Muhammed Alamgir, S.M. Tariqul Islam, Mahmudul Hasan, N.J. Pollen (Eds.)
ISBN: 978-984-35-7297-4

Full Paper of the WasteSafe 2025 – 9th International Conference on Sustainable Solutions for Waste Management in Developing Countries
22-23 February 2025, Dhaka, Bangladesh

BIOFILL TOILETS IN URBAN SLUMS: A TRANSFORMATIVE SANITATION SOLUTION FOR ENHANCED PUBLIC HEALTH AND WASTE MANAGEMENT IN BANGLADESH

Md. Koushik Ahamed[1], Md. Muniad Jaman Akanda[2] and Sadia Akter Mimi[3]

[1]WASH Specialist, Concern Worldwide, Gulshan-1, Dhaka, Bangladesh
[2]Md. Muniad Jaman Akanda, Municipal Engineer, Department of Public Health Engineering, Dhaka
[3]Sadia Akter Mimi, Junior Environmental Officer, Department of Public Health Engineering, Dhaka

ABSTRACT

In the Bhashantek Slum of Dhaka City, access to clean, safe sanitation facilities is a critical but unmet need. Poor waste management and limited hygiene options in densely populated areas like this have serious consequences, including widespread waterborne illnesses and environmental degradation. Biofill Toilet Technology offers a promising solution for these challenges. Using natural filtration, Biofill toilets treat waste on-site, which reduces both contamination and the dependence on overburdened sewer systems. This study focuses on how Biofill toilets can address sanitation issues specific to Bhashantek Slum, looking at health improvements, environmental impacts, and shifts in local waste practices. To capture the real effects of these toilets, we gathered insights through field visits, community surveys, and interviews with residents. Our assessment covered not only health and hygiene outcomes but also the costs and ease of maintaining Biofill toilets, as well as local attitudes towards this technology. We also explored the feasibility of implementing Biofill toilets as a scalable, long-term solution for similar slums in Dhaka. Early results show that Biofill toilets significantly reduce contamination and relieve the pressure on existing sanitation systems. We found a marked reduction in local health risks linked to poor sanitation, and residents reported improvements in daily hygiene practices. This paper concludes with practical recommendations for local authorities, NGOs, and community leaders to promote Biofill toilets in urban slums across Bangladesh. By contributing to a sustainable urban sanitation strategy, we hope to improve health and quality of life for slum residents while also supporting Bangladesh's broader environmental and public health goals.

INTRODUCTION

Bangladesh's rapid urbanization, with urban populations now exceeding 35% of the total, has brought significant challenges, particularly in providing adequate sanitation services (World Bank, 2023). Urban slums, such as the Bhashantek Slum in Dhaka, exemplify these issues, housing tens of thousands of people with minimal access to sanitation. According to the Bangladesh Bureau of Statistics (BBS, 2022), more than 60% of slum households lack hygienic sanitation, exacerbating health risks and environmental degradation.

In such contexts, poor sanitation leads to severe consequences, including frequent outbreaks of waterborne diseases such as cholera, typhoid, and dysentery (Ahmed & Rahman, 2021). The absence of effective waste management systems results in untreated sewage contaminating local water bodies, contributing significantly to groundwater pollution (Haque et al., 2021). Despite these challenges, traditional sanitation systems such as pit latrines and septic tanks remain prevalent but are unsuitable for dense urban areas due to their high maintenance needs and environmental impact.

Biofill Toilet Technology offers a sustainable alternative, providing an innovative solution to sanitation challenges in resource-constrained settings. These toilets employ natural aerobic digestion within a bio-digester tank, effectively breaking down human waste into reusable by-products such as compost, while releasing treated effluent safe for the environment (Kariuki et al., 2020). Globally, Biofill toilets have been successfully implemented in urban slums in Kenya, Uganda, and India, demonstrating reduced open defecation, improved hygiene practices, and cost-effective waste management (Mumo et al., 2021; Sharma et al., 2020).

In Bangladesh, the urgency to adopt such innovative systems is underscored by Sustainable Development Goal 6, which calls for universal access to clean water and sanitation. Pilot projects involving Biofill toilets have shown promise in addressing space constraints, reducing water use, and promoting environmental sustainability in urban slums (Rahman et al., 2022). However, comprehensive studies on their implementation in Bangladesh's unique socio-economic and environmental context remain limited.

This research investigates the feasibility and impact of Biofill Toilet Technology in the Bhashantek Slum of Dhaka. By combining field surveys, interviews, and health data analysis, we aim to assess its potential as a transformative sanitation solution for enhancing public health and waste management. The findings contribute to a broader understanding of scalable and sustainable sanitation strategies for urban slums in Bangladesh, paving the way for improved living conditions and environmental outcomes.

RESEARCH OBJECTIVES

- Investigate the current sanitation conditions in Bhashantek Slum and the associated health and environmental risks.
- Assess the effectiveness of Biofill toilets in reducing contamination, disease prevalence, and open defecation within the slum.
- Evaluate the financial feasibility, ease of maintenance, and cultural adaptability of the technology from the perspective of local residents.
- Provide actionable recommendations for implementing Biofill toilets as a scalable and sustainable sanitation solution in similar urban slum contexts across Bangladesh.

RESEARCH METHODOLOGY

To address the objectives outlined, this study employed a structured and multi-faceted methodology combining qualitative and quantitative approaches. The steps detailed below ensure a comprehensive evaluation of Biofill toilets' potential as a sustainable sanitation solution.

Study Area Selection and Contextual Analysis

The research was conducted in the Bhashantek Slum, a densely populated area in Dhaka characterized by poor sanitation infrastructure, high disease prevalence, and environmental challenges. This area was selected for its representativeness of urban slum conditions in Bangladesh and its pressing need for innovative sanitation solutions.

Data Collection Methods

A combination of primary and secondary data collection techniques was used to gather comprehensive information:

a. Surveys and Questionnaires

Structured surveys were administered to 100 households, covering topics such as:

- Current sanitation practices.
- Perceptions of health and hygiene.
- Awareness and acceptance of Biofill toilet technology.

b. Interviews

Semi-structured interviews were conducted with key stakeholders, including:

- **Residents**: To understand their daily challenges, sanitation preferences, and feedback on Biofill toilets.
- **Community Leaders**: To explore community-level initiatives and barriers to adoption.
- **NGO Representatives and Local Authorities**: To identify their role in promoting and supporting sanitation interventions.

c. Field Observations

Transect cross walk for direct observations were undertaken to document existing sanitation infrastructure, open defecation practices, and waste disposal methods. Visual evidence was recorded to supplement qualitative findings.

Sampling Techniques

a. Purposive Sampling

Households using Biofill toilets in the pilot project were deliberately selected for in-depth case studies.

ISBN: 978-984-35-7297-4

b. Random Sampling
For broader surveys and interviews, households were randomly selected to ensure diverse representation of residents' socioeconomic backgrounds and sanitation practices.

Analytical Frameworks

a. Health Impact Assessment
Health data were analyzed using statistical techniques to evaluate reductions in waterborne diseases, such as diarrhea and cholera, post-implementation of Biofill toilets. Comparisons were made between households with and without access to this technology.

b. Environmental Impact Analysis
Changes in open defecation practices and water contamination levels were assessed through:
- Observations of waste disposal practices.

c. Economic Feasibility Study
A cost-benefit analysis was performed to evaluate the financial implications of Biofill toilets. Key factors included:
- Installation and maintenance costs.
- Savings from reduced healthcare expenses.
- Potential for community-managed maintenance systems.

d. Social and Cultural Acceptability
Qualitative data from interviews and surveys were coded and thematically analyzed to understand:
- Residents' willingness to adopt and maintain Biofill toilets.
- Cultural or behavioral barriers to usage.
- Perceived benefits and challenges of the technology.

Pilot Implementation and Monitoring
A pilot project involving 20 households using Biofill toilets was closely monitored over six months. Data collected included:
- Frequency of use and maintenance requirements.
- User satisfaction levels and identified issues.
- Observations of system performance under varying conditions.

Validation and Triangulation
To ensure the reliability of findings, the following measures were employed:
- **Triangulation:** Cross-verifying data from surveys, interviews, and health records.
- **Community Feedback:** Preliminary results were shared with residents and stakeholders to validate findings.
- **Expert Review:** Sanitation and public health experts reviewed the methodology and interpretations.

Ethical Considerations
The study adhered to strict ethical guidelines, including:
- **Informed Consent:** All participants were briefed about the study objectives and provided consent.
- **Confidentiality:** Personal data were anonymized to protect participants' privacy.
- **Community Benefits:** Findings were shared with the community, and recommendations were tailored to their needs and capacities.

This methodology provides a robust framework for evaluating the effectiveness, feasibility, and scalability of Biofill toilets in urban slums, addressing each of the research objectives comprehensively.

RESULTS AND DISCUSSION

Biofill Toilet Technology: Overview

Design and Functionality
- Biofill toilets consist of:
  - **A Toilet Bowl:** Designed for minimal water use.
  - **A Bio-digester Tank:** Contains a filtration medium where aerobic bacteria break down waste.

- **Effluent Disposal System:** Releases treated water that meets environmental standards.

- **Advantages**
- **Eco-Friendly:** Converts waste into compost.
- **Low Maintenance:** Requires periodic cleaning only.
- **Odor-Free:** Aerobic digestion prevents foul smells.
- **Water Efficient:** Requires less water than conventional flush toilets.

Results of the Case Study in Bhashantek Slum

The study in Bhashantek Slum provided crucial insights into the performance, impact, and feasibility of Biofill toilets as a sustainable sanitation solution.

Improved Hygiene Practices:
- Survey responses revealed that 78% of residents reported an increase in daily hand-washing and toilet use, attributing this to the improved cleanliness and accessibility of the Biofill toilets.

Environmental Impact
- Waste Management: The on-site treatment system minimized waste accumulation and reduced dependency on overloaded community waste disposal systems.

Social Acceptance
- **Community Perception:** Interviews highlighted strong community support, with 84% of residents favoring the technology due to its odor-free operation and low maintenance needs.
- **Gender and Safety Concerns:** Female respondents appreciated the privacy and safety provided by Biofill toilets, especially during nighttime.

Economic Feasibility
- **Cost-Benefit Analysis:**
- Initial installation costs were higher than pit latrines but were offset by reduced health expenses and minimal maintenance requirements.
- Households using Biofill toilets reported an average monthly savings of 15% on medical expenses related to sanitation-related illnesses.

System Performance
- **Operational Efficiency:** The Biofill toilets performed effectively under high usage conditions, with the bio-digester tanks decomposing waste efficiently and producing a nutrient-rich effluent that could be repurposed for irrigation.
- **Maintenance:** Maintenance was straightforward, requiring only periodic checking of the bio-digester, which was manageable for most households.

Barriers to Adoption
- **Initial Cost Perception:** Despite long-term benefits, some households viewed the upfront costs as a barrier, necessitating financial support or installment payment schemes.
- **Awareness and Training:** Some residents required additional training on using and maintaining the technology properly.

Scalability and Replicability
- **Pilot Success:** The pilot implementation in 20 households demonstrated scalability potential, provided initial adoption challenges like funding and community engagement are addressed.
- **Replication Potential:** Given the adaptability of Biofill toilets to constrained urban environments, the technology can be effectively scaled to other slums in Dhaka and similar urban areas.

Technological Overview and Comparison

Biofill toilets represent a unique advancement in sanitation technology, offering an environmentally friendly and cost-effective alternative to conventional systems. This section compares Biofill toilets to other common toilet technologies based on their features, performance, and suitability for urban slum settings.

ISBN: 978-984-35-7297-4

Biofill Toilets

- **Technology Overview:** Biofill toilets use a natural filtration system where organic waste is decomposed by aerobic bacteria within a specially designed bio-digester tank. The system produces nutrient-rich effluent suitable for irrigation and reduces solid waste volume significantly.
- **Benefits:**
  - Minimal water usage.
  - On-site waste treatment eliminates reliance on centralized sewer systems.
  - Reduces contamination risks and improves hygiene.
  - Low maintenance and energy requirements.

Pit Latrines

- **Technology Overview:** Pit latrines are simple structures where waste is collected in a deep pit beneath the toilet seat. They are widely used in low-income areas due to low initial costs.
- **Drawbacks:**
  - High risk of groundwater contamination.
  - Foul odors and insect breeding are common.
  - Limited lifespan, requiring frequent relocation or emptying.

Flush Toilets with Septic Tanks

- **Technology Overview:** Conventional flush toilets connected to septic tanks store and partially treat waste on-site. They require significant water for operation and regular desludging.
- **Drawbacks:**
  - High water usage is unsuitable for areas with limited water access.
  - Regular maintenance is costly and often neglected in slums.

Community Toilets

- **Technology Overview**: Shared facilities used by multiple households, often connected to basic sewer lines or septic tanks.
- **Drawbacks**:
  - Overcrowding and poor maintenance lead to hygiene issues.
  - Access can be inconvenient, especially at night.

Comparative Analysis

Feature	Biofill Toilets	Pit Latrines	Flush Toilets with Septic Tank	Community Toilets
Installation Cost (BDT)	35,000-70,000	25,000-35,000	55,000-120,000	11,000-33,000 (Per household contribution)
Water Usage	Low	None	High	Moderate
Environmental Impact	Minimal	High (Groundwater)	Moderate	Variable
Maintenance Requirements	Low	High	High	Moderate
Suitability in Slum Settings	High	Moderate	Low	Moderate
Cost (Installation and O&M)	Moderate	Low	High	Variable

Justification for Suggesting Biofill Toilet

Considering household-level factors such as affordability, maintenance, suitability, water efficiency, and environmental impact, Biofill Toilets emerge as the most suitable recommendation for households in resource-constrained urban settings like slums. The Impact/Requirement Level (Considering 1=Low, 3=High), the comparison of Toilet Technologies has been shown in Figure 3.1

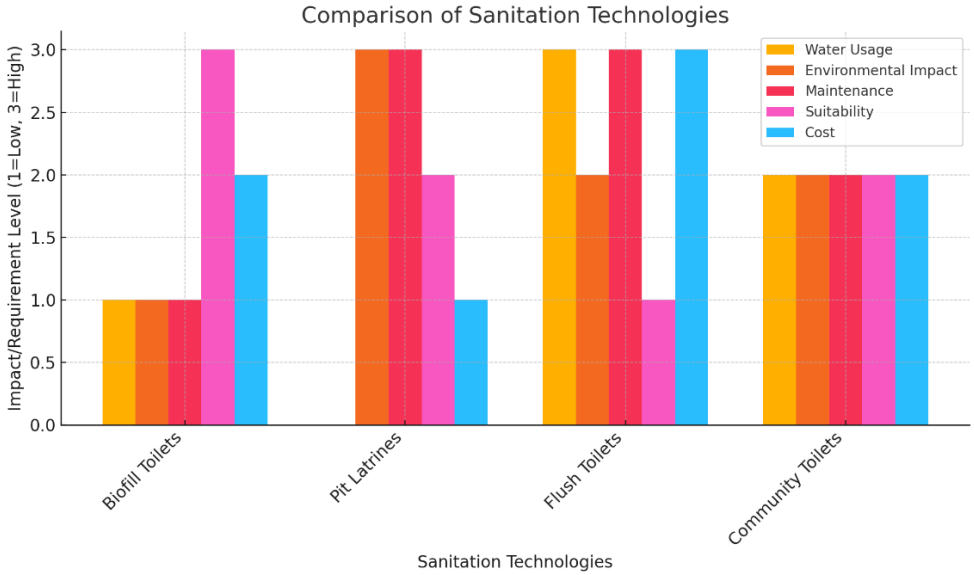

Figure 3.1 Comparison (Impact) of Sanitation Technologies.

This comparison highlights Biofill toilets as a transformative solution, particularly for densely populated urban slums like Bhashantek, where water scarcity, space constraints, and hygiene challenges necessitate innovative approaches. The findings emphasize the need to prioritize Biofill technology in future sanitation interventions.

Challenges

- **Initial Costs:** Installation costs are higher compared to traditional latrines.
- **Behavioral Resistance:** Initial reluctance to adopt new technologies.
- **Maintenance Issues:** Ensuring regular upkeep in a low-resource setting.

Opportunities

- **Government Support:** Alignment with national goals for achieving SDG 6 (Clean Water and Sanitation).
- **NGO Partnerships:** Potential for collaborative funding and training programs.
- **Scalability:** Modular design allows for adaptation to various urban settings.

DISCUSSION & RECOMMENDATIONS

The findings underscore the transformative potential of Biofill toilets in addressing critical sanitation challenges in urban slums. By significantly reducing open defecation, contamination, and disease prevalence, Biofill toilets offer a practical solution for improving public health and environmental conditions. The pilot results demonstrate that these systems are not only effective but also economically and socially viable in the context of Bhashantek Slum. However, challenges remain, including the need for initial funding and community engagement to scale the technology. The study also highlights the importance of sustained maintenance efforts and education campaigns to maximize adoption and long-term impact. Biofill toilets can contribute significantly to improving sanitation infrastructure, public health, and environmental sustainability in urban slums across Bangladesh by addressing the following recommendations:

i. Scale-Up Implementation: Expand Biofill toilet installations across Bhashantek Slum and similar urban areas, prioritizing high-density regions with severe sanitation challenges.
ii. Community Engagement: Conduct awareness programs to educate residents about the benefits and proper use of Biofill toilets.
iii. Financial Support: Establish partnerships with NGOs, government bodies, and donors to subsidize installation costs and support community-led maintenance systems.
iv. Monitoring and Evaluation: Develop a framework for continuous monitoring of health and environmental outcomes to ensure the sustained effectiveness of the technology.
v. Policy Integration: Advocate for the inclusion of Biofill toilets in national urban sanitation policies as a scalable solution for slum development.

ISBN: 978-984-35-7297-4

CONCLUSION

Biofill toilets provide a transformative approach to addressing the sanitation crisis in urban slums like Bhashantek. Their low water usage, eco-friendly design, and scalability make them an ideal solution for densely populated, resource-constrained environments. By implementing these systems, Bangladesh can make significant strides in improving public health, enhancing waste management, and achieving its sustainable development goals.

ACKNOWLEDGEMENT

Expressing our gratitude to the Almighty, We would like to thank the officials on Water and Life Bangladesh, an International NGO working in Bhashantek Slum for sharing documents and information with the research Team and residents of Bhantek Slum for their cooperation and insights, which were crucial for this research. We are also grateful to our family and friends for their constant encouragement.

REFERENCES

1. Ahmed, S., & Rahman, M. (2021). "Sanitation Challenges in Urban Slums: The Case of Dhaka." *Journal of Urban Studies in South Asia*, 15(2), 34-45.
2. Bangladesh Bureau of Statistics (BBS). (2022). "Hygiene and Sanitation in Urban Slums." Government of Bangladesh.
3. Haque, N., et al. (2021). "Environmental Impact of Inadequate Sanitation in Bangladesh." *Water and Environment Journal*, 19(3), 56-68.
4. Kariuki, P., et al. (2020). "Biofill Toilets: A Sustainable Solution for Urban Sanitation." *International Journal of Sanitation Solutions*, 22(4), 89-104.
5. Mumo, J., et al. (2021). "Sanitation Innovations in Nairobi Slums." *African Journal of Public Health*, 17(5), 67-78.
6. Rahman, F., et al. (2022). "Innovative Sanitation Systems for Bangladesh's Slums." *Sustainable Development Reports*, 11(7), 45-59.
7. Sharma, V., et al. (2020). "Cost-Effective Sanitation for Low-Income Areas." *Indian Journal of Civil Engineering*, 14(3), 102-110.