 ton/day	~28 tons/day [14]	~40 tons/day [15]
Waste diversion rate (%)	16% of the total waste is diverted from landfills	11% of the total waste is diverted from landfills	16% of the total waste is diverted from landfills
Fecal sludge treatment rate	7-8 m^3/day (~12% of generation)	29 m^3/day (~20-25% of generation)	251 m^3/day (~28.5% of generation)
Compost sold (%)	Not detailed	Not detailed	~1 t/day sold
Community awareness	Generally negative or underdeveloped	Generally negative or underdeveloped	Local role-model status reported

Table 6 Summary of Key Findings

Domain	Key Finding
Operational Model	IWMP is managed by Mati Organics Ltd. with no municipal waste transport integration.
Infrastructure Utilization	SWTP:18.18% of design capacity utilized. FSTP: 15-18% of design capacity utilized.
Collection Coverage	Limited to 2–3 wards using 2 small vehicles.
Illegal Dumping	Predominant disposal practice within the Pourashava boundary.
Compost Quality	No laboratory testing conducted; compost remains unsold.
Policy & Institutional Gaps	No formal PPP agreements regulating municipal cooperation or monitoring.
Environmental Impact	Negligible benefits due to non-functional waste flow to the plant.

The results reveal that Shibganj IWMP infrastructure exists but is operationally dysfunctional due to institutional, logistical, and regulatory failures. Managed by Mati Organics Ltd., the plant operates independently of municipal waste processes, resulting in minimal inflow—only **1 t/day of MSW (≈3.2% of total)** and **3–4 m^3/day of fecal sludge (≈12% of total)**—and widespread illegal dumping (**≈92% of collected waste**). The absence of compost testing prevents effective resource recovery, while uncollected fecal sludge (**≈86–90%**) exacerbates environmental and public health risks.

Currently, the IWMP does not function as an integrated system and fails to deliver meaningful environmental or economic benefits. The IWMP processes a tiny fraction of MSW, and the FSTP operates at only **50–67% of design capacity**, reflecting technical, institutional, and behavioral bottlenecks.

Nevertheless, the plant has achieved modest success in diverting some waste from open dumping, initiating composting practices, and improving select environmental indicators. To fully realize the benefits of integrated waste management, urgent interventions are needed to increase infrastructure utilization, strengthen policy enforcement, raise public awareness, and develop market linkages for compost and other recovered resources.

Table 7 Methodology vs Result Mapping

Methodology Activity	Where Reflected in Results
Field Observations	Plant operation, illegal dumping, collection van operations
Stakeholder Interviews (with officials, plant operators)	Private management (Mati Organics Ltd.), governance gaps, compost testing issues, illegal dumping
Community Surveys	(Section 4.3 – retained as in your previous draft)
Document Analysis (policies, operational reports)	Institutional gaps, absence of PPP enforcement, compost certification absence
Performance Data Analysis	SWTP: 43% of MSW processed; severely underused. FSTP: 25% of design capacity utilized.
Environmental Impact Data Review	Waste diversion failure, uncontrolled dumping, non-existent compost distribution
Comparative Analysis	Performance benchmarking with Rajshahi and Jashore IWMPs

Chapter Five:

Conclusions and Future Works

5.1 Conclusions

The study demonstrates that the Shibganj IWMP, while formally established with infrastructure for municipal solid waste (MSW) and fecal sludge management (FSM), operates at a fraction of its intended capacity. Daily MSW generation is approximately 18.7 tonnes, yet only 8 tonnes are collected, and merely 1 tonne reaches the treatment plant, with 87.5% of collected waste disposed of illegally. Informal recovery accounts for ~10.7%, leaving nearly half of the waste uncollected. FSM generation is estimated at 29.2 m^3/day, but only 24–27% is collected formally, with treatment plant utilization at 15–18% of design capacity.

Compared with Rajshahi and Jashore IWMPs, Shibganj performs poorly. Rajshahi processes ~28 t/day of MSW and treats ~20–25% of FSM, while Jashore handles ~40 t/day with higher resource recovery and compost utilization. In contrast, Shibganj's IWMP achieves minimal waste diversion (~16%), negligible recycling, and unsold compost, reflecting operational fragmentation, weak municipal-private coordination, limited community engagement, and lack of enforcement.

In summary, Shibganj's IWMP suffers from severe underutilization, institutional gaps, and low public participation, resulting in minimal environmental and health benefits. Enhancing operational integration, expanding collection coverage, instituting compost quality control, and implementing sustained awareness programs are crucial for achieving effective and sustainable waste management in Shibganj.

5.2 Limitations and Recommendations for Future Works

The study acknowledges several limitations, which impacted some of the scope and findings:

Limited Data Availability: Access to detailed operational data was limited as monitoring systems were not fully implemented or data was not regularly reported by the IWMP.

Community Engagement: The success of the community surveys depended on the willingness of residents to participate, which was affected by a lack of awareness or interest in waste management issues.

Financial and Time Constraints: Due to limited resources, the scope of field observations and the number of interviews had been constrained, potentially limiting the depth of data collection.

This methodology ensured a comprehensive evaluation of the **Shibganj Municipality IWMP**, considering both its operational aspects and its environmental outcomes. By integrating **qualitative** and **quantitative** methods, the study provided a thorough analysis of the plant's effectiveness, challenges, and social impact. The findings helped identify **opportunities for improvement** and provide **actionable recommendations** for enhancing the sustainability and long-term viability of the IWMP in Shibganj and similar urban municipalities.

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APPENDIX

APPENDIX-A: Questionnaire

(1) Detailed Field Survey Questionnaire

Title: Field Survey on Fecal Sludge and Solid Waste Management in XYZ Municipality

Section A: General Information

Name (Optional): _____

***Gende*r: ☐ Male ☐ Female ☐ Other

Age: ☐ 18-30 ☐ 31-50 ☐ 51+

Occupation: ☐ Household ☐ Business Owner ☐ Sanitation Worker ☐ Municipal Staff ☐ Other

Municipality Ward No.: _____

Section B: Fecal Sludge Management (FSM)

B.1 What type of sanitation facility do you use?

☐ Septic Tank

☐ Pit Latrine

☐ Community Latrine

☐ Open Defecation

☐ Other (Specify) _____

B.2 How frequently is your septic tank/pit latrine emptied?

☐ Every 6 months

☐ Every year

☐ Every 2-3 years

☐ Never

B.3 Who empties the fecal sludge?

☐ Municipal service

☐ Private desludging operators

☐ Informal (manual) cleaners

☐ No service available

B.4 How is the fecal sludge disposed of after emptying?

☐ Dumped in open fields

☐ Discharged into drains/rivers

☐ Taken to treatment facility

☐ Don’t know

B.5 Do you face any problems with fecal sludge disposal?

☐ Bad smell

☐ Overflowing tanks

☐ High emptying cost

☐ No service available

Section C: Solid Waste Management (SWM)

C.1 How is household waste disposed of?

☐ Municipal collection

☐ Open dumping

☐ Burning

☐ Composting

☐ Other (Specify) _____

C.2 How frequently is waste collected from your area?

☐ Daily

☐ 2-3 times a week

☐ Once a week

☐ Rarely

C.3 Is waste segregation practiced in your household/business?

☐ Yes

☐ No

☐ Sometimes

C.4 What type of waste do you generate most?

☐ Organic Waste (food, garden waste)

☐ Plastic Waste

☐ Hazardous Waste (batteries, chemicals)

☐ Mixed Waste

C.5 What are the major problems faced in solid waste disposal?

☐ No proper collection service

☐ Dumping site too far

☐ Waste scattered on roads

☐ Health issues (bad odor, diseases)

Section D: Environmental and Public Health Concerns

D.1 Have you noticed any environmental issues caused by improper waste disposal?

☐ Water Pollution

☐ Air Pollution

☐ Bad Smell

☐ Increased Disease Incidence

D.2 Have you or your family members suffered from any health issues due to waste mismanagement?

☐ Diarrhea

☐ Skin Diseases

☐ Respiratory Issues

☐ Other (Specify) _____

Section E: Willingness to Pay for Improved Services

E.1 Would you be willing to pay for improved FSM & SWM services?

☐ Yes

☐ No

☐ Maybe

E.2 If yes, how much would you be willing to pay per month?

☐ Less than 50 BDT

☐ 50-100 BDT

☐ 100-200 BDT

☐ More than 200 BDT

E.3 What suggestions do you have for improving waste management in **XYZ** Municipality?

(2) Stakeholders for the Research

Key Stakeholders and Their Roles

Stakeholder Group	Role/Interest in FSM & SWM
Municipality Officials	Policy enforcement, budgeting, service management
Fecal Sludge Emptiers	On-ground service providers, desludging challenges
Waste Collectors & Transporters	Daily waste collection, disposal methods
Community Representatives (Local Leaders, Civil Society)	Represent local concerns, advocacy for better services
Private Sector (Waste Processing Companies, Recycling Firms)	Business opportunities in waste treatment and recycling
NGOs & Environmental Groups	Technical support, awareness programs, sustainability
Academic Researchers & Engineers	Feasibility studies, technological innovations
Households & Business Owners	Primary waste generators, service users

(3) Detailed Stakeholder Consultation Questionnaire

Title: Stakeholder Consultation for Integrated Fecal Sludge & Solid Waste Management in XYZ Municipality

Section A: Institutional & Policy Aspects

A.1 What are the current FSM & SWM policies in **XYZ** Municipality?

A.2 What regulatory gaps exist in fecal sludge and solid waste management?

A.3 How does the municipality coordinate with private sector waste operators?

A.4 Are there existing PPP (Public-Private Partnership) models in FSM & SWM?

A.5 What are the main financial constraints in implementing sustainable FSM & SWM?

Section B: Infrastructure & Service Delivery Challenges

B.1 What is the current capacity of the municipality's FSM & SWM system?

B.2 What are the biggest challenges faced in FSM service delivery?

☐ Lack of equipment

☐ Poor coordination among authorities

☐ Limited budget

☐ Other (Specify) _____

B.3 Are there any ongoing projects for FSM & SWM improvement?

B.4 What role does technology play in waste management in **XYZ**?

B.5 How efficient is the waste collection and transportation system?

Section C: Environmental & Public Health Concerns

C.1 What are the major environmental risks of poor FSM & SWM in **XYZ**?

☐ Groundwater contamination

☐ Surface water pollution

☐ Air pollution from open dumping/burning

☐ Public health risks (disease outbreaks)

C.2 Have there been any reported health crises due to unmanaged fecal sludge or solid waste?

C.3 How does waste mismanagement affect local water bodies and ecosystems?

Section D: Opportunities & Future Strategies

D.1 What are the biggest opportunities for improving FSM & SWM in **XYZ**?

D.2 What are your views on establishing an integrated FSM & SWM plant?

☐ Strongly Support

☐ Support with Modifications

☐ Neutral

☐ Oppose

☐ Strongly Oppose

D.3 What technologies (biogas, composting, recycling) can be introduced to improve waste management?

D.4 What role should private companies and NGOs play in FSM & SWM improvement?

D.4 What policy recommendations would you suggest for better FSM & SWM management?

(3) **QUESTIONNAIRE FOR STAKEHOLDERS** (Executive Engineer/Poura Nirbahi Officer/ Conservancy Inspector or Conservancy In-Charge, NGO or Environmental Groups, 3rd party Business Group)

Section A: Awareness and Practices

A.1 Are you familiar with the concept of Integrated Fecal Sludge and Solid Waste Management?

 Yes

 No

A.2 How does your organization/region currently handle fecal sludge and solid waste management? (Select all that apply)

 Fecal sludge treatment plants

 Solid waste collection and recycling systems

 Open dumping

 Composting

 Incineration

 Other (Please specify)

A.3 What challenges do you face in managing fecal sludge and solid waste in your area? (Check all that apply)

 Insufficient infrastructure (e.g., treatment plants, collection systems)

 Financial constraints

 Lack of public awareness or engagement

 Poor waste segregation at source

 Lack of policy or regulations

 Environmental contamination

 Health risks and disease outbreaks

 Other (Please specify)

Section B: Challenges

B.1 What are the main technical challenges in managing fecal sludge and solid waste? (Please select all that apply)

 Inadequate treatment technologies

 High costs of technology and operation

 Lack of trained personnel

 Limited waste processing capacity

 Inefficient collection and transportation systems

 Inconsistent quality of sludge and waste

 Other (Please specify)

B.2 What are the financial challenges associated with Integrated FSSWM?

- High upfront capital costs for infrastructure
- Operational costs exceeding available budgets
- Insufficient funding from local or national government
- Lack of private sector investment
- Other (Please specify)

B.3 What are the social challenges related to Integrated FSSWM in your region?

- Lack of community involvement or awareness
- Cultural attitudes towards waste management and sanitation
- Resistance to paying for waste management services
- Inequality in waste management service coverage
- Other (Please specify)

Section C: Opportunities for Improvement

C.1 What opportunities exist for improving Integrated FSSWM in your region?

- Adoption of innovative technologies (e.g., waste-to-energy, biogas production)
- Public-private partnerships
- Government subsidies or financial support
- Improved community engagement and behavior change campaigns
- Enhanced regulatory frameworks and policies
- Collaboration with international organizations
- Other (Please specify)

C.2 How can the government and private sector collaborate to address waste management challenges?

- Joint infrastructure investment
- Public awareness and education campaigns
- Financial incentives for waste management solutions
- Research and development of new technologies
- Policy support and enforcement of regulations
- Other (Please specify)

Section D: Environmental Impacts

D.1 What environmental impacts have you observed due to improper fecal sludge and solid waste management?

- Groundwater contamination
- Soil pollution and degradation
- Air pollution from open waste burning
- Water pollution (e.g., rivers, lakes)
- Climate change impact due to methane emissions
- Loss of biodiversity
- Other (Please specify)

D.2 How do you assess the long-term sustainability of current waste management practices in terms of environmental impact?

- Sustainable with minimal impact
- Somewhat sustainable, but with significant improvements needed
- Unsustainable with high environmental risks
- Unsure

D.3 What measures should be taken to reduce the environmental impact of fecal sludge and solid waste management?

- Improved waste segregation and recycling
- Increased investment in waste-to-energy technologies
- Enhanced treatment technologies for sludge
- Community-led environmental initiatives
- Stronger regulatory enforcement
- Other (Please specify)

Section E: Policy and Governance

E.1 How effective are the current policies and regulations for fecal sludge and solid waste management in your region?

- Very effective
- Moderately effective
- Ineffective
- No policies in place
- Don’t know

E.2 What improvements do you think are necessary in the policies and regulations governing waste management?

 Stronger enforcement of laws

 More funding and incentives for waste management projects

 Inclusion of climate change considerations in waste management policies

 Incentivizing waste reduction and circular economy models

 Other (Please specify)

 What additional recommendations do you have for improving Integrated Fecal Sludge and Solid Waste Management in your region?

 Are there any case studies or examples of successful waste management initiatives you would like to share?

** Also, Semi-structured Interviews with Accounts Section:

- Source of Income and Expenditure of Conservancy Section (Conservancy Tax percentage, Budget of the last three fiscal year)

- Cost of O&M and fuel of Waste Transporters;

- Salary of Waste collectors/sweepers/conservancy section.

(4) FGD with Waste Collectors/Transporters/Sweepers

Focal Group Discussion (FGD) Questionnaire for Waste Collectors, Transporters, and Sweepers

Participants: Waste Collectors, Transporters, and Sweepers

Moderator: [Your Name/Research Team]

Date & Location:

Time:

Section A: Work and Service Conditions

A.1 Can you describe your daily work routine related to waste collection and transportation?

A.2 What types of waste do you mostly handle? (Household, commercial, hazardous, Hospital etc.)

A.3 What type of equipment and tools do you use for waste collection and sludge management?

A.4 Do you have access to safety gear (gloves, masks, boots)? If not, what risks do you face?

A.5 What are the most difficult challenges you face in your job?

☐ Health issues

☐ Low wages

☐ Irregular payments

☐ Lack of safety equipment

☐ Harassment/discrimination

☐ Other (Specify) _____

Section B: Waste Collection and Transportation Process

B.1 How often do you collect waste in different areas of **XYZ** Municipality?

☐ Daily

☐ 2-3 times a week

☐ Weekly

☐ Occasionally

B.2 How do you transport solid waste and fecal sludge?

☐ Handcarts

☐ Municipal Trucks

☐ Private Vehicles

☐ Other (Specify) _____

B.3 Where do you dispose of the collected waste?

☐ Designated landfill/dumping site

☐ Open fields/roadsides

☐ Rivers/canals/drains

☐ Waste treatment facility

☐ Other (Specify) _____

B.4 What are the biggest problems in the waste collection and disposal process?

☐ Poor roads/infrastructure

☐ Limited waste collection vehicles

☐ Overloaded work schedules

☐ Lack of proper disposal sites

☐ Other (Specify) _____

Section C: Health and Safety Concerns

C.1 Have you or your colleagues suffered from health issues due to your work?

☐ Skin diseases

☐ Respiratory problems

☐ Diarrheal diseases

☐ Injuries from waste handling

☐ Other (Specify) _____

C.2 Do you receive any medical check-ups or health support from the municipality or employers?

☐ Yes

☐ No

☐ Sometimes

C.3 What safety measures should be introduced to protect your health?

☐ Regular health check-ups

☐ Free protective gear

☐ Training on safe waste handling

☐ Improved waste disposal facilities

Section D: Employment and Livelihood Issues

D.1 Who employs you for waste collection work?

☐ Municipality

☐ Private waste companies

☐ Community-based organizations

☐ Self-employed

D.2 Do you have a formal contract or regular salary?

☐ Yes

☐ No

☐ Irregular payments

D.3 Do you think your income is fair for the work you do?

☐ Yes

☐ No

☐ Need better payment

D.4 What changes would improve your working conditions?

☐ Better wages

☐ Health benefits

☐ Recognition and respect

☐ Access to better waste management technology

Section E: Opportunities for Waste Management Improvement

E.1 What improvements do you suggest for solid waste and fecal sludge management in **XYZ**?

E.2 Would you be interested in skill development training (e.g., waste recycling, composting, biogas production)?

☐ Yes

☐ No

☐ Maybe

E.3 How can the municipality and community better support waste collectors and transporters?

Closing Discussion & Recommendations

What final suggestions do you have for improving waste management in **XYZ** Municipality?

APPENDIX-B: Calculation

Sample Size Equation:

$$Sample\ size = \frac{\frac{Z^2 \times P(P-1)}{E^2}}{1 + \left(\frac{Z^2 \times P(P-1)}{E^2 N}\right)}$$

Where:

- N = Population size
- Z = Z-score (e.g., 1.96 for 95% confidence)
- P = Standard of deviation
- E = Margin of error

The result of sample size is 381.34 ≈ 375

Total Solid Waste Generation (2025 Estimates)

Step 1: Total Daily Waste Generation

Total MSW = Population ×Per capita waste generation rate

Total MSW=52,006×0.36kg/day≈18,722kg/day≈18.72tonnes/day

Step 2: Household and Non-Household Waste

- Household waste (70%): 0.70×18.72≈13.10 tons/day
- Non-household waste (30%): 0.30×18.72≈5.62 tons/day

Total Municipal Solid Waste (MSW) Generated:

13.10 tonnes/day (household) + 5.62 tonnes/day (non-household) = 18.72 tonnes/day

- Total solid waste generation: Approximately 18.72 tonnes/day
- Household waste: Approximately 13.10 tonnes/day
- Non-household waste: Approximately 5.62 tonnes/day

Collection Performance

- **Total Waste Collected**: **8 tonnes/day (approx.)**
- **Waste Collected by Pourashava System**:

  Operational records from municipal waste transport vehicles indicate that approximately **13 tonnes/day** are collected by municipal trucks and vans.

- **Waste Transported to Treatment Plant**:

  Of the collected waste, only **1 tonne/day** is transported to the Integrated Waste Management Plant (IWMP), representing **minimal formal processing.** The rest is disposed of at illegal or unauthorized sites.

Solid Waste Recovery by Informal Sector

- Based on interviews with informal waste recovery agents and apex traders, the **informal sector recovers approximately 2 tonnes/day**, consisting mainly of plastics, metals, and paper.
- **Waste Recovered in Percentage Terms**:

  (2 tonnes/day ÷ 18.72 tonnes/day) × 100 =10.68 **% (**approx **10.68%)**

Uncollected Solid Waste

- **Total Uncollected Waste**:

  18.72 tonnes/day (generated) – 8 tonnes/day (collected) – 2 tonnes/day (recovery) = **8.72 tonnes/day**
  (However, with rounding in field estimation, **1 tonnes/day** is considered uncollected.)

- **Percentage of Uncollected Waste**:

  (16 tonnes/day ÷ 30 tonnes/day) × 100 = **46.56%**

Illegal SW Dumping

A significant finding is that almost all waste collected by the Pourashava system, including municipal dump trucks and small collection vans, is **disposed of at unauthorized dumpsites**, bypassing the IWMP entirely. This results in:

- **Illegal Dumping Percentage**:
- **87.5%** of total waste collected is directly dumped at illegal or informal sites within the Pourashava boundary.

Summary of Solid Waste Flow Data

Illegal Dumping (out of treatment plant dumping) = 92% (as all the wastes collected by Pourashava system also dumped in illegal sites)

Summary of Solid Waste Flow Data

Parameter	Quantity	Percentage (%)
Total Population	52,006	—
Total MSW Generated	18.71 tonnes/day	100%
Household Waste Generation	13.10 tonnes/day	70%
Non-Household Waste Generation	5.62 tonnes/day	30%
Total Waste Collected	18.72 tonnes/day	42.7%
Waste Collected by Pourashava	8 tonnes/day	69.4%
Waste to IWMP (Treatment Plant)	1 tonne/day	5.3%
Waste Recovered by Informal Sector	2 tonnes/day	10.68%
Total Uncollected Waste	8.72 tonnes/day	46.56%
Waste Disposed via Illegal Dumping	Approx. 7 tonnes/day	87.5% (of collected waste)

Solid Waste Plant Performance Flow Table

Parameter	Unit	Value / Observation	Remarks
Waste Transported to IWMP (Treatment Plant)	tonnes/ day	1	Only a fraction of the collected waste reaches the plant
TIWMP Plant Capacity	tonnes/ day	5.5	Maximum design capacity of the plant
Utilization of Plant Capacity		(1÷5.5) ×100%=18.18%	Significantly underutilized treatment plant.

Total Fecal Sludge Management (FSM) (2025 Estimates)

Here's a clean reference-style write-up of the **Saidpur Municipality (WaterAid, 2017) survey findings** on faecal sludge production:

- **Average per capita faecal sludge production**: **0.561 liters per person per day**

Verification and Calculation:

Parameter	Value	Calculation / Notes
Population	52,006 persons	As per census / study area
Per capita faecal sludge generation	0.561 L/person/day	From Saidpur Municipality survey (Water Aid, 2017) [10]
Total daily faecal sludge generation	52,006 × 0.561 ≈ 29,166 L/day	Multiply population by per capita daily generation
Total daily faecal sludge generation (m^3)	29,166 ÷ 1,000 ≈ 29.2 m^3/day	Convert liters to cubic meters
Total annual faecal sludge generation	29.2 × 365 ≈ 10,658 m^3/year	Multiply daily generation by 365 days

The fecal sludge treatment system is underperforming. Of the **estimated 500,000 liters/month of fecal sludge generated**, only **~5700 liters/month** are treated at the plant.

Total FSM Collected:
Operational data and field observations indicate that only about **7–8 m^3/day** of fecal sludge is collected by formal service providers, against an estimated generation of **29.2 m^3/day**.

Total FSM Transported to FSTP:
Almost all formally collected sludge (≈ **7–8 m^3/day**) is transported to the Fecal Sludge Treatment Plant (FSTP). However, this represents only a **small fraction (~24–27%)** of the total daily generation.

Uncollected FSM

Total Uncollected FSM:

Estimated generation−Collected=29.2m^3/day−3.5m^3/day≈21.7m^3/day

Percentage of Uncollected FSM:

(21.7 ÷ 29.2) × 100 ≈ **74.3%**

This indicates that **around 74.3% of fecal sludge is not collected through formal channels**, highlighting the heavy reliance on unsafe or informal disposal practices.

Informal / Unsafe Disposal Practices

A significant portion of household's dispose of fecal sludge through **manual emptying and direct discharge** into drains, open fields, or water bodies. Field interviews and community surveys suggest that **≈ 74.3%** of the total generated FSM follows these unsafe disposal routes.

Summary: FSM Collection Performance

Parameter	Percentage (%)
Collected (formal)	24–27% of total generated
Uncollected / informal / unsafe disposal	74.3%
Transported to FSTP	100% of formally collected sludge

Summary of Fecal Waste Data

Parameter	**Quantity**	**Percentage (%)**
Total Population	52,006	—
Estimated Fecal Sludge Generated	52,006 × 0.561 ≈ 29,166 L/day	100%
Total daily faecal sludge generation (m^3)	29,166 ÷ 1,000 ≈ 29.2 m^3/day	100%
FSM Collected (Formal/Truck Service)	7-8 m^3/day	≈24-27%
FSM Treated at FSTP	7-8 m^3/day	≈100%
Uncollected / Illegally Disposed FSM	4-5m^3/day	≈74.3%
Treatment Plant Utilization Rate	6-8 m^3/day vs 45 m^3/day	≈ 15-18% of design capacity

Fecal Waste Plant Performance Flow Table

Parameter	Unit	Value / Observation	Remarks
Waste Transported to IWMP (Treatment Plant)	tonnes/ day	1	Only a fraction of the collected waste reaches the plant
IWMP Plant Capacity	tonnes/ day	45	Maximum design capacity of the plant
Utilization of Plant Capacity		15%-18%	Based on current throughput vs capacity

Infrastructure and Capacity Utilization

Field observations and plant-level data show that the **Shibganj IWMP** includes waste segregation units, composting chambers, recycling zones, and a Fecal Sludge Treatment Plant (FSTP).

Operational data indicate that **31 tonnes/day** of municipal solid waste (MSW) are generated, of which **13.5 tonnes/day (42%)** are collected formally. The **Pourashava collects 12.5 tonnes/day**, but about **92% of this is dumped illegally**, including outside the treatment plant. Only **1 tonne/day (~3.2%)** reaches the IWMP, and **1.5 tonnes/day (6.5%)** is recovered by the informal sector. Approximately **15 tonnes/day (51.6%)** remain uncollected.

The FSTP, designed for **6 m^3/day**, treats only **3–4 m^3/day (50–67% of capacity)**, representing **10–14% of total fecal sludge (~29.2 m^3/day)**. Most sludge is uncollected or disposed of informally.