

OBSERVATION OF HOSPITAL WASTE MANAGEMENT SYSTEM IN SAVAR AREA, BANGLADESH

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A Thesis Paper Submitted to the Department of Civil Engineering, Daffodil International University, in Partial Fulfillment of the Requirements for the Degree of **Bachelor of Science in Civil Engineering.**



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November 2024

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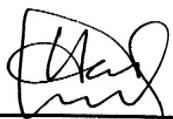
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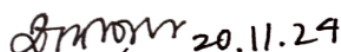
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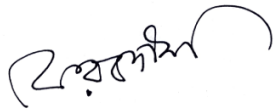
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It is hereby declared that except for the contents where specific reference has been made to the work of others, the design contained in the thesis report is the result of a detailed research work carried out by the authors under the supervision of **Md. Masud Alom**, Assistant Professor, Department of Civil Engineering, Daffodil International University.

No part of this report has been submitted to any other university or other educational establishment for a degree, diploma or other qualification.

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DEDICATED

Dedicated
To
Our Parents & All Teacher

ABSTRACT

This research examines the management procedures of hospital waste in public and private healthcare institutions in Savar Area, Dhaka, Bangladesh. The study seeks to assess current waste management systems, pinpoint significant difficulties, and suggest practical changes to improve public health and environmental safety. A mixed-methods strategy, utilizing both quantitative and qualitative data collection techniques, was employed to provide comprehensive insights. Field surveys, interviews with hospital staff, and direct on-site inspections were performed at 10 hospitals, comprising 1 public and 9 private institutions, with responses gathered from around 100 individuals engaged in waste management. The findings indicate substantial discrepancies between hospitals' compliance with the Medical Waste Management and Processing Rules (2008) and their actual execution. Identified common categories of hazardous waste include infectious waste, pathological and anatomical waste, and hazardous pharmaceutical and chemical waste, with no hospitals producing radioactive waste. Private hospitals demonstrated greater adherence to waste management protocols than public hospitals; nonetheless, all institutions encounter difficulties, including inadequate staff training, limited infrastructure, ineffective waste segregation, and financial limitations. The survey of hospitals revealed that the most commonly produced wastes are blood and blood products, bandages, and dressings, while the least produced wastes are human organs and expired medicines. Moreover, the majority of hospitals depend on an external waste management company, PRISM Bangladesh, for the collection and treatment of hazardous waste utilizing techniques such as autoclaving, incineration, and landfilling.

The study indicates that, notwithstanding the presence of a legislative framework, significant enhancements are required to guarantee successful hazardous waste management. It is recommended that according to Medical Waste Management and Processing Rules (2008) encompass the establishment of a 4-bin waste segregation system, improved staff training initiatives, intensified regulatory control, and augmented governmental investment in waste treatment technologies. The study emphasizes the necessity for coordinated actions by governmental bodies and healthcare organizations to enhance hazardous waste management and protect public health and the environment in Bangladesh.

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Table of Contents

CHAPTER I - INTRODUCTION

1.1 General.....	1
1.2 Scope of Study	1
1.3 Objectives	2

CHAPTER II - LITERATURE REVIEW

2.1 Introduction.....	3
2.2 Types of Hospital Waste.....	3
2.3 Risks and Impacts of Improper Waste Management	4
2.4 Background of Hazardous Hospital Waste Management Systems Globally.....	5
2.5 Global Challenges in Hospital Waste Management	5
2.6 Global Regulatory Framework for Hospital Hazardous Waste Management	6
2.6.1 International Conventions and Guidelines.....	6
2.7 Key Components of Effective Regulatory Frameworks.....	7
2.8 Background of Hazardous Hospital Waste Management in Bangladesh	9
2.9 Addressing the challenges of HHW management in Bangladesh	9
2.10 Hospital Waste Management Practices.....	9
2.11 Key Practices in Our Country in Hospital Waste Management	10
2.12 Regulatory Framework	11
2.12.1 Medical Waste Management and Processing Rules (2008).....	11
2.12.2 Environment Conservation Act (ECA) 1995	12
2.12.3 Bangladesh Labor Act, 2006.....	13
2.12.4 Municipal Laws and Local Government Ordinances	14
2.12.5 Department of Environment (DoE) Guidelines	14
2.13 Challenges in Implementation of Regulatory Framework.....	14
2.14 Sustainable Approaches to Waste Management.....	15
2.15 The 4 Bins System	16
2.15.1 Yellow Bin – Infectious and Pathological Waste	17
2.15.2 Red Bin – Sharps Waste	17
2.15.3 Blue Bin – Pharmaceutical and Chemical Waste	18
2.15.4 Black Bin – General Non-Hazardous Waste	18
2.16 Importance of the 4-Bin System in Bangladesh	18

2.17 Challenges and Recommendations for Implementing the 4-Bin System in Bangladesh.....	19
2.18 Summery	20
CHAPTER III - METHODOLOGY	
3.1 General.....	21
3.2 Methodology	21
3.3 Study Area Selection.....	22
3.4 Methods of Data Collection.....	23
3.5 Survey Questions	23
3.6 Sampling Methodology.....	24
3.7 Data Examination.....	24
3.8 Ethical Considerations	25
3.9 Summery	25
CHAPTER IV - RESULTS AND DISCUSSIONS	
4.1 Introductions	26
4.2 Data Analysis.....	26
4.3 Responsible party of hazardous waste disposal.....	32
4.4 Methods Used for HHW management.....	32
4.5 Waste Collections:	33
4.6 Storage Requirements or Precautions	33
4.7 Challenges according to hospitals authority	34
4.8 Training of stuffs.....	34
4.9 Summery	35
CHAPTER V - CONCLUSION AND RECOMMENDATION	
5.1 Introduction.....	36
5.2 Conclusion	36
5.3 Recommendations.....	37
REFERENCES	38
Appendix.....	41

Figures

Figure 2.1: Needles and syringes at the sample collection counter.	4
Figure 2.2: different types of waste in hospitals.	4
Figure 2.3: 4-Bins outside of the government hospital.	17
Figure 3.1 Study Area.....	22
Figure 4.2.1: Maximum waste generated in a day in every hospital.....	28
Figure 4.2.2: Percentages of Different Waste Types Within Total Hazardous Waste	29
Figure 4.2.3: Hazardous waste management cost according to hospital..	29
Figure 4.2.4: Number of beds in every hospital.....	30
Figure 4.2.5: Number of health workers in every hospital.....	31
Figure 4.4.1: Percentages of used treatment methods of hazardous waste	33
Figure 4.5: Waste collection Covered VAN of PRISM Bangladesh	33

Data Table & Chart

Table 4.2.1: Types of medical services does the hospital provide	26
Table 4.2.2: Types of hazardous waste are generated in the hospital	27
Table 4.7.1: Key Challenges according to hospitals authority	34

CHAPTER I

INTRODUCTION

1.1 General

Hazardous hospital waste (HHW) is a significant environmental and public health issue worldwide. Inadequate management can lead to severe repercussions, including the spread of infectious diseases, contamination of water sources, and adverse effects on ecosystems. As major producers of hazardous healthcare waste, hospitals play a critical role in ensuring its safe and environmentally responsible disposal. In Bangladesh, the rapid growth of healthcare facilities has resulted in a proportional increase in the volume of healthcare waste generated. However, effective management of this waste is challenging due to factors such as insufficient awareness, lack of infrastructure, and inadequate regulations.

This thesis investigates the practices and challenges associated with hazardous healthcare waste management in public and private hospitals in Savar Municipality, Dhaka, Bangladesh. Through a comprehensive survey, data were gathered on the types of hazardous waste generated, storage methods, transportation procedures, and disposal techniques employed by these institutions. The findings will provide valuable insights into the current state of HHW management in the region and support the development of evidence-based recommendations to improve practices and promote environmental sustainability. Addressing a crucial gap in the management of hazardous hospital waste in a rapidly expanding healthcare sector, this study offers meaningful insights for policymakers, hospital administrators, and environmental authorities by evaluating current practices and regulatory compliance. The recommendations aim to enhance the efficiency and sustainability of waste management systems, thereby protecting public health and the environment. Moreover, the research contributes to the global discourse on sustainable healthcare waste management by presenting a case study from a developing country, offering applicable insights for similar contexts worldwide (**Haque & Karim, 2019**).

1.2 Scope of Study

This study focuses on the hazardous waste management practices in hospitals across Savar Municipality, Dhaka, Bangladesh, evaluating the effectiveness of current systems

and identifying key areas for improvement. The research investigates compliance with national waste management guidelines, training of personnel, and the role of third-party waste disposal contractors like PRISM Bangladesh Foundation. The study aims to explore the gap between policy and practice, especially in waste segregation, handling, and disposal, and offer sustainable solutions.

1.3 Objectives

The objectives of this thesis on hazardous hospital waste (HHW) management in Bangladesh are:

- To classify the types of medical waste
- To observe the existing medical waste management system.

By achieving these objectives, this thesis aims to contribute to the improvement of HHW management in Bangladesh and promote a safer and healthier environment.

CHAPTER II

LITERATURE REVIEW

2.1 Introduction

Hospitals produce considerable waste, including toxic substances that present serious threats to public health and the environment. Hazardous hospital waste includes infectious, poisonous, and radioactive substances, necessitating meticulous management and disposal. Efficient treatment of this waste is crucial to avert disease transmission, environmental pollution, and to adhere to regulatory norms (**Sharma & Gupta, 2015**). The swift growth of the healthcare industry in Bangladesh has resulted in a rise in medical waste production, underscoring the critical necessity for enhanced waste management procedures (**Haque & Karim, 2019**). The nation's healthcare industry produces substantial hazardous waste, comprising infectious, poisonous, and radioactive substances, which, if mismanaged, can present grave threats to human health and the environment. Inadequate waste management infrastructure, insufficient regulatory enforcement, and a lack of knowledge have become hospital waste management a pressing issue in the country.

2.2 Types of Hospital Waste

Hospital waste is broadly classified into two categories:

- **Non-Hazardous Waste:** This encompasses products such as paper, plastics, and organic waste, which do not provide substantial hazards if managed appropriately.
- **Hazardous Waste:** This includes the following:
 - ▶ **Infectious waste:** Comprises objects contaminated with blood, bodily fluids, or other potentially infectious substances, including old bandages and syringes (**Aljabre, 2017**).
 - ▶ **Pathological waste:** Comprises human tissues, organs, and body components excised during surgical procedures or autopsies (**Bangladesh Department of Environment, 2020**).

- **Sharps waste:** Comprises needles, syringes, and other sharp tools capable of inflicting injuries and transmitting diseases (Sharma & Gupta, 2015).



Figure 2.1: Needles and syringes at the sample collection counter.

- **Chemical waste:** Consists of waste chemicals from diagnostic and cleaning procedures, including disinfectants and solvents (Patwary et al., 2011).
- **Radioactive waste:** Produced from diagnostic and therapeutic interventions, including cancer therapies (Lee et al., 2018).
- **Pharmaceutical Waste:** Comprises outdated or unused drugs and contaminated pharmaceutical items (Das et al., 2016).

Hazardous waste accounts for 10-25% of total hospital waste and requires special disposal techniques.

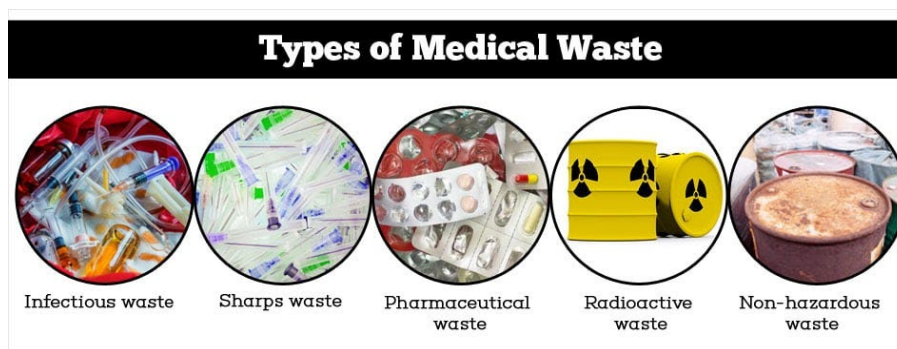


Figure 2.2: different types of waste in hospitals.

2.3 Risks and Impacts of Improper Waste Management

Inadequate management of hazardous hospital waste in Bangladesh poses substantial risks to public health and the environment. Infectious waste has the potential to transmit diseases such as HIV, hepatitis, and bacterial infections to healthcare personnel, trash handlers, and the general populace (Sharma & Gupta, 2015). Chemical and pharmaceutical waste can pollute soil and water, resulting in enduring ecological harm

and impacting biodiversity (**Haque & Karim, 2019**). If improperly managed, radioactive waste can lead to significant health problems and environmental pollution (**Patwary et al., 2011**). Furthermore, inadequate incineration of garbage emits detrimental chemicals, including dioxins and furans, exacerbating air pollution and respiratory diseases (**Lee et al., 2018**). Owing to insufficient awareness and inadequate infrastructure, hazardous waste frequently accumulates in open dumps or is inadequately managed, so exposing the public to various health hazards.

2.4 Background of Hazardous Hospital Waste Management Systems Globally

Hazardous hospital waste management worldwide is regulated by a confluence of international treaties, regional statutes, and national legislation. The World Health Organization (WHO) offers detailed guidelines for the management of healthcare waste, highlighting the importance of waste segregation, safe treatment, and disposal (**WHO, 2014**). The **Basel Convention (1989)** governs the transboundary transport of hazardous waste to guarantee environmentally appropriate management. Regional frameworks, exemplified by the European Union's Waste Framework Directive (**2008/98/EC**), provide rigorous criteria for waste management techniques, encompassing medical waste (**European Union, 2008**). Countries such as the United States and Germany have implemented comprehensive regulatory frameworks, including the Resource Conservation and Recovery Act (RCRA) in the U.S. and the Closed Substance Cycle Waste Management Act in Germany, which require specific protocols for waste segregation, treatment, and disposal (**EPA, 2016; Germany, 2020**).

2.5 Global Challenges in Hospital Waste Management

Hospital waste management presents considerable challenges globally, intensified by rising healthcare demands and environmental issues. A principal concern is the insufficient segregation of waste at the source, resulting in the amalgamation of hazardous and non-hazardous materials. The World Health Organization (**WHO, 2018**) states that inadequate segregation can pose significant health hazards, as non-hazardous waste may become contaminated with infectious items, jeopardizing healthcare professionals and the adjacent community.

A further difficulty is the deficiency of suitable waste treatment and disposal facilities. Numerous low- and middle-income countries (LMICs) lack the requisite infrastructure

for the proper treatment of hazardous waste, resulting in dependence on open burning or landfill disposal, which poses risks to public health and the environment (**Baldé et al., 2017**). Moreover, budgetary limitations and insufficient governmental regulation frequently impede hospitals' capacity to execute efficient waste management strategies, especially in rural regions (**Zhang et al., 2019**).

Furthermore, the swift progression of medical technology generates novel waste categories, including single-use devices and electronic trash, hence complicating current waste management systems (**Pérez et al., 2020**). As healthcare institutions produce escalating amounts of trash, the necessity for sustainable and effective waste management procedures intensifies.

There is frequently insufficient knowledge and training among healthcare professionals concerning the significance of effective waste management techniques. Research indicates that insufficient training might result in the inappropriate management and disposal of hazardous waste, hence increasing health hazards (**Ayres et al., 2018**). Confronting these worldwide difficulties necessitates a holistic strategy, encompassing refined rules, augmented training initiatives, and investment in waste management infrastructure.

2.6 Global Regulatory Framework for Hospital Hazardous Waste Management

The regulation of hazardous hospital waste is dictated by numerous frameworks globally, due to its substantial threats to human health and the environment. Countries and international organizations have instituted legislation, standards, and treaties to ensure the proper management, treatment, and disposal of hazardous healthcare waste. The global regulatory framework can be classified into International Conventions, Regional Regulations, and National Frameworks.

2.6.1 International Conventions and Guidelines

International organizations such as the World Health Organization (WHO), United Nations Environment Program (UNEP), and Basel Convention play a key role in providing global guidance on hazardous hospital waste management.

- **World Health Organization (WHO):** The WHO offers comprehensive guidelines for the management of healthcare waste, highlighting the significance of waste segregation, secure disposal, and treatment of hazardous substances. It categorizes

healthcare waste into classifications including infectious, pharmaceutical, radioactive, and chemical waste, and recommends optimal management strategies for each category.

- **WHO's Safe Management of Wastes from Health-Care Activities (2004):** This document, referred to as the "Blue Book," functions as an international reference for healthcare waste management, detailing procedures for appropriate segregation, collection, storage, transport, and disposal.
- **Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal (1989):** This international treaty was created to govern the transboundary flow of hazardous waste, assuring its environmentally appropriate management. This pertains to healthcare waste that may be transferred worldwide for disposal or treatment. The Basel Convention advocates for nations to reduce the production of hazardous waste and to facilitate its disposal at the point of origin, thereby mitigating environmental damage.
- **Stockholm Convention on Persistent Organic Pollutants (POPs):** This convention pertains to the regulation of hazardous chemicals and waste, with a specific emphasis on healthcare waste that has the potential to emit deleterious substances such as dioxins and furans during burning. Signatory countries to this convention are required to implement measures to eradicate or diminish the emission of these hazardous compounds from hospital waste management practices.
- **UNEP Global Partnership on Waste Management:** UNEP has collaborated with international partners to advocate for the ecologically responsible handling of hazardous healthcare waste. It offers technical assistance and resources to aid countries in formulating and executing sustainable waste management policies.

2.7 Key Components of Effective Regulatory Frameworks

An effective regulatory framework for hazardous hospital waste management is crucial to ensure the protection of public health and the environment. Key components include:

- **Clear Definitions and Classifications:** Regulations must explicitly delineate the criteria for hazardous waste, encompassing several categories of hospital waste, including infectious, chemical, and pharmaceutical waste. This clarity enables healthcare facilities to accurately classify and manage their waste. The World Health Organization (2018) asserts that accurate classification is essential for efficient waste management.

- **Segregation Guidelines:** Regulations must require waste segregation at the source. Segregation reduces the likelihood of hazardous waste contaminating non-hazardous waste streams and promotes appropriate treatment and disposal. (Prüss-Üstün et al. 2019) assert that waste segregation is crucial for mitigating health risks and safeguarding waste handlers.
- **Treatment and Disposal Standards:** Regulations must delineate permissible techniques for the treatment and disposal of hazardous waste. This encompasses protocols for processes including burning, autoclaving, and landfill disposal. (Caniato et al., 2016) emphasize the necessity of complying with treatment regulations to avert environmental pollution and public health risks.
- **Training and Awareness Programs:** It is imperative to provide training for healthcare staff on waste management procedures. Regulations must incorporate stipulations for ongoing training and capacity-building initiatives to guarantee that personnel are informed of the most recent waste management standards. According to (Islam et al., 2020), ongoing education can markedly enhance compliance and safety.
- **Monitoring and Enforcement Mechanisms:** Effective regulatory systems must incorporate strong monitoring and enforcement tools to guarantee compliance. This include routine inspections, reporting obligations, and sanctions for non-compliance; (Kabir et al., 2017) contend that robust enforcement is essential for the efficacy of any regulatory structure.
- **Public Participation and Stakeholder Engagement:** Involving stakeholders, such as healthcare professionals, local communities, and waste management firms, is essential for the formulation and execution of effective policies. (Ahsan et al., 2018) underscore the necessity of a collaborative strategy to guarantee that rules are both pragmatic and efficacious.
- **Periodic Review and Adaptation:** Regulations must undergo regular review and modification to align with technological improvements and evolving waste management methods. (Gupta et al., 2018) propose that a dynamic regulatory framework, which adapts to emerging difficulties, is crucial for sustained efficacy.

2.8 Background of Hazardous Hospital Waste Management in Bangladesh

The administration of hazardous hospital waste in Bangladesh has garnered attention due to the proliferation of healthcare institutions and the resultant increase in medical waste production. Notwithstanding legislative frameworks such as the **Medical Waste Management and Processing Rules (2008)**, numerous hospitals encounter difficulties in compliance owing to insufficient infrastructure, inadequate training, and financial limitations (**Haque & Karim, 2019**). This issue is intensified in rural regions where healthcare institutions lack resources, resulting in inadequate waste disposal methods such as open dumping and uncontrolled incineration (**Chowdhury & Rahman, 2020**).

2.9 Addressing the challenges of HHW management in Bangladesh

- Safeguarding public health and mitigating the transmission of infectious illnesses.
- Protecting the environment and preventing the pollution of water sources and ecosystems.
- Guaranteeing the safety and welfare of healthcare professionals.
- Advancing sustainable growth and enhancing the overall quality of life inside the nation.
- Comprehending the context of HHW management in Bangladesh enables the formulation of appropriate strategies and interventions to tackle these difficulties and enhance the situation.

2.10 Hospital Waste Management Practices

Effective hospital waste management involves several key steps:

- ❖ Segregation at the source: It is essential to segregate hazardous waste from non-hazardous trash at the point of origin to minimize contamination and guarantee appropriate disposal (**Aljabre, 2017**).
- ❖ Collection and Transportation: Waste must be collected and carried in appropriate containers and vehicles to avert leakage and exposure (**Patwary et al., 2011**).
- ❖ Treatment methods: Techniques include burning, autoclaving, and chemical disinfection are utilized to process hazardous waste prior to disposal (**Das et al., 2016**).

- **Incineration:** Typically utilized for hazardous medical waste; yet, it generates detrimental emissions if inadequately controlled.
- **Autoclaving:** An alternate method for sterilizing infectious waste that employs pressurized steam to eliminate microorganisms without producing hazardous emissions.
- **Chemical treatment:** Employed for the neutralization of dangerous compounds, rendering them safe for disposal.
- **Landfilling:** Hazardous waste that is untreatable may be securely kept in specially engineered landfills to avert environmental leakage.

In Bangladesh, the management of hospital waste has numerous obstacles, such as inadequate infrastructure, ineffective waste segregation, and insufficient oversight (Haque & Karim, 2019). Numerous hospitals, particularly in urban locales such as Dhaka and Chittagong, produce substantial quantities of garbage yet lack the requisite resources for its proper management.

2.11 Key Practices in Our Country in Hospital Waste Management

- **Poor segregation:** Hospitals frequently neglect to separate hazardous trash from non-hazardous waste at the point of origin. This results in the contamination of general garbage, augmenting the quantity of hazardous material necessitating specialized treatment.
- **Limited treatment options:** A multitude of hospitals in Bangladesh are deficient in adequate waste treatment facilities, including burning and autoclaving. Consequently, garbage is frequently disposed of in open landfills or incinerated, resulting in environmental contamination.
- **Manual handling of waste:** Owing to the restricted access to contemporary waste management technologies, refuse is often managed manually by personnel who frequently lack training and appropriate protective equipment.

While several larger hospitals, especially in Dhaka, have begun using contemporary waste management strategies, the overwhelming majority of healthcare facilities in rural regions continue to grapple with fundamental garbage disposal techniques.

2.12 Regulatory Framework

Bangladesh has implemented a legal framework for the management of hazardous medical waste, principally through the Medical Waste Management and Processing Rules (2008) and the Environment Conservation Act (1995). These regulations require the segregation, collection, transportation, treatment, and disposal of medical waste, while designating tasks to hospital authorities and waste management operators (**Government of Bangladesh, 2008**). The Department of Environment (DoE) supervises the implementation of these regulations; nevertheless, enforcement is deficient due to constrained resources and oversight abilities (**Bangladesh Department of Environment, 2020**). The following is a detailed overview of the principal regulatory frameworks concerning hospital waste management in Bangladesh:

2.12.1 Medical Waste Management and Processing Rules (2008)

- **Overview:** The Medical Waste Management and Processing Rules (MWMPR) 2008, established under the Environment Conservation Act of 1995, are the principal regulatory framework for hospital waste management in Bangladesh. These regulations offer comprehensive directives for the collection, segregation, transportation, treatment, and disposal of medical waste. The regulations were implemented to mitigate the escalating concerns regarding the incorrect management of hazardous medical waste, particularly in metropolitan areas.
- **Key Provisions:**
 - **Categorization of Waste:** The MWMPR-2008 categorizes hospital waste into various classifications, including general trash, infectious waste, pathological waste, sharps, and radioactive waste. Each category necessitates distinct management and disposal techniques.
 - **Waste Segregation:** Hospitals are required to separate garbage at the source, which is the essential initial step in diminishing the quantity of hazardous waste. Color-coded receptacles are necessary to distinguish between infected, non-infectious, sharps, and chemical waste.
 - **Collection and Transportation:** The regulations delineate the procedures hospitals must follow for the collection and transportation of trash from the facility to disposal locations. Vehicles designated for waste transportation

must be adequately labeled, fitted with containment systems, and routinely sanitized.

- **Waste Treatment Methods:** The regulations propose several treatment procedures according to the waste type:
 - **Infectious waste:** Autoclaving, incineration, or chemical treatment.
 - **Sharps waste:** Encapsulation in a sharps container before incineration or landfilling.
 - **Pathological waste:** Incineration or deep burial.
 - **Chemical waste:** Neutralization or safe disposal.
- **Waste Disposal:** Post-treatment, the residual non-hazardous waste may be disposed of in safe landfills or designated hazardous waste disposal sites.
- **Record Keeping:** Hospitals are required to keep comprehensive records of waste production, management, and disposal. This data is subject to examination by pertinent authorities.
- **Responsibilities:**
 - **Hospital Authorities:** The regulations designate hospital administrators as primarily responsible for the management of hospital trash. They must implement effective waste management systems and assure adherence to the requirements.
 - **Waste Management Operators:** Licensed private operators frequently oversee the collection and transportation of trash from hospitals to specified treatment and disposal sites.
 - **Department of Environment (DoE):** The Department of Energy is responsible for overseeing adherence to the Municipal Waste Management Policy Regulations. It grants permissions and licenses for waste treatment facilities and can impose penalties on hospitals that do not adhere to regulations.

2.12.2 Environment Conservation Act (ECA) 1995

- **Overview:** The Environment Conservation Act (ECA) of 1995 serves as the principal environmental legislation in Bangladesh. It establishes the principles for environmental preservation, encompassing the handling of hazardous waste. The Act addresses several environmental challenges, with specific parts pertaining to hazardous waste management in hospitals.

➤ **Key Provisions:**

- **Hazardous Waste Control:** The ECA requires the regulation of hazardous waste production, processing, and disposal to avert environmental deterioration. Hospitals generating hazardous waste are obligated to adhere to regulations and must prevent environmental contamination from their waste.
- **Environmental Clearance Certificate (ECC):** All hospitals and healthcare facilities must acquire an Environmental Compliance Certificate (ECC) from the Department of Environment (DoE), confirming that their operations adhere to environmental requirements, including waste management protocols.
- **Penalties for Non-Compliance:** The ECA empowers the government to levy fines and sanctions on institutions that do not adhere to environmental standards. Hospitals discovered inappropriately disposing of hazardous waste may incur significant fines, including the revocation of their licenses.

2.12.3 Bangladesh Labor Act, 2006

- **Overview:** The Bangladesh Labor Act of 2006 largely addresses worker rights and workplace safety. Certain provisions of the law apply to healthcare professionals and waste management personnel frequently exposed to hazardous substances in medical facilities.

➤ **Key Provisions:**

- **Occupational Safety and Health:** The Act requires that all personnel, including hospital waste handlers, get personal protective equipment (PPE) and maintain safe working conditions. Employers are accountable for instructing personnel on the management of hazardous products, including garbage.
- **Hazardous Materials Exposure:** The Act encompasses regulations for the secure management of hazardous substances, safeguarding employees from undue hazards. Hospitals must have policies to safeguard employees from potential illnesses and injuries caused by sharps or chemical exposure.

2.12.4 Municipal Laws and Local Government Ordinances

- **Overview:** Municipalities in Bangladesh are crucial in the management of hospital waste, particularly in major centers such as Dhaka and Chittagong. The local government authorities oversee rubbish collection and disposal within their areas.
- **Key Provisions:**
 - **Waste Collection:** Municipalities frequently oversee the collection of garbage from hospitals and its subsequent transportation to treatment or disposal facilities. They must collaborate with private trash management firms to guarantee appropriate disposal.
 - **Municipal Dumping Sites:** Local authorities allocate designated zones for the disposal of hazardous medical waste. Nevertheless, owing to constrained resources, these disposal sites sometimes lack the requisite infrastructure to securely hold and handle hazardous substances.

2.12.5 Department of Environment (DoE) Guidelines

The Department of Energy provides directives for hospitals regarding proper waste management techniques, encompassing waste segregation, storage, and disposal. These guidelines aim to augment current standards and assist hospitals in adhering to national environmental legislation.

2.13 Challenges in Implementation of Regulatory Framework

Despite the existence of these regulations, Bangladesh faces several challenges in effective hospital waste management:

- **Weak Enforcement:** Inadequate enforcement procedures and poor oversight by the Department of Environment lead to inconsistent compliance with waste management legislation (**Government of Bangladesh, 2008**).
- **Limited Infrastructure:** Numerous hospitals, particularly in rural regions, lack the requisite equipment, including incinerators and autoclaves, for adequate waste management (**Das et al., 2016**).
- **Lack of Awareness:** A significant number of healthcare professionals and hospital administrators lack comprehensive knowledge of the legislation and consequences linked to incorrect waste management, resulting in inadequate adherence to segregation and disposal protocols. Healthcare professionals

frequently receive insufficient training in appropriate waste management protocols, resulting in non-compliance (**Haque & Karim, 2019**).

- **Inadequate Monitoring:** Regulatory bodies are deficient in people and resources for the routine inspection of healthcare institutions, resulting in frequent unaddressed infractions of waste management regulations.
- **Financial Constraints:** The substantial expenses related to the acquisition and maintenance of waste treatment technologies restrict their accessibility and utilization in numerous hospitals (**Patwary et al., 2011**).

Although Bangladesh has instituted a legal framework for hospital waste management via the Medical Waste Management and Processing Rules (2008), the Environment Conservation Act (1995), and additional legislation, effective implementation continues to be a difficulty. Enhancing enforcement, constructing infrastructure, increasing awareness, and delivering training are crucial for rectifying deficiencies in hazardous waste management. For enduring success, both the government and healthcare institutions must cooperate to guarantee the safe and sustainable management of hospital waste.

2.14 Sustainable Approaches to Waste Management

Sustainability in hospital waste management focuses on reducing environmental impacts and minimizing hazardous waste production. Sustainable practices include:

- **Reducing waste at the source:** Reducing the generation of hazardous waste through the use of eco-friendly products and efficient procurement practices (**Lee et al., 2018**).
- **Recycling and reuse:** Implementing recycling programs for non-infectious waste to reduce the overall waste volume (**Aljabre, 2017**).
- **Waste-to-energy technologies:** Converting waste into energy through processes like incineration with energy recovery or biogas production to reduce landfill use and generate useful energy (**Das et al., 2016**).
- **Alternative treatment methods:** Adopting methods such as autoclaving and chemical disinfection as alternatives to incineration to minimize harmful emissions (**Patwary et al., 2011**).

To improve hospital waste management in Bangladesh, sustainable practices must be adopted. Some recommended approaches include:

- **Segregation at the source:** Proper segregation of waste at the point of generation can significantly reduce the volume of hazardous waste that needs special treatment. Hospitals should ensure that different types of waste are disposed of in color-coded containers.
- **Improved treatment methods:** Autoclaving, which uses steam to sterilize infectious waste, is an eco-friendly alternative to incineration. Some hospitals in Bangladesh have started using this method to reduce the environmental impact of hazardous waste disposal.
- **Training and awareness programs:** Regular training sessions for healthcare workers on the proper handling, segregation, and disposal of hazardous waste can improve waste management practices. Awareness campaigns can also educate the general public and waste handlers about the dangers of improperly handled hospital waste.
- **Strengthening regulatory enforcement:** The government needs to allocate more resources to the Department of Environment to ensure that regulations are enforced more strictly and that healthcare facilities comply with waste management standards.

2.15 The 4 Bins System

The **4-bins system** is a standardized method for segregating medical waste at the source, enhancing the efficiency of waste management processes. The system includes according to (Haque & Karim, 2019):

- **Yellow Bin:** For infectious and pathological waste.
- **Red Bin:** For sharps waste.
- **Blue Bin:** For pharmaceutical and chemical waste.
- **Black Bin:** For general non-hazardous waste.

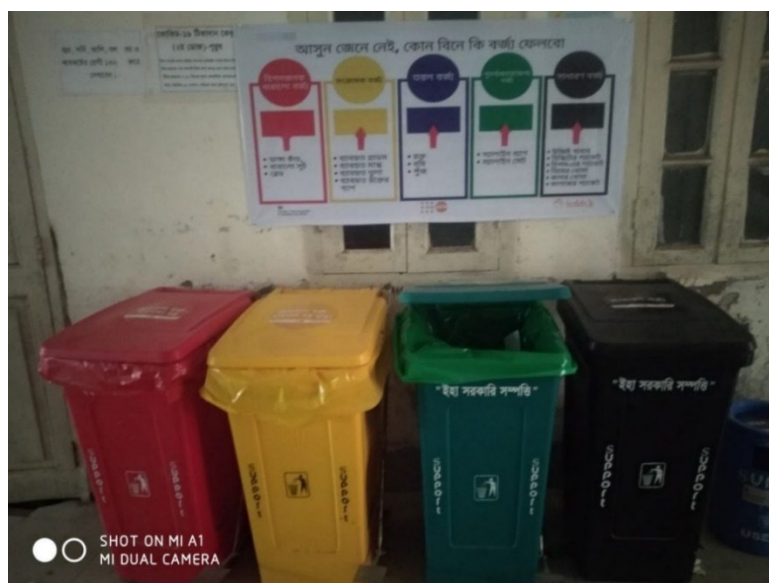


Figure 2.3: 4-Bins outside of the government hospital.

Implementing the four-bin system in Bangladeshi hospitals can markedly enhance waste segregation, diminish contamination hazards, and ensure adherence to national standards (Chowdhury & Rahman, 2020).

2.15.1 Yellow Bin – Infectious and Pathological Waste

- **Contents:** Infectious materials include utilized bandages, swabs, personal protective equipment (PPE) contaminated with blood or bodily fluids, and human tissues or organs. Biological cultures, samples, and other clinical waste that may present an infection risk.
- **Handling & Treatment:** Collected in impermeable, puncture-resistant yellow bags or containers marked with the biohazard sign. Treated using autoclaving, incineration, or chemical disinfection. Ultimate disposal at a specialized hazardous landfill or via incineration.

2.15.2 Red Bin – Sharps Waste

- **Contents:** Sharp implements including needles, syringes, scalpel blades, glass vials, and other devices capable of inflicting cuts or puncture wounds.
- **Handling & Treatment:** Sharps must be disposed of in puncture-resistant, rigid red containers labeled with a biohazard or "sharps" symbol. Sharps waste is generally subjected to autoclaving or incineration to guarantee total

annihilation. Post-treatment, garbage is either dispatched to a secure landfill or recycled inside a regulated environment.

2.15.3 Blue Bin – Pharmaceutical and Chemical Waste

- **Contents:** Expired or unutilized pharmaceuticals, pharmaceutical items, and dangerous substances (e.g., solvents, disinfectants).
- **Handling & Treatment:** Pharmaceuticals and chemicals must be gathered in distinct blue containers, clearly labeled by their respective categories (pharmaceutical or chemical). Pharmaceutical waste is typically burnt at elevated temperatures, whereas chemicals may have specialized treatment depending on their composition. Final disposal may entail a licensed chemical disposal facility or a safe hazardous waste dump.

2.15.4 Black Bin – General Non-Hazardous Waste

- **Contents:** Non-hazardous waste includes paper, packaging, food waste, and things that do not present biological, chemical, or radioactive hazards. This bin is designated for general garbage from healthcare facilities that can be discarded alongside standard municipal waste.
- **Handling & Treatment:** Gathered in black bags or receptacles. No preferential treatment is required. This waste may be directed to standard municipal landfills or recycling centers.

2.16 Importance of the 4-Bin System in Bangladesh

- **Segregation at Source:** The use of the 4-bin system facilitates adequate waste segregation at the source, mitigating contamination risks and assuring suitable handling and treatment of various waste kinds.
- **Minimizing Cross-Contamination:** Clearly delineated bins minimize the risk of infectious trash contaminating general rubbish, so safeguarding both healthcare personnel and the environment from potential dangers.
- **Environmental Benefits:** By properly separating garbage, healthcare institutions can diminish the quantity of hazardous waste requiring specialist treatment (such as incineration) and enhance the volume of waste eligible for recycling or disposal in standard municipal landfills.

- **Compliance with Regulations:** The 4-bin system facilitates adherence to the Medical Waste Management and Processing Rules (2008) by assuring accurate classification, management, and treatment of both hazardous and non-hazardous medical waste.

2.17 Challenges and Recommendations for Implementing the 4-Bin System in Bangladesh

Implementing the 4-bins system in Bangladesh faces several challenges:

- **Awareness and Training:** Healthcare professionals must receive training on the significance of appropriate waste segregation and the implementation of the 4-bin system (Haque & Karim, 2019).
- **Monitoring and Enforcement:** Periodic audits and inspections by regulatory bodies are essential to verify adherence to the 4-bin system (Government of Bangladesh, 2008).
- **Infrastructure and Logistics:** It is imperative that healthcare facilities, particularly in rural regions, are equipped with adequate bins, waste storage systems, and access to treatment technologies, such as incinerators and autoclaves, to ensure the system's efficacy. All healthcare facilities must build adequate infrastructure, including labeled bins and secure storage locations (Chowdhury & Rahman, 2020).
- **Financial Support:** Government incentives or subsidies may be essential for assisting hospitals and clinics, particularly smaller establishments, in investing in the appropriate waste management infrastructure. Financial incentives or subsidies may be necessary to assist hospitals in obtaining the requisite infrastructure and training programs (Patwary et al., 2011).

Implementing a 4-bin system will enable healthcare facilities in Bangladesh to enhance their waste management procedures, conforming to national norms and international standards for the safe and effective disposal of healthcare waste. Suggestions to address these difficulties comprise augmenting governmental investment in waste management infrastructure, improving training initiatives for healthcare personnel, and reinforcing regulatory enforcement mechanisms (Haque & Karim, 2019).

2.18 Summery

Efficient treatment of hazardous medical waste is crucial for safeguarding human health and the environment. An integrated strategy necessitates appropriate segregation, treatment, and compliance with legislation. Developed countries possess established systems, whereas emerging nations encounter persistent obstacles. Hospitals must invest in enhanced infrastructure, training, and compliance systems to ensure safe and sustainable waste management. The handling of hazardous waste in hospitals is a critical concern in Bangladesh, with substantial ramifications for public health and the environment. Despite the government's advancements in establishing regulatory frameworks, substantial efforts are still required to rectify the deficiencies in infrastructure, awareness, and enforcement. Effective segregation, sustainable waste treatment, and enhanced training programs are crucial for optimizing hospital waste management in the country. Implementing sustainable practices, including trash reduction and environmentally conscious treatment methods, is essential for enduring enhancements in hospital waste management.

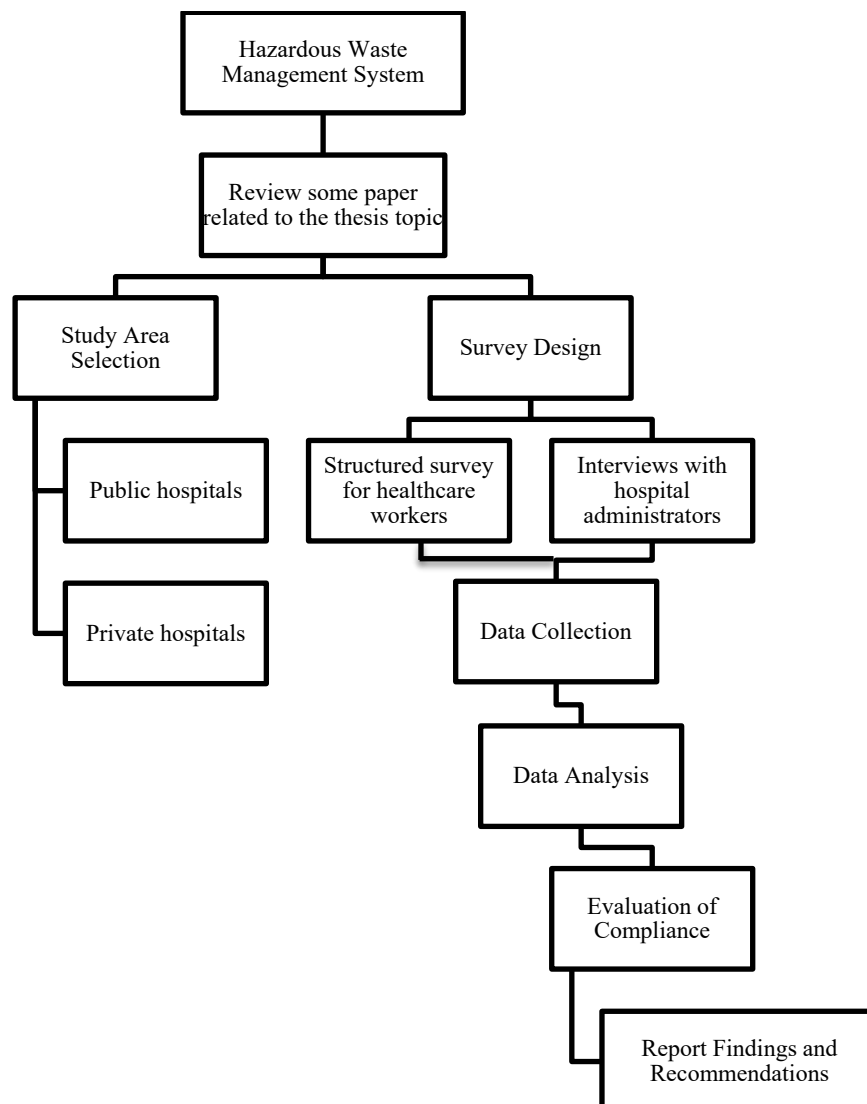
CHAPTER III

METHODOLOGY

3.1 General

This research methodology delineates the systematic strategy employed to evaluate the existing conditions of hazardous hospital waste management in Savar Municipality, Dhaka, Bangladesh. This chapter outlines the research methodology employed to acquire information regarding waste management strategies in both public and private hospitals. Due to the subject's significance, a mixed-methods approach was employed, integrating both quantitative and qualitative data to achieve a thorough understanding of the existing waste management systems. The study utilizes both field data and secondary sources to elucidate the efficacy and constraints of existing waste management systems, providing insights for enhancements to safeguard public safety and promote environmental sustainability.

3.2 Methodology



3.3 Study Area Selection

This research focused on selecting a wide range of public and private hospitals in Savar Municipality, Dhaka, Bangladesh. By including both urban centers like Dhaka and rural regions, the study highlights differences in waste management strategies due to resource availability, regulation, and infrastructure. This comparative approach examined hospitals' practices in waste segregation, collection, treatment, and disposal, identifying key gaps. The findings emphasize variations between well-equipped urban hospitals and under-resourced rural ones, providing insights into improving hazardous hospital waste management across Bangladesh through tailored policy recommendations.

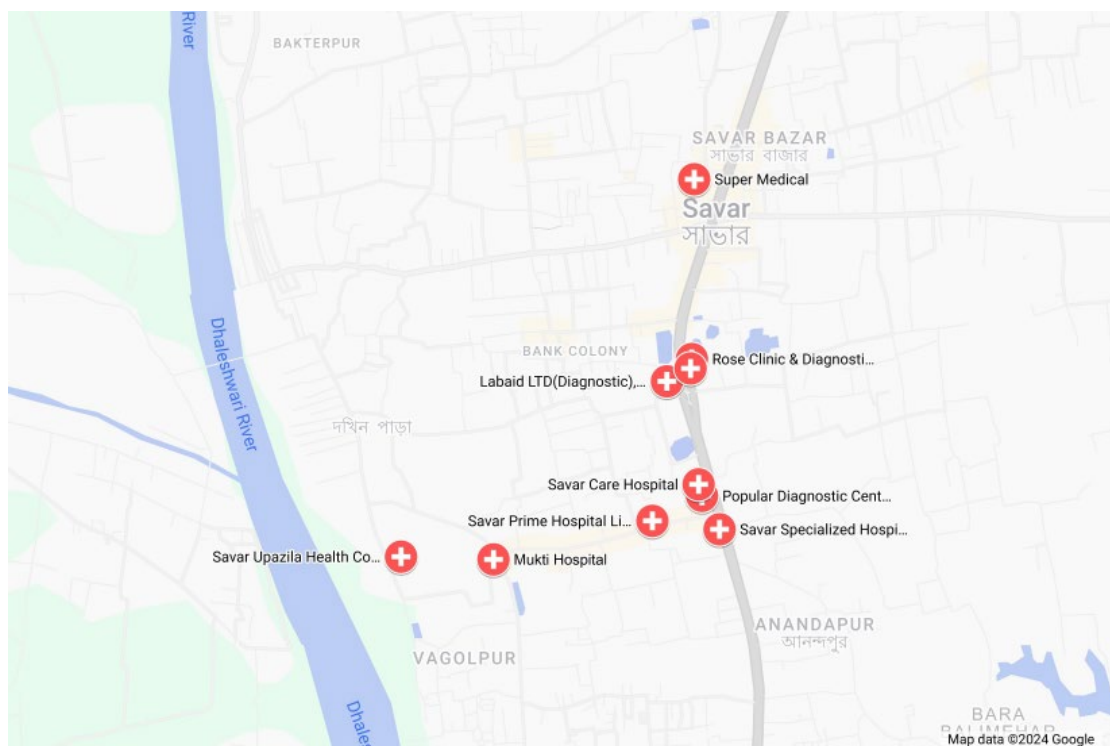


Figure 3.1 Study Area

3.4 Methods of Data Collection

A hybrid approach utilizing both primary and secondary data gathering methods is implemented to obtain extensive information on hazardous waste management procedures.

Primary data is gathered through:

1. **Field Surveys:** Structured questionnaires are distributed to hospital administration and pertinent workers to assess the current waste management processes.
2. **Key Informant Interviews:** Comprehensive interviews are done with hospital officials, waste management personnel, and cleaning staff to acquire an in-depth understanding of the techniques implemented, obstacles encountered, and prospective areas for enhancement.
3. **On-site Observations:** Direct observations are conducted at the hospitals to evaluate waste management, segregation, storage, and disposal processes.

3.5 Survey Questions

Questionnaire Survey for Authorized Person:

1. How much does it cost for waste disposal purposes?
2. What is the capacity of your hospital?
3. What are the regulations or guidelines governing hazardous waste management that the hospital must adhere to? How does the hospital ensure compliance with these regulations?
4. Have staff members received training on proper hazardous waste management practices?
5. What are the challenges or obstacles you faced in managing hazardous waste at the hospital?
6. What is your opinion or suggestions on how to improve the waste management system?
7. What disposal methods are used for hazardous waste?

Questionnaire Survey for Persons Responsible for Waste Handling:

1. How long have you been working at this hospital?
2. What types of medical services does the hospital provide?

3. What types of hazardous waste are generated in the hospital?
4. Can you estimate the daily/weekly/monthly volume of hazardous waste generated?
5. Are there specific procedures for handling different types of hazardous waste?
6. How many people works with you per day?
7. Are there specific procedures for handling different types of hazardous waste?
8. Where is hazardous waste stored before disposal?
9. How is hazardous waste transported from the hospital to the disposal site?
10. Who is responsible for arranging the transportation of hazardous waste?
11. What disposal methods are used for hazardous waste?
12. What are the main challenges or obstacles faced in managing hazardous waste at the hospital?
13. What are your suggestions for improvement or enhancing the hazardous waste management system?
14. What support or resources would be helpful in implementing these improvements?

3.6 Sampling Methodology

The study used a purposive sample method to pick hospitals that accurately represent the varied healthcare facilities in Savar Municipality. A total of 10 hospitals, comprising 1 public and 9 private institutions, are selected based on facility, size, service type, and waste generation volume. Data has been collected from almost 100 people from these hospitals. The sample size is considered adequate to reflect variations in waste management techniques among various hospital types.

3.7 Data Examination

The data analysis encompasses both quantitative and qualitative methodologies:

1. **Quantitative Analysis:** Statistical tools are employed to analyze survey data, revealing patterns, trends, and correlations in waste management practices.
2. **Qualitative Analysis:** Interview transcripts and observational notes are systematically coded and thematically analyzed to investigate the underlying factors affecting waste management efficiency and compliance.

3.8 Ethical Considerations

All participants are apprised of the study's objective and their rights to confidentiality and anonymity. Informed consent is secured prior to the execution of interviews and surveys. The research complies with ethical standards to uphold the dignity and rights of all participants.

3.9 Summery

This chapter's methodology offers a comprehensive framework for assessing hazardous hospital waste management in Savar Municipality. The mixed-methods approach guarantees a thorough evaluation of the current systems, emphasizing critical areas for enhancement to protect public health and foster environmental sustainability.

CHAPTER IV

RESULTS AND DISCUSSIONS

4.1 Introductions

This chapter delineates the data gathered throughout the research and offers a comprehensive analysis of the results. This chapter aims to methodically organize and analyze the data to address the research questions and fulfil the study's objectives. Quantitative data collected via structured questionnaires and qualitative insights gained from interviews and observations are analyzed to assess the current hospital waste management methods in Savar Municipality, Dhaka. The investigation identifies significant trends, patterns, and inconsistencies in waste management practices among various types of hospitals. This chapter seeks to deliver a thorough understanding of the strengths, limitations, and opportunities for enhancement in existing waste management systems by amalgamating numerical data with thematic insights.

4.2 Data Analysis

Table 4.2.1: Types of medical services does the hospital provide

What types of medical services does the hospital provide?				
Name of the Hospitals	Emergency room services.	Short-term hospitalization.	X-ray/radiology services/Laboratory services.	General and specialty surgical services/Blood services
Super Medical Hospital (Pvt) Ltd	☒	☒	☒	☒
LABZONE Consultancy Center	☒	☒	☒	☒
LABAID Ltd. (Diagnostics)	☐	☐	☒	☐
Rose Clinic & Diagnostic Center	☒	☒	☒	☒
Savar Prime Hospital Limited	☒	☒	☒	☒
Savar Care Hospital	☒	☒	☒	☒
Popular Diagnostic Centre Ltd. - Savar Branch	☐	☐	☒	☒
Savar Specialized Hospital	☒	☒	☒	☒
Mukti Hospital	☒	☒	☒	☒
Upozila Health Complex	☒	☒	☒	☒

Findings:

- **Emergency Room Services:** Most hospitals provide emergency room services, except LABAID Ltd. (Diagnostics) and Popular Diagnostic Centre Ltd.
- **Short-term Hospitalization:** Several hospitals offer short-term hospitalization services, while LABAID Ltd. (Diagnostics), and Popular Diagnostic Centre Ltd do not.
- **X-ray/Radiology/Laboratory Services:** All the listed hospitals provide these services.
- **General and Specialty Surgical Services/Blood Services:** All hospitals provide these services, except LABAID Ltd. (Diagnostics).

Table 4.2.2: Types of hazardous waste are generated in the hospital

What types of hazardous waste are generated in the hospital?				
Name of the Hospitals	Infectious waste/Sharps/Highly infectious waste	Pathological and anatomical waste	Hazardous pharmaceutical waste/Hazardous chemical waste	Radioactive waste
Super Medical Hospital (Pvt) Ltd	☒	☒	☒	☐
LABZONE Consultancy Center	☒	☒	☒	☐
LABAID Ltd. (Diagnostics)	☒	☒	☒	☐
Rose Clinic & Diagnostic Center	☒	☒	☒	☐
Savar Prime Hospital Limited	☒	☒	☒	☐
Savar Care Hospital	☒	☒	☒	☐
Ibn Sina Diagnostic & Consultation Center	☒	☒	☒	☐
Savar Modern Hospital	☒	☒	☒	☐
Mukti Hospital	☒	☒	☒	☐
Centre for the Rehabilitation of the Paralyzed (CRP)	☒	☒	☒	☐
Upozila Health Complex	☒	☒	☒	☐

Findings:

- **Infectious Waste/Sharps/Highly Infectious Waste:** Comprises objects contaminated with blood, bodily fluids, or other potentially infectious substances, including old bandages and syringes. All hospitals generate this type of waste.

- **Pathological and Anatomical Waste:** Comprises human tissues, organs, and body components excised during surgical procedures or autopsies. All hospitals generate this type of waste.
- **Hazardous Pharmaceutical Waste/Chemical Waste:** Comprises needles, syringes, and other sharp tools capable of inflicting injuries and transmitting diseases, chemicals from diagnostic and cleaning procedures, including disinfectants and solvent, outdated or unused drugs and contaminated pharmaceutical items.
- **Radioactive Waste:** None of the hospitals generate radioactive waste.

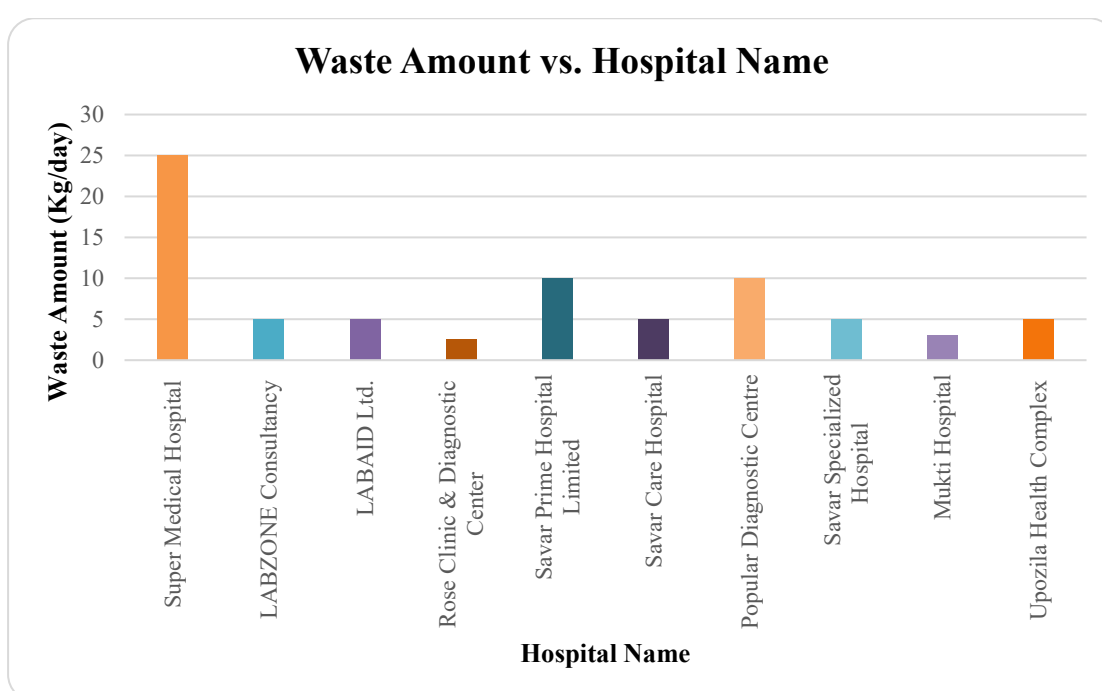


Figure 4.2.1: Maximum waste generated in a day in every hospital

Findings:

- The hospitals generating the most waste is **Super Medical Hospital (Pvt) Ltd** each with over 20 kg/day.
- **Savar Prime Hospital Ltd.** and **Popular Diagnostic Centre Ltd**, also produce relatively high amounts of waste, around 10 or more kg/day.
- **Super Medical Hospital**, despite having the most beds, generates comparatively less waste, approximately 10 kg/day.

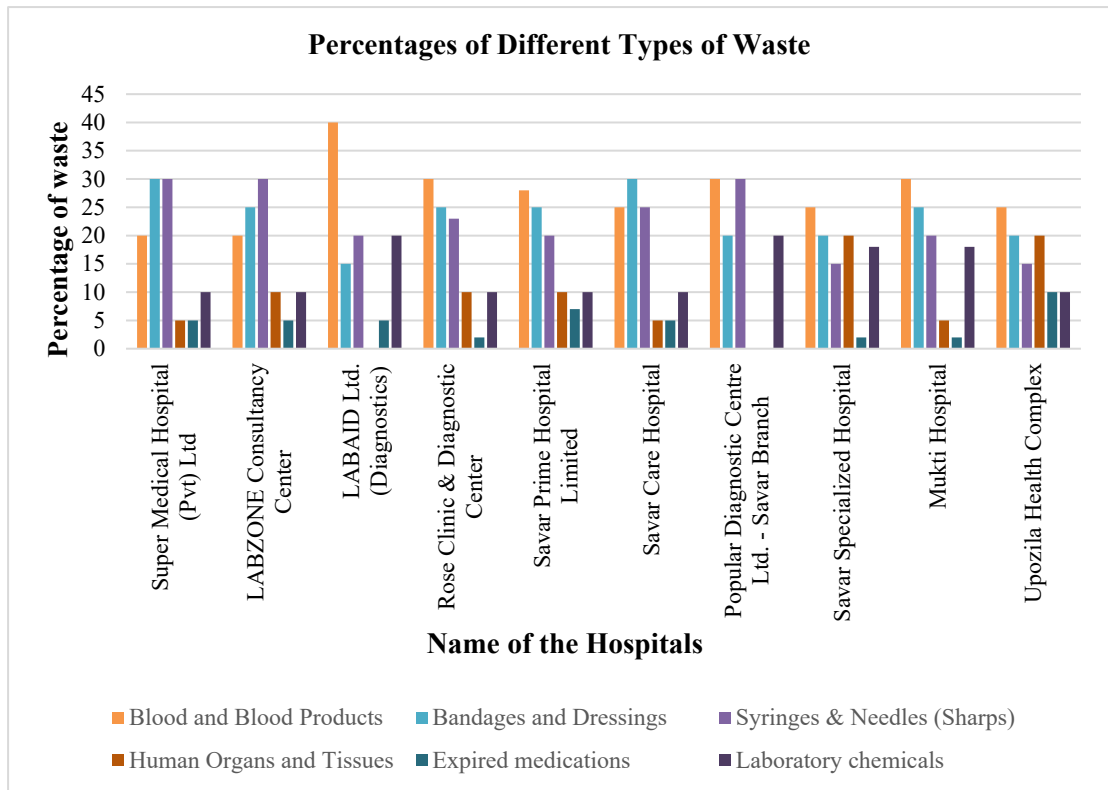


Figure 4.2.2: Percentages of Different Waste Types Within Total Hazardous Waste

Finding:

The graph shows percentages of different waste types within total hazardous waste generated in every hospital located in the Savar Municipality, Dhaka, Bangladesh.

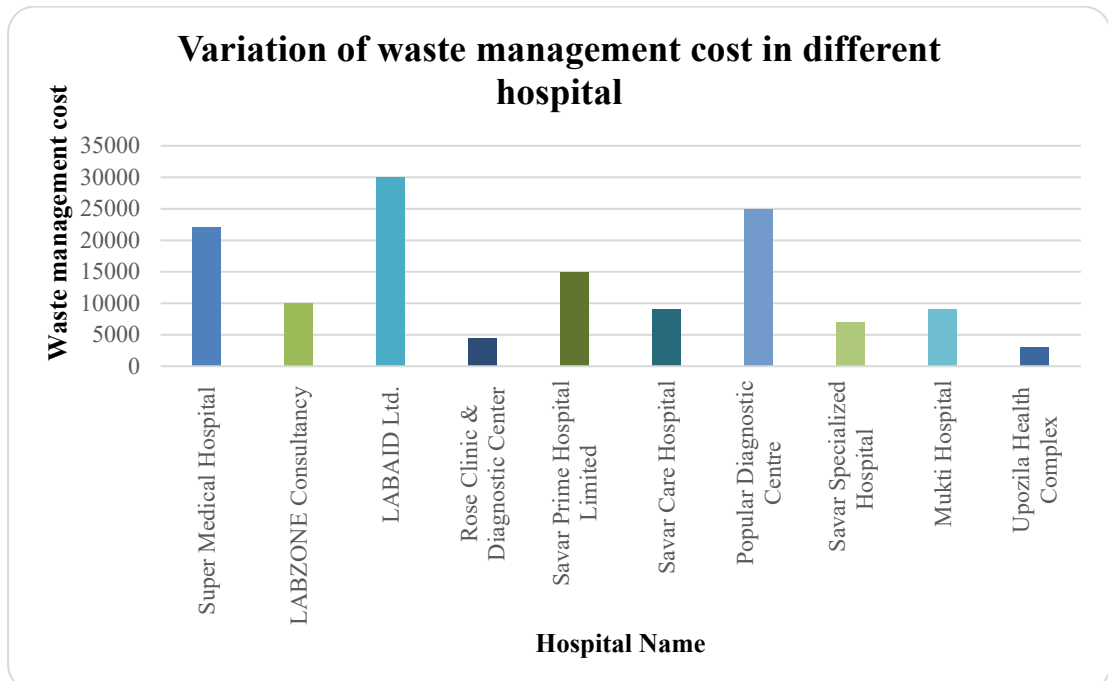


Figure 4.2.3: Hazardous waste management cost according to hospital

Findings:

- **Super Medical Hospital (Pvt) Ltd, LABAID Ltd. (Diagnostics) and Popular Diagnostic Centre Ltd.** have the highest waste management costs (above 20,000 BDT).
- **Rose Clinic & Diagnostic Center** and **Upazila Health Complex** have the lowest waste management costs (below 5,000 BDT).
- All other hospitals have moderate waste management costs ranging between 5,000 and 15,000 BDT.

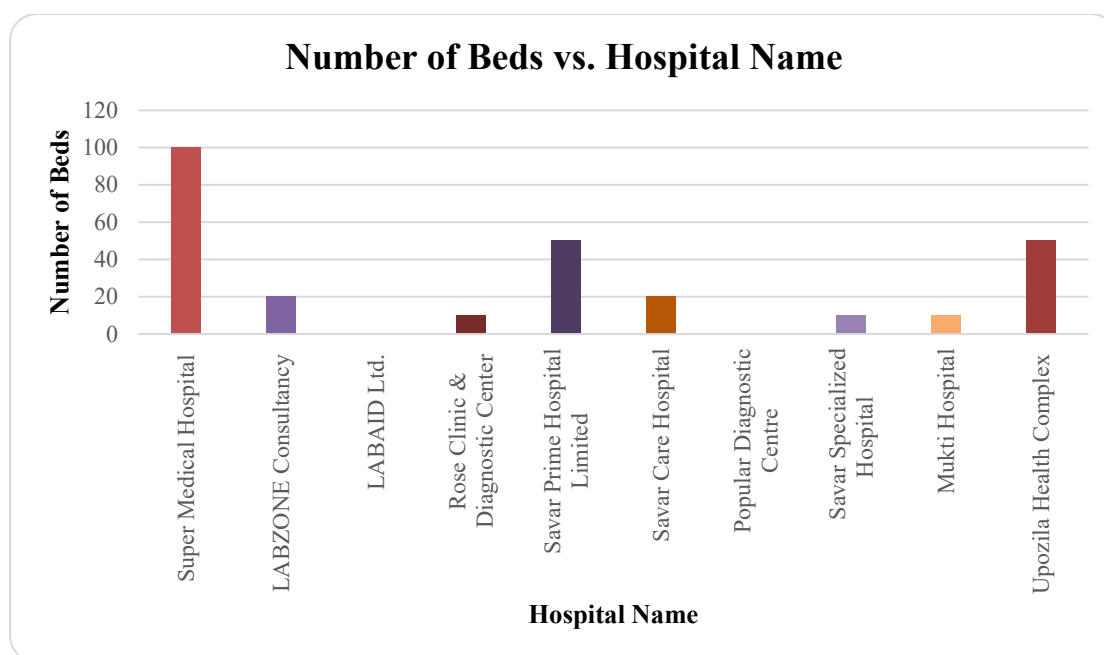


Figure 4.2.4: Number of beds in every hospital

Findings:

- **Super Medical** has the highest number of beds, around 100, significantly more than any other hospital.
- **LABZONE Co., LABAID Ltd., Rose Clinic**, and other hospitals have relatively fewer beds, ranging from 0 to around 50.
- **LABAID Ltd. (Diagnostics) and Popular Diagnostic Centre Ltd** have no beds as they are a consultancy center only.

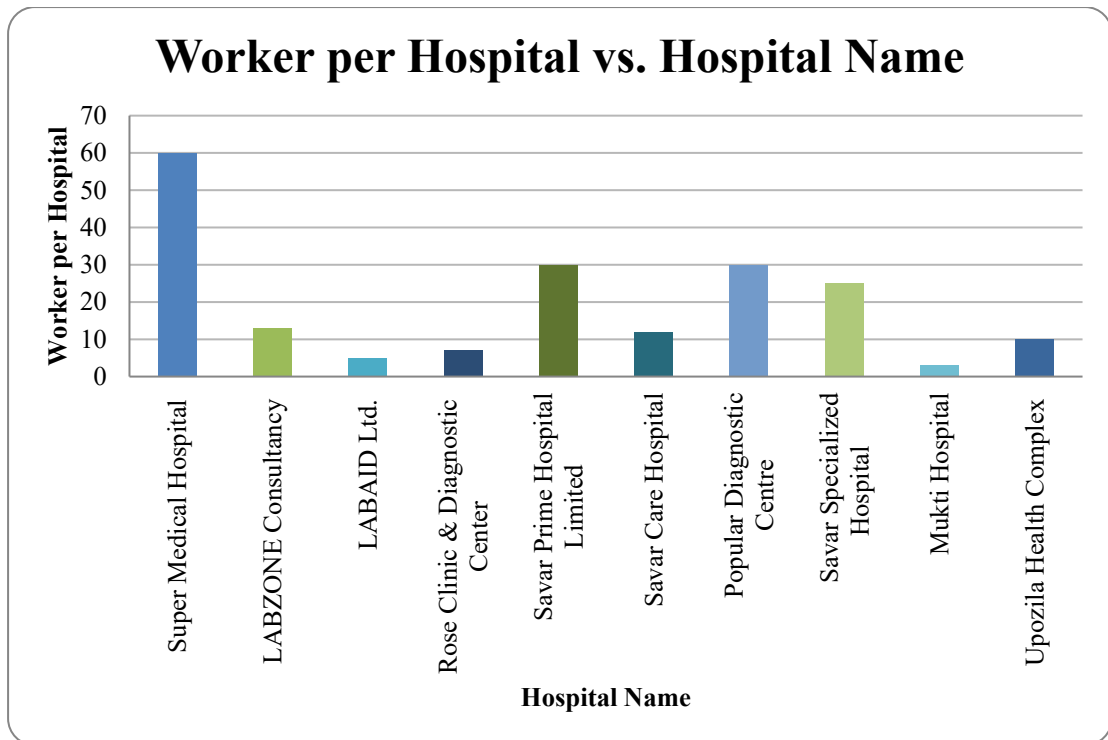


Figure 4.2.5: Number of health workers in every hospital

Findings:

- **Super Medical Hospital** has the highest number of workers per hospital, indicating it is likely a larger facility with more services and staff to accommodate patient needs.
- **LABZONE Consultancy** and **LABAID Ltd.** appear to have significantly fewer workers compared to Super Medical Hospital, suggesting these may be smaller facilities or focused more on specialized services rather than general hospital care.
- **Savar Prime Hospital Limited** and **Savar Care Hospital** have moderate numbers of workers, indicating they may serve a balanced patient load without the extensive staffing of larger hospitals.
- **Other hospitals** (e.g., Popular Diagnostic Centre, Savar Specialized Hospital, Mukti Hospital, and Upozila Health Complex) have varied worker counts, but all are lower than Super Medical Hospital, suggesting they may be smaller or specialized facilities.

4.3 Responsible party of hazardous waste disposal

PRISM Bangladesh (Project in Agriculture, Rural Industry, Science, and Medicine) is an organization engaged in the management of medical and hazardous waste in Bangladesh. PRISM has established waste management systems targeting medical waste from hospitals and clinics, predominantly in urban locales like Dhaka.

4.4 Methods Used for HHW management

➤ **Autoclaving (Sterilization):**

PRISM Bangladesh uses autoclaving as a principal approach for the treatment of infectious medical waste. This technique sterilizes trash through the application of high-pressure steam to eliminate microorganisms. Autoclaved garbage is frequently shredded subsequently to diminish volume prior to disposal in a landfill. Approximately 60-70% of infectious trash is processed with autoclaving, particularly for garbage that does not necessitate incineration.

➤ **Incineration (Thermal Treatment):**

PRISM further manages burning facilities for the treatment of hazardous and pathological waste, including human tissues, medicines, and sharps. Incineration is predominantly employed for garbage that cannot be disinfected or for materials that are significantly contagious or hazardous. Approximately 20-30% of hazardous medical waste undergoes incineration. This is often designated for highly pathogenic or hazardous substances.

➤ **Landfilling:**

Following autoclaving and incineration, non-infectious and inert leftovers are frequently disposed of in sanitary landfills. PRISM guarantees that the leftovers get treatment prior to landfill disposal to mitigate environmental effect. Approximately 10% of processed trash, classified as non-hazardous, is disposed of in landfills.

All information was collected from the PRISM Bangladesh Foundation website on 9th October 2024.

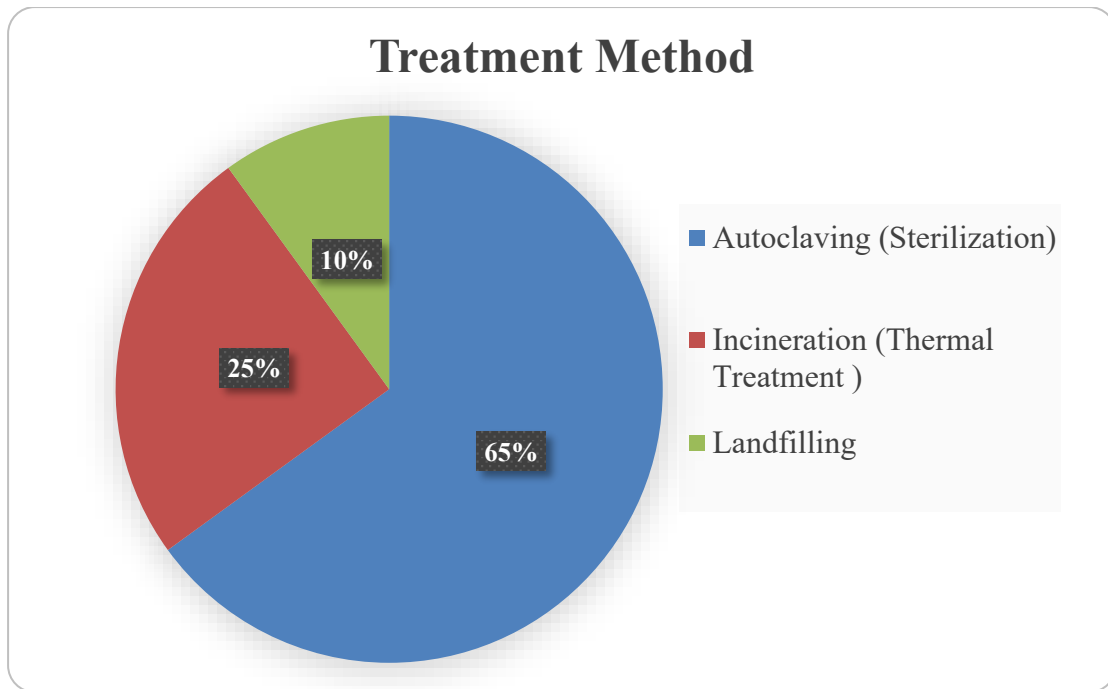


Figure 4.4.1: Percentages of used treatment methods of hazardous waste

4.5 Waste Collections:

Trained personnel collect clinical trash using a covered van equipped with an isolated container. They transport them to the waste disposal facility located at Matuail sanitary landfill. This institution employs six 3-ton vehicles and two specialized collection vehicles ranging from 1.5 to 2 tons for secure collection and transportation purposes. (PRISM Bangladesh, 2017).



Figure 4.5: Waste collection Covered VAN of PRISM Bangladesh

4.6 Storage Requirements or Precautions

Most hospitals utilize distinct bins for the prompt collection of hazardous trash. Nevertheless, although waste is generally collected on a regular basis, several hospitals do not implement a specialized long-term storage system for hazardous substances.

Waste is temporarily stored in these containers until it is transported for treatment or disposal.

4.7 Challenges according to hospitals authority

Table 4.7.1: Key Challenges according to hospitals authority

1. Lack of Awareness	Insufficient knowledge among healthcare workers and management regarding hazardous waste handling.
2. Inadequate Training	Limited training programs for staff on proper waste segregation, handling, and disposal techniques.
3. Poor Infrastructure	Insufficient facilities for waste treatment and disposal, leading to improper management practices.
4. Inefficient Waste Segregation	Failure to properly segregate hazardous waste from non-hazardous waste at the source, causing contamination.
5. Inconsistent Regulations	Lack of stringent enforcement of existing regulations and guidelines for hazardous waste management.
6. Limited Resources	Shortage of funding and resources for implementing effective waste management systems.
7. Transportation Issues	Unsafe and inefficient transportation of hazardous waste to disposal sites, increasing risks of exposure.
8. Environmental Concerns	Risks of environmental contamination due to improper disposal methods and lack of treatment facilities.
9. Community Resistance	Public opposition to waste treatment facilities due to perceived health and safety risks.
10. Political Will	Insufficient commitment from government authorities to prioritize hazardous waste management initiatives.

4.8 Training of stuffs

Hospitals frequently employ cleaners based on their experience or physical prowess, neglecting to authenticate their training credentials. In numerous instances, qualifications may not be verified before to recruiting. Upon hiring, hospital authorities generally furnish only a fundamental summary of waste management and segregation protocols. Nonetheless, compliance with these regulations is frequently inadequate, as numerous employees do not constantly adhere to the norms.

4.9 Summery

The survey conducted across multiple public and private hospitals in Savar, Bangladesh, highlighted significant deficiencies in hazardous waste management practices, revealing a gap between hospitals' claims of compliance with the Medical Waste Management and Processing Rules (2008) and their actual adherence. Many institutions exhibit a facade of compliance rather than genuine execution. A critical finding was the lack of training among cleaning and waste management personnel, with many employees reporting inadequate knowledge of proper waste segregation and handling protocols. This deficiency leads to the mixing of hazardous and non-hazardous waste, jeopardizing both efficiency and safety. Furthermore, hospitals typically do not dispose of hazardous waste directly but rely on PRISM Bangladesh, a contracted waste management firm. While this service collects waste daily, the lack of permanent storage solutions in hospitals creates potential vulnerabilities. Improper use of waste receptacles was also noted, with many personnel failings to follow segregation guidelines, which exacerbates health risks. A shortage of waste bins and high costs associated with acquiring them were additional challenges faced by hospitals.

Key challenges identified included a lack of awareness among healthcare staff, inadequate infrastructure for waste management, inconsistent enforcement of regulations, and financial constraints affecting access to treatment technologies. The study emphasizes that while a legislative framework exists for hazardous waste management, its implementation is inadequate, particularly in rural areas. The findings indicate an urgent need for the implementation of a 4-bin system for waste segregation, increased government investment in waste management technologies, enhanced training programs, and improved regulatory monitoring. Financial incentives for hospitals to optimize waste management procedures are essential for achieving sustainable hazardous waste management in Bangladesh

CHAPTER V

CONCLUSION AND RECOMMENDATION

5.1 Introduction

This chapter consolidates the results of the research on hazardous waste management procedures in hospitals located in Savar Municipality, Dhaka, Bangladesh. This section will conclude on the efficacy of existing waste management practices, delineate essential recommendations for enhancement, and suggest avenues for future research based on the thorough analysis provided in the preceding chapter. The objective is to tackle the issues associated with hazardous waste management, guaranteeing both health and environmental safety.

5.2 Conclusion

The categorization of medical waste in healthcare establishments within Savar Municipality identified a variety of hazardous waste forms, predominantly infectious waste (Syringes & Needles, Bandages and Dressings etc), pathological waste (Blood and Blood Products, Human Organs and Tissues etc), and hazardous pharmaceutical (Expired Medications) and chemical waste (Laboratory Chemicals). Although the majority of hospitals complied with fundamental waste segregation protocols, none were identified as producing radioactive waste. Private hospitals exhibited somewhat superior adherence in the classification and management of hazardous waste relative to public facilities. Nonetheless, irregular categorization and inadequate waste separation persist as considerable issues, highlighting the necessity for more stringent criteria and personnel training on appropriate trash classification.

The examination of the current medical waste management system revealed significant discrepancies between statutory standards and actual practices inside hospitals. All surveyed hospitals employ PRISM Bangladesh for garbage collection and treatment; nonetheless, inefficiencies were noted in the segmentation, storage, and transportation of hazardous waste. Common difficulties included infrastructure restrictions, insufficient personnel training, and inadequate enforcement of the Medical Waste Management and Processing Rules (2008). The results highlight the critical necessity for enhanced waste management systems, increased adherence to legislation, and the implementation of comprehensive training and oversight measures to protect public health and the environment.

5.3 Recommendations

Future research should focus on the following areas:

- Expand the study to include a larger number of hospitals for a more representative sample.
- Cover a broader geographic area to capture regional variations in waste management practices.
- Collect more comprehensive data to gain accurate insights into the current hospital waste management system.

Investigating these domains can enhance the understanding of hazardous waste management in healthcare environments and guide the formulation of appropriate policies and procedures.

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Appendix

Waste Treatment methods:

Treatment Method	Percent of waste
Autoclaving (Sterilization)	65
Incineration (Thermal Treatment)	25
Landfilling	10

Different Types of perimeters of every hospital:

Hospital Name	Waste management cost	Number of Beds	Waste Amount	Worker per Hospital
Super Medical Hospital (Pvt) Ltd	22000	100	25	60
LABZONE Consultancy Center	10000	20	5	13
LABAID Ltd. (Diagnostics)	30000	-	5	5
Rose Clinic & Diagnostic Center	4500	10	2.5	7
Savar Prime Hospital Limited	15000	50	10	30
Savar Care Hospital	9000	20	5	12
Popular Diagnostic Centre Ltd. - Savar Branch	25000	-	10	30
Savar Specialized Hospital	7000	10	5	25
Mukti Hospital	9000	10	3	3
Upozila Health Complex	3000	50	5	10

Percentages of Different Waste Types Within Total Hazardous Waste:

Name of the waste	Name of Hospitals									
	Super Medical Hospital (Pvt) Ltd	LABZONE Consultancy Center	LABAID Ltd. (Diagnostics)	Rose Clinic & Diagnostic Center	Savar Prime Hospital Limited	Savar Care Hospital	Popular Diagnostic Centre Ltd. - Savar Branch	Savar Specialized Hospital	Mukti Hospital	Upozila Health Complex
Blood and Blood Products	20	20	40	30	28	25	30	25	30	25
Bandages and Dressings	30	25	15	25	25	30	20	20	25	20
Syringes & Needles (Sharps)	30	30	20	23	20	25	30	15	20	15
Human Organs and Tissues	5	10	0	10	10	5	0	20	5	20
Expired medications	5	5	5	2	7	5	0	2	2	10
Laboratory chemicals	10	10	20	10	10	10	20	18	18	10
Total	100	100	100	100	100	100	100	100	100	100

Some Pictures During Survey



Figure 1: Site visit at PRISM Bangladesh Foundation medical waste treatment plant.



Figure 2: Questionary survey with Director of Savar Specialized Hospital.



Figure 3: Poor segregation of waste outside of Savar Care Hospital.



Figure 4: Non-hazardous waste collected by municipality worker from LABZONE Consultancy Center.



Figure 5: Waste collected by PRISM Bangladesh Foundation from different hospitals.

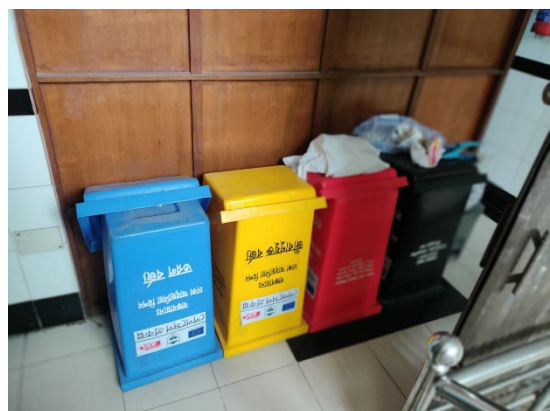


Figure 6: Unused bins.

