

Development and Implementation of a Sustainable Waste Management System Project at District General Hospital Matale with Digital Monitoring and Evaluation

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Abstract:

➤ *Introduction:*

Healthcare waste management at District General Hospital (DGH) Matale, Sri Lanka, faced increasing environmental and safety challenges from inadequate segregation, storage, and disposal of clinical and non-clinical wastes. A sustainable, systems-based approach including digital monitoring was introduced to address these issues.

➤ *Objective:*

To develop, implement, and evaluate a sustainable healthcare waste management system at DGH Matale that improves waste segregation, reduces clinical waste volumes and disposal costs, and enhances operational efficiency and compliance.

➤ *Methodology:*

A comprehensive intervention launched in early 2025 included formation of a Waste Management Steering Committee, development of institutional waste management policies, staff training, construction of a dedicated waste management center, and deployment of a real-time digital waste monitoring system. The digital platform tracked waste generation and disposal, supported compliance monitoring, and leveraged behavioral influence (Hawthorne Effect). Waste volumes and disposal costs were measured pre- and post-intervention; trends in clinical and non-clinical waste categories were analyzed.

➤ *Results:*

Post-intervention, clinical waste volume decreased by 42.36% and disposal costs declined by 42.27%. Improvements were observed in segregation practices and operational workflows. Non-clinical waste streams (e.g., clean plastic, food waste) showed mixed trends, indicating variable impacts across categories. Digital tracking improved accuracy of waste data and compliance monitoring.

➤ *Conclusion:*

Integrating institutional policy, staff training, dedicated infrastructure, and digital monitoring substantially improved clinical waste management at DGH Matale, yielding notable reductions in waste volume and disposal costs and enhancing operational efficiency.

➤ *Recommendations:*

- Scale and adapt the model to other healthcare facilities in Sri Lanka with contextual tailoring.
- Extend interventions to target non-clinical waste streams through targeted training and source-reduction measures.
- Enhance the digital system by incorporating AI-driven predictive analytics for waste forecasting, optimization of reduction strategies, and real-time segregation recommendations.
- Conduct longitudinal studies to assess sustained behavioral change and long-term system performance across diverse healthcare settings.

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I. INTRODUCTION

It was revealed in recent years, concern over the solid waste from healthcare facilities like hospitals, clinics, laboratories, pharmacies and other supported healthcare services, has increased throughout the world (1).

➤ *Problem Description*

The growing concerns regarding the waste management in healthcare facilities have necessitated the development of efficient and sustainable systems that minimize environmental impact while ensuring the safe disposal of hazardous materials. District General Hospital (DGH) Matale, a prominent healthcare provider in Central Province Sri Lanka, has faced significant challenges in effectively managing the waste generated from its various units and wards during recent past years specially the post pandemic era. This problem was first identified in 2024, as the hospital's existing waste management practices failed to address the increasing volume and complexity of waste materials including general waste as well as clinical waste. The lack of a comprehensive system to monitor, segregate, and properly dispose of waste raised concerns about the environmental, occupational and public health risks associated with improper waste handling.

In response to these challenges, the Public Health unit of DGH Matale submitted the proposal for the establishment of a sustainable institutional waste management system at the Hospital to the Ministry of Health in 2024. This proposal was submitted to secure funding and approval for the development of a comprehensive waste management system that would not only enhance operational efficiency but also contribute to the hospital's commitment to environmental sustainability. With the allocation of funds and resources in early 2025, the project officially commenced in March of the same year, focusing initially on the construction of the necessary infrastructure to support waste segregation, storage and disposal.

A steering committee was formed in June 2025 to oversee the implementation and management of the system. The committee's primary responsibility is to ensure that the project adheres to national and international standards and guidelines for waste management in healthcare settings. In line with this, the institutional waste management policy guidelines were drafted, and the terms of reference for the committee were finalized by July 2025. These guidelines outline the roles, responsibilities, and operational procedures for effective waste management within the hospital, ensuring that all staff members are trained and aware of their responsibilities in waste segregation, collection, and disposal.

One of the key innovations in this project is the integration of a digital waste monitoring and evaluation system. This system, in the form of a software application, is

designed to collect and analyze data on the amount of waste generated in each unit and ward of the hospital. The app categorizes waste according to established segregation standards and tracks the volume of waste collected and disposed of at the waste management center. This digital system also monitors the weight of waste at various stages of collection, facilitating real-time tracking and reporting. By providing accurate, up-to-date data, the system will enable the hospital to optimize its waste management practices, reduce costs, and ensure compliance with regulatory requirements. The way forward for this digitalization process is to ensure the monitoring of waste generation, segregation, collection, and disposal at each level, while also promoting the 'Hawthorne effect,' a phenomenon where individuals alter their behavior due to the awareness of being observed or studied.

The overarching goal of this research project is to develop and implement a sustainable institutional waste management system at DGH Matale. This system will include the establishment of a clear institutional waste management policy, the construction of necessary infrastructure, and the implementation of a digital monitoring system that ensures the efficient tracking, management, and disposal of waste. Through this initiative, DGH Matale aims to not only improve the environmental impact of its operations but also set a precedent for other healthcare institutions in the region to adopt similar sustainable practices. By the end of 2025, the hospital expects to achieve a fully operational and integrated waste management system that will serve as a model for sustainable healthcare waste management in Sri Lanka.

➤ *Justification*

Effective healthcare waste management (HCWM) is crucial for safeguarding public health, protecting the environment, and ensuring compliance with national and international standards. At District General Hospital (DGH) Matale, the absence of a structured waste management system has led to significant challenges, including improper waste segregation, increased clinical waste volumes, and environmental hazards. This justification outlines the key issues contributing to the current situation and emphasizes the need for a comprehensive HCWM system.

➤ *Lack of Staff Awareness and Commitment*

A primary factor contributing to improper waste segregation at DGH Matale is the insufficient awareness and training among healthcare staff regarding HCWM practices. Studies have shown that healthcare professionals' knowledge and attitudes significantly influence waste management practices. For instance, a study conducted in the health care institute Phuket Thailand revealed that while 76.9% of healthcare professionals had high knowledge levels about HCWM, only 53.8% exhibited positive attitudes towards waste management practice (2). This disparity often leads to improper segregation and handling of hazardous waste.

➤ *Increased Clinical Waste Volumes and Associated Costs*

Improper segregation has resulted in an increased volume of clinical waste, particularly yellow waste bags, at DGH Matale. The hospital generates an average of 4,000 kg of clinical waste monthly, with a disposal cost of 239 LKR per kilogram. Consequently, the hospital incurs significant expenses for waste disposal, which could be mitigated through effective segregation and recycling practices (3).

➤ *Absence of Legislation and Institutional Guidelines*

The lack of formal legislation and institutional guidelines for waste disposal at DGH Matale has led to inconsistent practices among HCWs including cleaning staff. Without clear policies and training, staff may inadvertently contribute to improper waste handling, segregation which can be increasing the risk of environmental contamination and occupational hazards. The World Bank emphasizes the importance of segregation and identification in reducing risks associated with hazardous HCW disposal (4).

➤ *Inadequate Waste Storage Facilities Leading to Environmental Hazards*

The absence of proper waste storage facilities at DGH Matale has resulted in environmental issues such as foul odors, rodent infestations, and the proliferation of mosquitoes and flies. The Centers for Disease Control and Prevention in United States (CDC) recommends that medical waste be stored in labeled, leak-proof, puncture-resistant containers to prevent such hazards (5).

➤ *The Hawthorne Effect and Behavioral Change*

The Hawthorne effect is the tendency for individuals to change their behavior or performance simply because they know they are being observed or studied. This often results in improvements in performance, as people may try harder or act differently when under observation or monitoring (6).

Implementing a digital monitoring and evaluation system can leverage the "Hawthorne effect," where individuals modify their behavior due to the awareness of being observed. A systematic review found that 78% of studies reported behavioral changes among healthcare professionals when they were aware of being observed, leading to increased compliance with best practices (7). A study conducted in the UK highlighted that different individuals view waste segregation either as waste or a resource. It emphasizes the need for a clear definition of waste and a policy guideline to establish an effective system (8).

The challenges faced by DGH Matale in managing healthcare waste underscore the need for a comprehensive and sustainable HCWM system. Addressing issues such as staff awareness, waste segregation, infrastructure, and monitoring can significantly improve waste management practices, reduce costs, and mitigate environmental hazards. Implementing a digital monitoring system can further enhance compliance and sustainability in HCWM practices.

II. RATIONALE FOR THE IMPLEMENTATION OF THE PROJECT

➤ *Frameworks, Models, and Concepts*

The project at DGH Matale utilizes several frameworks and models to improve healthcare waste management:

- Waste Management Hierarchy emphasizes waste prevention, minimization, recycling, and disposal as a last resort. The project targets better waste segregation to reduce hazardous waste and costs.
- Health Belief Model (HBM) focuses on increasing staff awareness of the health and environmental risks associated with poor waste management, encouraging more responsible behavior through training (9).
- Theory of Planned Behavior (TPB) highlights the importance of attitudes, social norms, and perceived control over waste segregation, with the intervention aiming to modify these through training, policy, and real-time digital monitoring (10).

➤ *Assumptions*

Key assumptions include:

- Improved waste management through better storage infrastructure.
- Increased staff awareness leading to behavior change.
- The feasibility of real-time waste tracking with digital monitoring.
- Ongoing support from the Ministry of Health and cost reductions in waste disposal through improved segregation practices.

➤ *Why the Intervention is Expected to Work*

The intervention is expected to succeed for several reasons:

- Behavioral Change: Digital monitoring leverages the "Hawthorne Effect," encouraging better practices.
- Evidence-Based Practices: Studies show that waste segregation reduces clinical waste volume and environmental risks.
- Cost Savings: Improved segregation is anticipated to reduce waste disposal costs in the long term.
- Environmental and Public Health Benefits: Proper waste handling minimizes environmental hazards and reduces the spread of infectious diseases

➤ *Objectives*

• *General Objective*

To develop and implement a sustainable institutional waste management system at District General Hospital Matale by establishing an effective waste management policy, necessary infrastructure, and a digital monitoring and evaluation system in 2025

- *Specific Objectives*

- ✓ To design and establish an institutional waste management policy at DGH Matale by July 2025, ensuring compliance with national and international waste management standards
- ✓ To construct the required waste management infrastructure including disposal facilities, at DGH Matale by August 2025
- ✓ To implement a digital waste monitoring and evaluation system by August 2025, allowing real-time tracking and reporting of waste generation and disposal to evaluate the waste management process at DGH Matale

III. METHODS

The methodology for developing and implementing a sustainable healthcare waste management system at DGH Matale was executed in several key phases, each addressing the primary issues identified in the problem description. These phases included the establishment of a waste management committee, the creation of an institutional policy, staff awareness and training, the development and implementation of a digital monitoring system, construction of a waste management center, and the implementation of a zero-polyethylene / plastic policy.

- *Context*

The context for introducing the sustainable healthcare waste management system at District DGH Matale was devised by several key factors. The hospital, located in Central Province, Sri Lanka, had been facing increasing challenges in managing the waste generated by its various units and wards, particularly in the post-pandemic era. The existing waste management system was insufficient to handle the growing volume and complexity of waste materials, including general and clinical waste. This led to concerns about environmental, occupational, and public health risks due to improper waste segregation, storage, and disposal. This has been proven in the international context, as effective Bio Medical Waste management requires teamwork, government support, dedicated healthcare workers, continuous monitoring, and strong regulations. The article also emphasizes the need for research and development in eco-friendly medical devices and waste disposal systems to promote a cleaner environment (11). In Sri Lankan context a study conducted revealed generation of different types of hospital waste can be analyzed efficiently and effectively by implementing electronic database management system. This information can be used to establish a sustainable waste management system and for future planning purposes (12).

- *Key Contextual Elements Considered:*

- The lack of a structured waste management system and inadequate infrastructure for waste segregation and disposal.
- Limited staff awareness and training on proper waste management practices.
- The need to comply with national and international waste management standards.

- The hospital's commitment to improving sustainability and reducing operational costs related to waste disposal.

- *Interventions*

- *Description of the Interventions*

The intervention was a multi-faceted approach aimed at establishing a sustainable and effective healthcare waste management system at DGH Matale. The key components of the intervention included:

- ✓ Formation of a Waste Management Steering Committee (WMSC) and Terms of References (TOR): This committee was responsible for overseeing the project's implementation and ensuring adherence to national and international standards. The Terms of Reference for the committee were developed, outlining roles, responsibilities, and the scope of the project. The TOR was circulated to all relevant stakeholders.
- ✓ Development of a waste management policy: A comprehensive policy was created to guide waste segregation, storage, collection, and disposal practices. The policy also outlined roles and responsibilities, ensuring compliance with regulatory standards.
- ✓ Staff training and awareness programs: A series of training sessions were held to educate hospital staff, including clinical and cleaning personnel, on the importance of proper waste segregation, safe handling of hazardous materials, and the use of the new digital monitoring system.
- ✓ Construction of a waste management center: A dedicated facility was established to securely store segregated waste. The center was equipped with color-coded rooms for different waste categories, ensuring safe and efficient waste processing.
- ✓ Implementation of a digital waste monitoring system: A software application was developed to track waste generation, segregation, and disposal in real-time. This system enabled the hospital to monitor waste volumes, track compliance with segregation guidelines, and identify opportunities for waste reduction.
- ✓ Zero-polyethylene / plastic policy: To minimize waste generation, a zero-polyethylene/plastic policy was enforced at all entry points to the hospital, with support from security staff to ensure compliance.

- *Specifics of the Team Involved*

This project was initiated by the Public Health Unit under the purview of the Director and the Deputy Director. In addition to them, various stakeholders were also involved in the intervention.

- Waste Management Steering Committee (WMSC): Comprised of representatives from medical, environmental services, and administrative departments at DGH Matale.
- Third-party vendor: A vendor was engaged to develop the digital monitoring app and provide technical support for its implementation.

- Hospital staff: Clinical, cleaning, and administrative staff were involved in training sessions and waste management activities.
- Ministry of Health: Provided guidance and support for ensuring that the intervention aligned with national healthcare waste management policies.

➤ *Study of the Interventions*

- *Approach Chosen for Assessing the Impact of the Interventions*

The impact of the intervention was assessed using a combination of qualitative and quantitative approaches. These included:

- ✓ Pre- and post-intervention comparisons: Waste generation, segregation practices, and disposal costs were measured before and after the intervention to evaluate improvements in waste management efficiency.
- ✓ Data comparison: Waste management data (e.g., weight of waste generated, disposal costs) from before and after the intervention were compared to isolate the impact of the specific components of the waste management system.
- ✓ Staff feedback: by key informant interviews.

➤ *Measures*

- *Measures Chosen for Studying Processes and Outcomes of the Interventions*

The following measures were chosen to assess the effectiveness of the intervention:

- ✓ Waste generation (kg): The amount of clinical and non-clinical waste generated was measured.
- ✓ Segregation compliance: The proportion of waste correctly segregated according to color-coded bins and waste categories was tracked.
- ✓ Cost of waste disposal: The total cost of waste disposal (calculated per kg) was compared before and after the intervention.

- *Rationale for Choosing the Measures:*

These measures were chosen because they directly reflect the core objectives of the intervention: improving waste segregation, reducing environmental impact, and lowering operational costs.

- *Description of the Approach to the Ongoing Assessment of Contextual Elements*

Ongoing assessments were conducted throughout the implementation period to evaluate contextual factors that influenced the success of the intervention:

- ✓ Staff compliance: Regular audits were carried out to assess how consistently hospital staff adhered to the waste segregation and disposal guidelines.

- ✓ Monitoring of waste management center: The efficiency of the new waste management center was evaluated through regular inspections and data from the digital monitoring system.

- *Methods Employed for Assessing Completeness and Accuracy of Data*

- ✓ Digital monitoring system: The system provided real-time data entry, ensuring accuracy in tracking waste volumes and segregation compliance.

- ✓ Data validation: Routine checks were implemented to ensure that data entered to the system was complete and accurate. Any discrepancies were flagged for review.

➤ *Analysis*

- *Quantitative Methods Used to Draw Inferences from the Data*

Descriptive statistics were used to analyze waste generation and disposal costs before and after the intervention. Paired t-tests or other appropriate statistical tests were used to assess the significance of changes in waste management practices.

➤ *Ethical Considerations*

Ethical Aspects of Implementing and Studying the Interventions

- *Formal Ethics Review:*

This is a quality improvement project implemented at DGH Matale as a major service requirement. Institutional approval taken from hospital management committee.

- ✓ Informed consent: All staff members involved in surveys or interviews provided informed consent, ensuring their participation was voluntary and that their responses were confidential.
- ✓ Conflict of interest: No conflicts of interest were identified during the study, and all project activities were conducted transparently and in alignment with ethical guidelines.

IV. RESULTS

- Formation of a Waste Management Steering Committee and Terms of References were formulated.
- A comprehensive policy was created to guide waste segregation, storage, collection, and disposal practices.
- A dedicated facility was established to securely store segregated waste.
- All the type of waste were entered to the app-based electronic data base.
- Previously, no proper records of general waste amounts were available.

Table 1 The Weight of Non-Clinical Waste in kg at DGH Matala in 2025

	1 st quarter monthly average	August	September
	kg	kg	kg
Clean Glass	267.3	275.35	249.6
Clean Papers	96.3	90.0	181.06
Clean Plastic Waste	288.1	344.29	354.0
Discarded Food	5670.4	5858.53	7074.74
General Non-Infectious other Waste	1225.6	1300.14	1831.52

Table 2 Comparison of 1st Quarter vs Post-Implementation of Non-Clinical Waste Monthly Average in kg in 2025

Waste Type	1st Quarter Monthly Average (kg)	August (kg)	September (kg)	August Change (%)	September Change (%)
Clean Glass	267.3	275.35	249.6	3.0	-6.6
Clean Papers	96.3	90.0	181.06	-6.5	88.0
Clean Plastic Waste	288.1	344.29	354.0	19.5	22.8
Discarded Food	5670.4	5858.53	7074.74	3.3	24.7
General Non-Infectious Waste	1225.6	1300.14	1831.52	6.0	49.4

According to the Table 1 and 2,

- Clean Glass: A slight increase of 3.01% in August, but a 6.62% decrease in September compared to the 1st quarter.
- Clean Papers: There was a 6.54% decrease in August, followed by a significant 88.02% increase in September.
- Clean Plastic Waste: A notable increase of 19.50% in August and 22.87% in September.

- Discarded Food: A 3.32% increase in August and a larger 24.77% increase in September.
- General Non-Infectious Waste: Increased by 6.08% in August and 49.44% in September.

These trends indicate that some waste types have increased, particularly Clean Plastic Waste, Discarded Food, and General Non-Infectious Waste, following the implementation of the waste management plan.

Table 3 The Weight of Clinical Waste Collected in kg at DGH Matala in 2025

	January	February	March	April	May	June	July	August	September
Clinical Waste in kg	7540.7	4518.9	5983	6090	8220	4826	10491	3600.1	4250.3

According to the Table 3, the comparison of clinical waste before and after the implementation of the waste management plan shows the following:

- Before the intervention (January to July), the average clinical waste was 6,809.94 kg per month.

- After the intervention (August and September), the average clinical waste decreased to 3,925.2 kg per month.

This results in a 42.36% reduction in clinical waste following the implementation of the waste management plan.

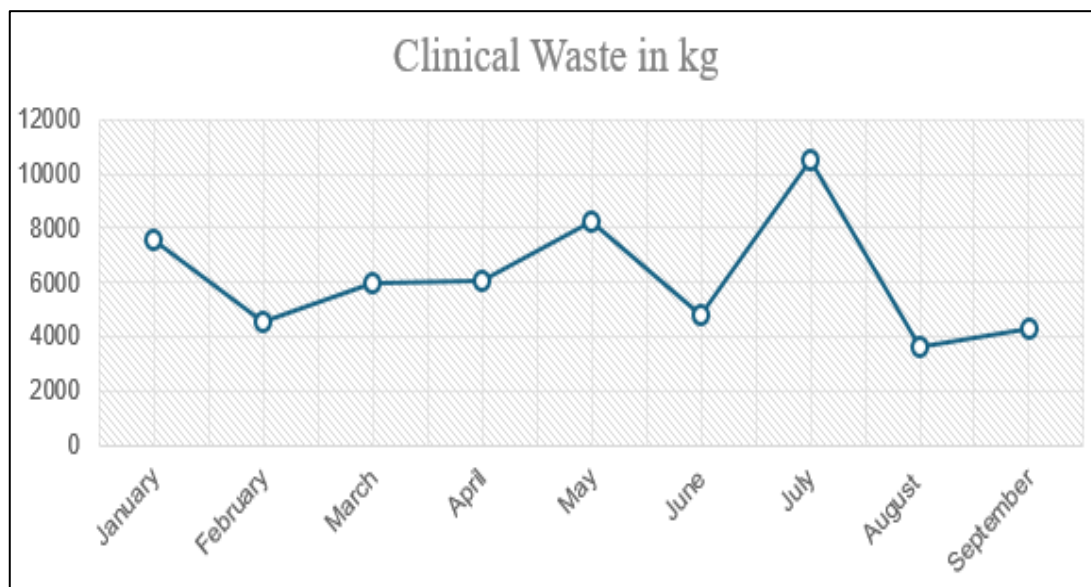


Fig 1 Trend of Monthly Clinical Waste Collection in 2025

Table 4 Monthly Cost for Clinical Waste Disposal at DGH Matale in 2025

	January	February	March	April	May	June	July	August	September
Cost for waste disposal in Millions (LKR)	2.31	1.32	1.83	1.87	2.52	1.48	3.22	1.10	1.30

According to the Table 4 the comparison of the clinical waste disposal cost before and after the implementation of the waste management plan shows the following:

- Before the intervention (January to July), the average cost for clinical waste disposal was LKR 2.08 million per month.

- After the intervention (August and September), the average cost decreased to LKR 1.20 million per month.

This represents a 42.27% reduction in the cost of clinical waste disposal following the implementation of the waste management plan.

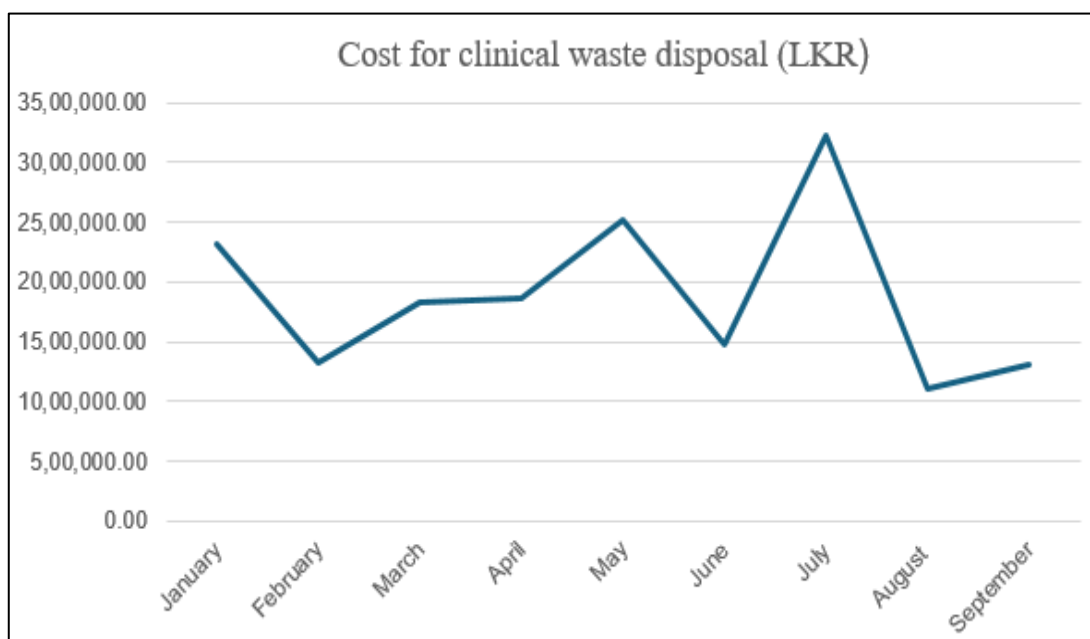


Fig 2 Trend of Monthly Clinical Waste Disposal Cost in 2025

The key results from the waste management implementation at DGH Matale in 2025 are:

- Formation of a Waste Management Steering Committee and Policy: A dedicated committee was formed, and a comprehensive waste management policy was established, covering waste segregation, storage, collection, and disposal practices.
- Waste Tracking System: An app-based database was introduced to track waste types, which previously lacked proper records.

➤ *Non-Clinical Waste Trends:*

- Clean Glass: A slight increase in August (+3.01%) but a decrease in September (6.62%).
- Clean Papers: Decreased by 6.54% in August, then increased significantly by 88.02% in September.
- Clean Plastic Waste: Increased by 19.50% in August and 22.87% in September.
- Discarded Food: Increased by 3.32% in August and 24.77% in September.

- General Non-Infectious Waste: Increased by 6.08% in August and 49.44% in September.

➤ *Clinical Waste Reduction:*

A 42.36% reduction in clinical waste was observed, from an average of 6,809.94 kg per month (January to July) to 3,925.2 kg per month (August and September).

➤ *Clinical Waste Disposal Costs:*

A 42.27% reduction in disposal costs, from an average of LKR 2.08 million per month (January to July) to LKR 1.20 million per month (August and September). These findings show that the waste management system led to improvements in waste segregation and reductions in both waste generation and disposal costs.

➤ *Details About Missing Data*

To assess the effects of the implemented waste management policy plan and the digitalized app-based monitoring system, qualitative analysis through key informant interviews with relevant stakeholders could not be completed at this time.

V. DISCUSSION

➤ *Summary of Key Findings, Including Relevance to the Rationale and Specific Aims*

The implementation of the sustainable waste management system at District General Hospital (DGH) Matale yielded significant results in waste segregation, reduction in clinical waste volumes, and a decrease in waste disposal costs. Key findings include a 42.36% reduction in clinical waste volume and a 42.27% reduction in associated disposal costs post-intervention. The introduction of a digital monitoring system enabled real-time tracking of waste, enhancing compliance with waste segregation practices. These findings are directly relevant to the project's overarching goals of establishing an effective waste management system to improve operational efficiency, reduce environmental impact, and ensure compliance with national and international standards. The integration of technology and staff training also contributed to the success of the intervention.

➤ *Strengths of the Project:*

- The project's holistic approach, combining infrastructure development, staff training, and digital monitoring, proved effective in addressing DGH Matale's waste management challenges.
- The creation of a Waste Management Steering Committee ensured consistent oversight, aligning the project with best practices and regulatory standards.
- Significant cost savings were achieved, with a clear reduction in waste disposal costs.

➤ *Interpretation of Nature of the Association Between the Interventions and the Outcomes*

The intervention demonstrated a clear association between the implementation of the waste management system and improved waste handling practices. The introduction of a digital tracking system leveraged the "Hawthorne effect," where the awareness of being monitored led to improved compliance in waste segregation. This behavioral change likely contributed to the increased accuracy in tracking waste types and volumes, directly influencing the observed reduction in waste generation and disposal costs. However, some waste types, such as general non-infectious waste and plastic waste, showed an increase post-intervention, suggesting that improvements in some areas may have led to the generation of more waste in others.

➤ *Comparison with Other Publications:*

- Similar studies in healthcare settings, such as those conducted in India, demonstrate the efficacy of waste segregation systems in reducing waste volumes and mitigating environmental risks (11). Our findings align with these, with DGH Matale experiencing a measurable reduction in clinical waste.
- In Sri Lankan healthcare institutions, the integration of digital monitoring has also been shown to enhance waste management accuracy (12), which was evident in this project.

➤ *Impact of the Project on People and Systems*

The impact on people was multifaceted, with staff exhibiting increased awareness and compliance due to the training and monitoring provided by the project. The integration of a digital system also empowered hospital staff to track waste in real-time, resulting in improved operational efficiency. On a systems level, the waste management system improved the hospital's ability to comply with national and international healthcare waste management standards, potentially influencing other healthcare institutions to adopt similar practices.

➤ *Reasons for Differences Between Observed and Anticipated Outcomes:*

The increase in certain waste categories, such as clean plastic waste and discarded food, may reflect changes in hospital practices, such as more stringent waste segregation policies or an increase in certain waste materials due to better recording. These shifts highlight that while waste management improvements were achieved, the nature of waste generation at the hospital has evolved, likely due to behavioral and procedural changes.

➤ *Costs and Strategic Trade-offs:*

The project incurred initial costs related to infrastructure development, staff training, and the implementation of the digital monitoring system. However, these were offset by the significant reductions in waste disposal costs. The opportunity costs of the project were minimal, as the long-term benefits, including cost savings, enhanced compliance, and environmental sustainability, outweighed the initial investments. Moreover, the hospital's capacity to handle waste more efficiently has reduced the burden on external waste disposal services.

VI. LIMITATIONS

➤ *Limits to Generalizability:*

While the findings are promising, the results of this project are specific to the context of DGH Matale, a hospital located in Sri Lanka. The healthcare environment, waste management challenges, and resource constraints in other settings may differ, which could affect the applicability of these findings in different regions or institutions.

➤ *Factors Limiting Internal Validity:*

Potential biases include the Hawthorne effect, where staff behavior may have been influenced by the awareness of being observed, leading to changes that may not be reflective of long-term practices. Additionally, incomplete qualitative data, such as key informant interviews, limited a deeper understanding of the intervention's effectiveness.

➤ *Efforts to Minimize Limitations:*

To mitigate these limitations, quantitative measures such as waste generation and disposal cost tracking were used to provide objective data. Moreover, regular audits and ongoing staff training ensured the intervention's alignment with waste management goals.

VII. CONCLUSION

➤ *Usefulness of the Work:*

The project has proven useful in addressing critical waste management issues at DGH Matale, including waste segregation and disposal costs. By successfully reducing clinical waste and associated disposal costs, the project demonstrates the potential for large-scale implementation in other healthcare settings.

➤ *Sustainability*

The integration of digital tools ensures ongoing tracking and monitoring, contributing to the long-term sustainability of the waste management system. The institutional commitment to maintaining the system further supports its potential for long-term success.

➤ *Potential for Spread to Other Contexts:*

The approach developed at DGH Matale has potential for broader application in other hospitals across Sri Lanka and the region, particularly in settings facing similar challenges related to waste segregation, environmental risks, and cost control.

➤ *Implications for Practice and Further Study:*

This work underscores the importance of integrating digital tools into waste management systems to enhance efficiency, compliance, and cost savings. Further studies could explore the long-term impact of digital monitoring on waste management practices and explore how contextual factors such as staff attitudes and training influence the success of similar projects in diverse healthcare settings.

RECOMMENDATIONS AND WAY FORWARD

- Expanding the digital monitoring system to include additional features, such as waste reduction goals and predictive analytics for waste forecasting by using AI (Artificial Intelligence) based monitoring.
- Further research into the behavioral dynamics of healthcare staff in waste segregation and how external factors, such as hospital bed strength, bed occupancy, OPD / clinic / inward patient admissions data and visitors of patients may influence the effectiveness of waste management systems.
- Exploring collaboration with other healthcare facilities to develop a standardized model for sustainable healthcare waste management.

This discussion highlights the key contributions, outcomes, and challenges of the waste management project at DGH Matale, emphasizing its relevance to the broader goals of healthcare sustainability and efficiency.

REFERENCES

- [1]. Al-Khatib IA, Sato C. Solid health care waste management status at health care centers in the West Bank – Palestinian Territory. *Waste Management* [Internet]. 2009 Apr 24 [cited 2025 Oct 07];29(8):2398–403. Available from: <https://www.sciencedirect.com/science/article/abs/pii/S0956053X0900097X>
- [2]. Pensiri Akkajit, Romin H, Mongkolchai Assawadithalerd, Al-Khatib IA. Assessment of Knowledge, Attitude, and Practice in respect of Medical Waste Management among Healthcare Workers in Clinics. *Journal of Environmental and Public Health* [Internet]. 2020 Sep 28 [cited 2025 Oct 07];2020:1–12. Available from: <https://onlinelibrary.wiley.com/doi/full/10.1155/2020/8745472>
- [3]. Hossain MS, Santhanam A, N.A. Nik Norulaini, Omar AKM. Clinical solid waste management practices and its impact on human health and environment – A review. *Waste Management* [Internet]. 2010 Dec 25 [cited 2025 Oct 10];31(4):754–66. Available from: <https://www.sciencedirect.com/science/article/abs/pii/S0956053X10005714>
- [4]. Ali M, Wang W, Chaudhry N, Geng Y. Hospital waste management in developing countries: A mini review. *Waste Management & Research The Journal for a Sustainable Circular Economy* [Internet]. 2017 Feb 1 [cited 2025 Oct 07];35(6):581–92. Available from: <https://journals.sagepub.com/doi/abs/10.1177/0734242X17691344>
- [5]. Federal and state regulation of medical waste: *Journal of Legal Medicine: Vol 15, No 1 - Get Access.* *Journal of Legal Medicine* [Internet]. 2025 [cited 2025 Oct 10]; Available from: <https://www.tandfonline.com/doi/pdf/10.1080/01947649409510937>
- [6]. The “Hawthorne Effect” – The Human Relations Movement – Baker Library | Bloomberg Center, Historical Collections [Internet]. Hbs.edu. 2025 [cited 2025 Oct 10]. Available from: <https://www.library.hbs.edu/hc/hawthorne/09.html>
- [7]. Choi WJ, Jung JJ, Grantcharov TP. Impact of Hawthorne effect on healthcare professionals: a systematic review. *University of Toronto medical journal* [Internet]. 2019 Mar 19 [cited 2025 Oct 10];96(2):21–32. Available from: https://www.researchgate.net/publication/359175585_Impact_of_Hawthorne_effect_on_healthcare_professionals_a_systematic_review
- [8]. Ebikapade Amasuomo, Baird J. The Concept of Waste and Waste Management. *Journal of Management and Sustainability* [Internet]. 2016 Nov 28 [cited 2025 Oct 09];6(4):88–8. Available from: https://www.researchgate.net/publication/311161719_The_Concept_of_Waste_and_Waste_Management
- [9]. Anees Alyafei, Easton-Carr R. The Health Belief Model of Behavior Change [Internet]. Nih.gov. StatPearls Publishing; 2024 [cited 2025 Oct 11]. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK606120/>
- [10]. Icek Ajzen, Schmidt P. Changing Behavior Using the Theory of Planned Behavior. Cambridge University Press eBooks [Internet]. 2020 Jul 6 [cited 2025 Oct 11];17–31. Available from: <https://www.researchgate.net/publication/374446342>

_Changing_Behavior_Using_the_Theory_of_Planne
d_Behavior

- [11]. Datta P, Gursimran Mohi, Chander J. Biomedical waste management in India: Critical appraisal. *Journal of Laboratory Physicians* [Internet]. 2018 Jan 1 [cited 2025 Oct 10];10(01):006-014. Available from: <https://pmc.ncbi.nlm.nih.gov/articles/PMC5784295/>
- [12]. Fernando S. Introduction of electronic waste management software to analyze waste generation at Base Hospital Udugama [Internet]. ResearchGate. unknown; 2023 [cited 2025 Oct 06]. Available from: https://www.researchgate.net/publication/374332097_Introduction_of_electronic_waste_management_software_to_analyse_waste_generation_at_Base_Hospital_Udugama