Development Of a Sustainable Financing Model for Medical Waste Management in Health Care Facilities. A Case Study of Mashonaland Central, Zimbabwe. Develop a Sustainable Financing Model for Medical Waste Management in Health Care Facilities. A Case Study of Mashonaland Central, Zimbabwe 2024.

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ABSTRACT

Background: Healthcare waste management in Mashonaland Central, Zimbabwe, faces significant challenges due to inadequate financing mechanisms, with only 3% of facilities having proper incinerators and 88% lacking adequate infrastructure.

Objective: To develop a sustainable financing model for medical waste management in healthcare facilities in Mashonaland Central, Zimbabwe.

Methods: A mixed-methods approach was employed, combining quantitative surveys and qualitative interviews across 33 healthcare facilities. Data was analysed using a weighted scoring model to evaluate different financing options.

Results: The study revealed that Extended Producer Responsibility (45%), donor funding (16%), and government funding (14%) were the most viable financing sources. Current challenges include insufficient infrastructure (88%), limited waste treatment facilities (67%), and equipment shortages (71%).

Conclusion: For sustainable healthcare waste management in Mashonaland Central, a hybrid financing model combining multiple funding sources, with emphasis on Extended Producer Responsibility and increased government funding, is recommended.

Keywords: Healthcare waste management, sustainable financing, Extended Producer Responsibility, Zimbabwe, medical waste disposal

INTRODUCTION OF THE CHAPTER

Introduction

Healthcare waste management is a critical public health concern, with approximately 15% of medical waste being hazardous and requiring specialized disposal methods ("World Health Organization (WHO)," n.d.). While developed nations have established robust financing mechanisms for waste management, developing countries struggle with sustainable funding models, particularly for hazardous medical waste disposal.

In Zimbabwe's Mashonaland Central province, this challenge is especially acute. The province's public health facilities operate with just one functional incinerator at 40% capacity, down from ten pre-COVID-19 incinerators. Site support visits to 23 healthcare facilities in 2023 revealed alarmingly low coverage rates for essential waste management indicators: only 4% had national budget allocation for waste management, 17% had local budget

provisions, and 30% had functional incinerators. Furthermore, 91% of facilities lack proper on-site waste treatment capabilities, forcing reliance on inadequate burning (burners) methods rather than thermo-regulated high-temperature incineration.

While previous studies have examined healthcare waste management in developing countries, there is limited research on sustainable financing models specifically tailored to Zimbabwe's healthcare context. This study addresses this gap by developing a context-specific financing model for Mashonaland Central, considering local resources, infrastructure constraints, and regulatory frameworks. The proposed model aims to provide practical solutions for both immediate operational funding needs and long-term infrastructure development, ultimately contributing to improved public health outcomes and environmental protection in the province.

Background of the study

Mashonaland Central province, located in northern Zimbabwe, has a population of 1,384,891 as of the 2022 census (Population & Housing Census - Zimbabwe Data Portal, 2022.) The province's healthcare infrastructure comprises 136 government clinics, 8 government hospitals (6 district and 2 rural), 5 mission hospitals, and 1 provincial hospital.

Before COVID-19 pandemic, the province maintained ten functional incinerators across district and mission hospitals. However, as of January 2024, only one public incinerator remains operational at Chimhanda hospital, functioning at 40% capacity (Mashonaland Central: 2nd & 3rd Quarter (2023) HCWM and IPC Site Support and Supervision Checklist and Responses, 2023.).

The province generates significant medical waste through various healthcare activities. In 2022, these included: 282,863 vaccinations (BCG, DPT, measles rubella, Pentavalent, Pneumococcal, and Rota virus), 122,160 malaria diagnostic tests, 38,481 institutional deliveries, 171,340 HIV tests and 9,565 TB screenings (Ministry of Health and Childcare, 2019)

According to WHO guidelines, approximately 15% of this healthcare waste is infectious and requires proper disposal ("World Health Organization (WHO)," 2023.). Without a sustainable financing model for medical waste management, this infectious waste poses significant risks to public health and environmental safety through potential contamination of water bodies and public spaces.

Statement of the problem

Healthcare waste management (HCWM) in Mashonaland Central Province faces critical challenges in infrastructure and financing. An assessment of 23 healthcare facilities revealed severely low coverage rates across key indicators: national budget allocation (4%), local budget allocation (17%), incinerator availability (30%), and on-site waste treatment (9%). Of facilities conducting on-site treatment, 100% rely on non-thermo-regulated burners rather than standard incinerators capable of reaching 1100°C, posing significant environmental and health risks (Ministry of Health and Childcare, 2019).

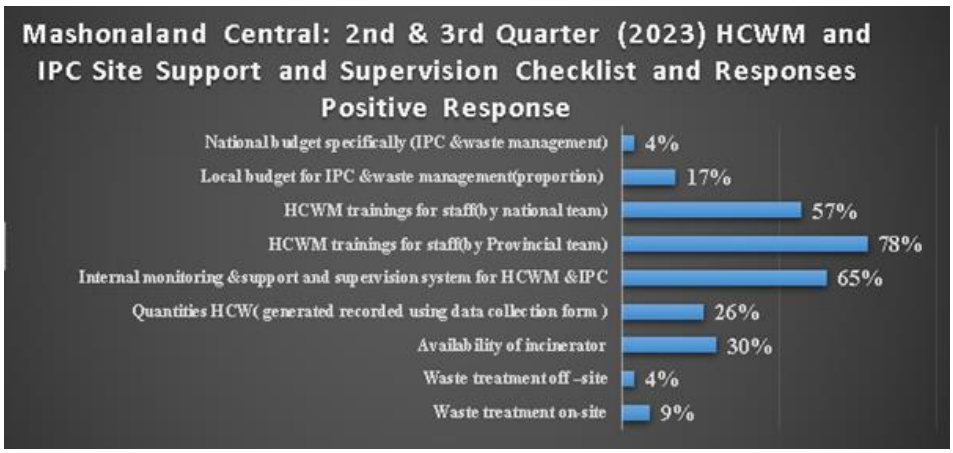

Figure 1.1: Healthcare Waste Management and IPC Site Support Assessment Results (2nd & 3rd Quarter 2023)

Source: (Mashonaland Central: 2nd & 3rd Quarter (2023) HCWM and IPC Site Support and Supervision Checklist and Responses, 2023.). (Data collected from 23 healthcare facilities - Assessment based on 31 standard indicators - Coverage percentages indicate compliance with national standards)

The province's waste treatment capacity has drastically declined from ten functional incinerators pre-COVID-19 to just one public incinerator operating at 40% capacity as of January 2024. This infrastructure deficit, coupled with inadequate financing mechanisms, has created a critical gap in medical waste disposal, particularly for sharps waste and vaccination vials. The absence of a sustainable financing model threatens public health and environmental safety, necessitating immediate intervention to ensure proper healthcare waste management across the province's 150 healthcare facilities.

Justification

The development of a sustainable financing model for healthcare waste management (HCWM) in Mashonaland Central is critical for four key reasons:

Public Health Protection

Health-care waste contains potentially harmful microorganisms that can infect hospital patients, health workers, and the general public. Other potential hazards may include drug-resistant microorganisms that spread from health facilities into the environment. A sustainable financing model would ensure the consistent implementation of proper waste handling protocols, reducing disease transmission risks.

Environmental Sustainability

Current waste disposal practices, including open burning and improper burial, contribute to environmental degradation through soil contamination and air pollution (United Nations Environment Programme [UNEP], 2023). Mashonaland Central's agricultural economy depends on maintaining environmental integrity, making proper waste management crucial for economic sustainability.

Regulatory Compliance

Healthcare facilities must comply with Zimbabwe's Public Health Act (15:17) Section 113, which mandates proper healthcare waste management (“PUBLIC HEALTH ACT [CHAPTER 15:17] | veritaszim,” 2018.). This study will help facilities meet these legal requirements through sustainable financing mechanisms.

Economic Efficiency

Structured financing for waste management can reduce long-term healthcare costs by preventing environmental remediation expenses and public health emergencies (“What a Waste 2.0 : A Global Snapshot of Solid Waste Management to 2050,” 2023.). Additionally, proper waste management systems can improve operational efficiency and resource allocation in healthcare facilities.

Hypothesis

H_0: Current financing methods for healthcare waste management (HCWM) in Mashonaland Central healthcare facilities are adequate and sustainable.

H_1: Current financing methods for healthcare waste management in Mashonaland Central healthcare facilities are inadequate and unsustainable.

Main objective

To develop a sustainable financing model for healthcare waste management in Mashonaland Central healthcare facilities.

Specific objectives

1. To evaluate current HCWM financing practices in Mashonaland Central healthcare facilities
2. To analyse successful HCWM financing models from comparable developing regions
3. To assess stakeholder perceptions of the proposed financing model's feasibility
4. To design a context-specific financing model for Mashonaland Central healthcare facilities

Research questions

1. What financing mechanisms currently support HCWM in Mashonaland Central healthcare facilities?
2. How effective are existing HCWM financing methods in meeting facility needs?
3. What elements should be included in a sustainable HCWM financing model specific to Mashonaland Central's context?
4. Which successful HCWM financing models from other regions could be adapted for Mashonaland Central?

LITERATURE REVIEW

Financing model

The management of healthcare waste requires structured financing frameworks to ensure sustainable operations. According to the World Bank (2023), global waste generation is projected to increase by 73% to 3.88 billion tonnes by 2050, with approximately one-third currently managed unsustainably. This growing challenge necessitates robust financing models, particularly in resource-limited settings. Healthcare facilities typically employ various financing mechanisms, including user fees, extended producer responsibility, public-private partnerships, and government subsidies (“Health financing,” n.d.) .

Evidence from Global Implementation

Public-Private Partnerships (PPPs)

Public-private partnerships have demonstrated significant potential in healthcare waste management across developing nations. Yeboah-Assiamah et al. (2017) documented improved waste collection coverage in Ghana through PPP initiatives, while similar partnerships in India led to enhanced technological adoption in solid waste management systems. However, these implementations revealed critical limitations. Studies by Kumar et al. (2021) highlighted transparency issues and inadequate oversight as primary concerns, emphasizing the need for detailed contract specifications and comprehensive stakeholder engagement protocols.

User Fees

The implementation of user fees represents a significant alternative to traditional tax-based funding in African healthcare systems. Gilson (2019) notes that user fees can generate sustainable operational funds for waste management activities. However, James et al. (2006) argue that these fees often create accessibility barriers for economically disadvantaged populations. Lagarde and Palmer (2018) further demonstrate that the effectiveness of user fee systems varies significantly based on local economic conditions and social contexts.

Extended Producer Responsibility (EPR)

EPR programs have shown promising results in several developing nations. In India, the Central Pollution Control Board's EPR guidelines have successfully regulated medical device waste management (Bhadra & Mishra, 2021).

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South Africa's implementation of the National Environmental Management Waste Act 59 of 2008 demonstrates effective pharmaceutical waste management through extended producer responsibility (Nahman, 2010). These programs have effectively promoted resource conservation and environmentally conscious practices by shifting responsibility to manufacturers and importers.

Current State in Mashonaland Central, Zimbabwe

Zimbabwe's healthcare waste management system operates without a nationally structured financing model. The National Health Strategy 2021-2025 acknowledges significant gaps in equipment inventory and maintenance planning, with many health institutions lacking functional waste disposal facilities ("National Health Strategy For Zimbabwe (2021 - 2025).

Government Initiatives

While the government has attempted to address healthcare infrastructure needs through the Targeted Approach Programme, which disbursed US$107 million between 2009 and 2014, specific allocations for waste management remain undefined (Parliament of Zimbabwe, 2016). The program primarily benefited central and provincial hospitals, but data on waste management expenditure is limited.

International Support

International organizations have played a crucial role in filling financing gaps. UNDP has invested in pharmaceutical waste infrastructure, constructing specialized incinerators at regional and central levels (UNDP, 2022). Cordaid's involvement in COVID-19 response led to the processing of 3,619.20 kg of vaccine-related waste in 2023 (Provincial Medical Directorate Vaccine Waste Management Reports, 2023). The Global Fund has supported specific programs like Indoor Residual Spraying waste management, processing 10,836 kg of medical waste in 2022-2023 (Provincial IRS Reports, 2023).

Mission Hospital Support

Mission hospitals have leveraged diverse funding sources, including private donations through organizations like Better Healthcare for Africa (BHA) and international development agencies. The Italian Agency for Cooperation and Development's donation of waste treatment equipment to Luisa Guidotti Hospital exemplifies such support (Newster System S.r.l., 2018)

MATERIALS AND METHODS

Research Design

A mixed-methods approach was employed, combining quantitative and qualitative data collection techniques. The convergent parallel design allowed for simultaneous collection of both data types, providing comprehensive insights into healthcare waste management (HCWM) financing (Creswell and Creswell, 2019). This approach enabled triangulation of findings and enhanced the validity of the proposed financing model.

Study Area

The research was conducted in Mashonaland Central Province, Zimbabwe, covering eight administrative districts. The province contains 150 healthcare facilities, including district hospitals, mission hospitals, and rural health centres.

Target Population

The study population comprised healthcare facilities in Mashonaland Central Province, including: 9 Government hospitals, 5 Mission hospitals and 136 Rural Health Centers/Clinics. Key informants included facility managers, environmental health technicians, and finance officers.

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Sample Size and Sampling Technique

Sample Size Determination

The study utilized the "10+3" rule for sample size determination

Table 3.1: "10+3" Rule of Thumb Application for Sample Size Determination

Predictor variable	No. of levels	Levels
Type of healthcare facility	3	clinic, government hospital, mission hospital
Funding source	3	government, private, NGO
Level of care provided	3	primary, secondary, tertiary
Total predictor variables	3	

Source: Research Methodology, 2024 (Predictor variables: Facility type, funding source, level of care. Base sample (10 per predictor) + 3 additional for interactions - Stratified sampling applied to ensure representation)

Statistical Power Analysis:

The rule ensures a minimum of 10 observations per predictor variable. With 3 predictor variables (facility type, funding source, level of care), this yields a base sample of 30. An additional 3 observations account for potential interaction effects. This approach achieves a statistical power of 0.80 at $\alpha = 0.05$ for detecting medium effect sizes (Cohen's $f^2 = 0.15$)

Validation from Previous Studies:

Harrell et al. (1996) demonstrated that 10 events per predictor variable minimizes estimation bias, while Green (1991) established that $N \geq 50 + 8m$ (where m is the number of predictors) for multiple regression. Our sample size (N=33) meets these criteria for 3 predictors in resource-limited settings

Practical Considerations:

- Population size: 150 healthcare facilities in Mashonaland Central
- 33 facilities represent 22% of the total population
- Stratified sampling ensures proportional representation
    - Clinics: 91% of sample
    - Government hospitals: 6% of sample
    - Mission hospitals: 3% of sample

Statistical Reliability:

- Confidence Level: 95%
- Margin of Error: ±10%
- Expected Response Rate: >90%

Resource Optimization:

- Balances statistical rigor with resource constraints
- Enables comprehensive data collection within time and budget limitations
- Allows for detailed qualitative assessment alongside quantitative analysis

Sampling Technique

Stratified random sampling ensured proportional representation of Clinics (91%), Government hospitals (6%) and Mission hospital (3%)

Data Collection Methods

Quantitative Data

Structured questionnaires (n=33)

DATA COLLECTION PLAN

Materials and Methods

Survey Questionnaire

A self-administered questionnaire was developed and distributed to healthcare facilities in Mashonaland Central, Zimbabwe, to gather data on current medical waste management practices, financing mechanisms, and challenges. The questionnaire was piloted to ensure validity and reliability.

Key Informant Interviews

In-depth interviews were conducted with healthcare professionals, facility managers, and government officials to gather more detailed information on the current medical waste management practices, financing mechanisms, and challenges in the province.

Observations

Direct observations were made to assess the existing infrastructure, equipment, and waste management practices in healthcare facilities. This helped in identifying areas for improvement and optimization.

Variables

The study considered various variables related to medical waste management, including waste segregation practices, waste treatment methods, cost of waste management, and financing mechanisms.

Data Analysis

The collected data was analysed to identify the current gaps and challenges in medical waste management in Mashonaland Central. The analysis focused on identifying the financial constraints and inadequate infrastructure that hinder proper waste management practices. This provided insights into the specific areas that need to be addressed in the sustainable financing model.

The obtained data was analysed using EpiData and Excel to respond to the research hypothesis. The following steps were followed for data analysis:

Data Cleaning

The collected data was checked for completeness, accuracy, and consistency. Any missing or erroneous data was addressed through data cleaning procedures.

Descriptive Analysis

Descriptive statistics, such as means, frequencies, and percentages, were calculated to summarize the data and provide an overview of the current state of medical waste management in healthcare facilities.

Development of the Sustainable Financing Model

Based on the analysis of the data, a sustainable financing model was developed. The model proposed mechanisms for funding the proper collection, quantification, and disposal of medical waste in healthcare facilities. It considered the financial constraints and infrastructure limitations in Mashonaland Central, aiming to ensure the long-term sustainability of waste management practices.

Ethical Considerations

The research was conducted in accordance with ethical principles, including:

1. **Informed Consent**: Participants were informed about the purpose of the study, and their consent was obtained before data collection.
2. **Confidentiality**: The data collected was kept confidential and anonymous.
3. **Anonymity**: The data collected was anonymized to protect the identities of participants.

RESULTS AND DISCUSSIONS

Facility and Participant Demographics

The study surveyed 33 healthcare facilities across Mashonaland Central, with the following distribution:

- Clinics: 91% (n=30)
- Government hospitals: 6% (n=2)
- Mission hospitals: 3% (n=1)

Participant demographics showed diverse representation across healthcare professions, with nurses comprising the largest group (45%), followed by environmental health technicians (35%), and other healthcare workers (20%). Gender distribution was relatively balanced, with 52% female and 48% male respondents.

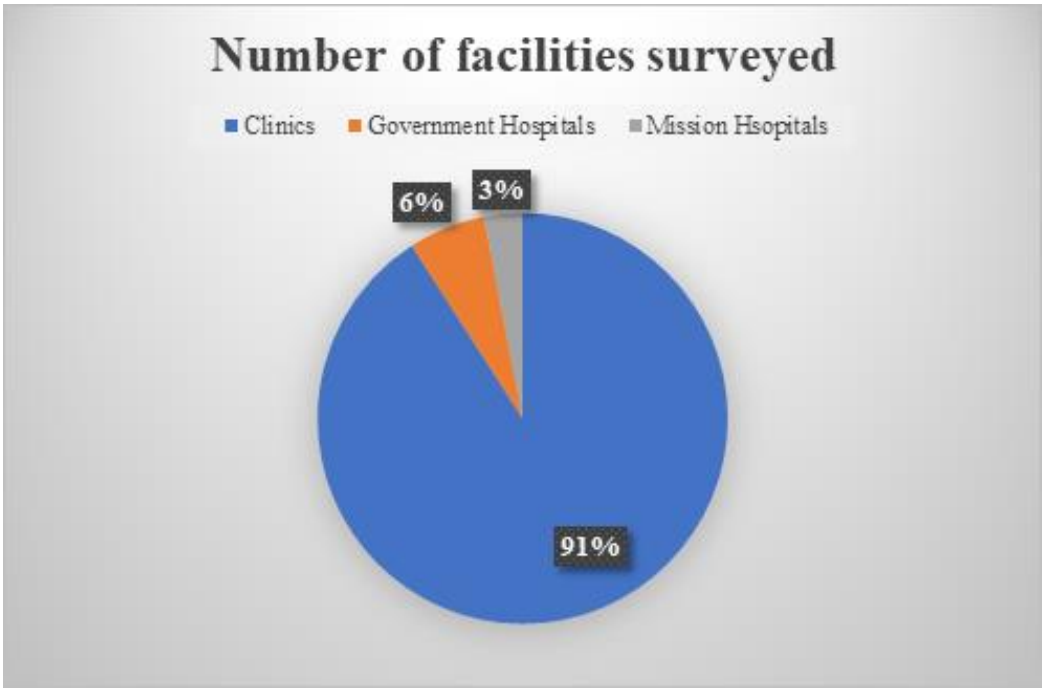

Figure 4.1: Distribution of Healthcare Facilities by Type in Mashonaland Central Province, Zimbabwe (N=33)

Source: Survey Data, 2024 (Data collected from 30 clinics, 2 government hospitals, and 1 mission hospital)

Participant Information

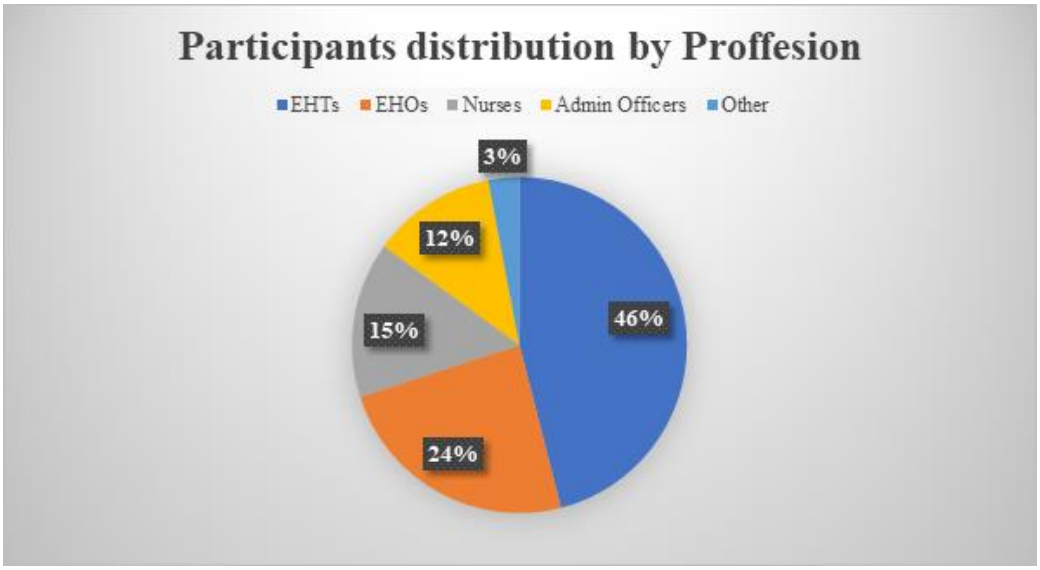

Figure 4.2: Healthcare Worker Distribution by Professional Category in Mashonaland Central Healthcare Facilities (N=33)

Source: Survey Data, 2024 (Categories include nurses, environmental health technicians, Environmental Health Officers, Admin Officers and Others)

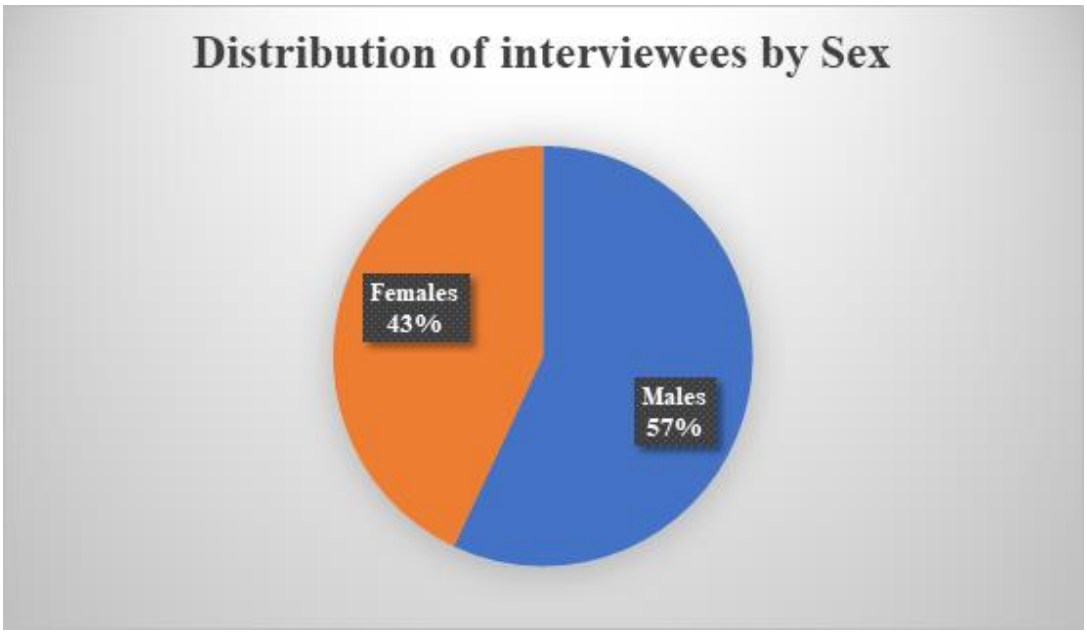

Figure 4.3: Gender Distribution of Healthcare Workers Involved in Waste Management (N=33)

Source: Survey Data, 2024 (Data represents staff directly involved in waste management activities)

Current HCWM Practices and Challenges:

The survey revealed that 92% of healthcare facilities are practicing waste segregation at the source, indicating their commitment to proper waste management, as shown below. However, a considerable proportion reported inadequate waste treatment infrastructure, storage and disposal facilities, and insufficient funding. These findings highlight the existing challenges that hinder sustainable waste management practices in the province.

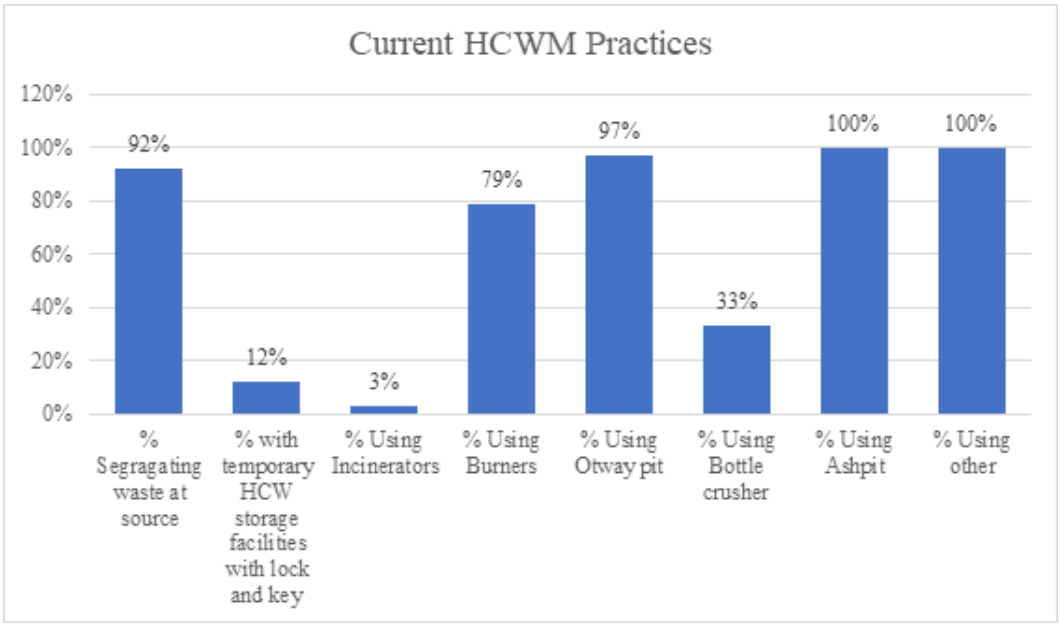

Figure 4.4: Current Healthcare Waste Management Practices in Mashonaland Central Facilities (N=33)

Source: Survey Data, 2024 (Practices assessed include waste segregation, storage, and disposal methods)

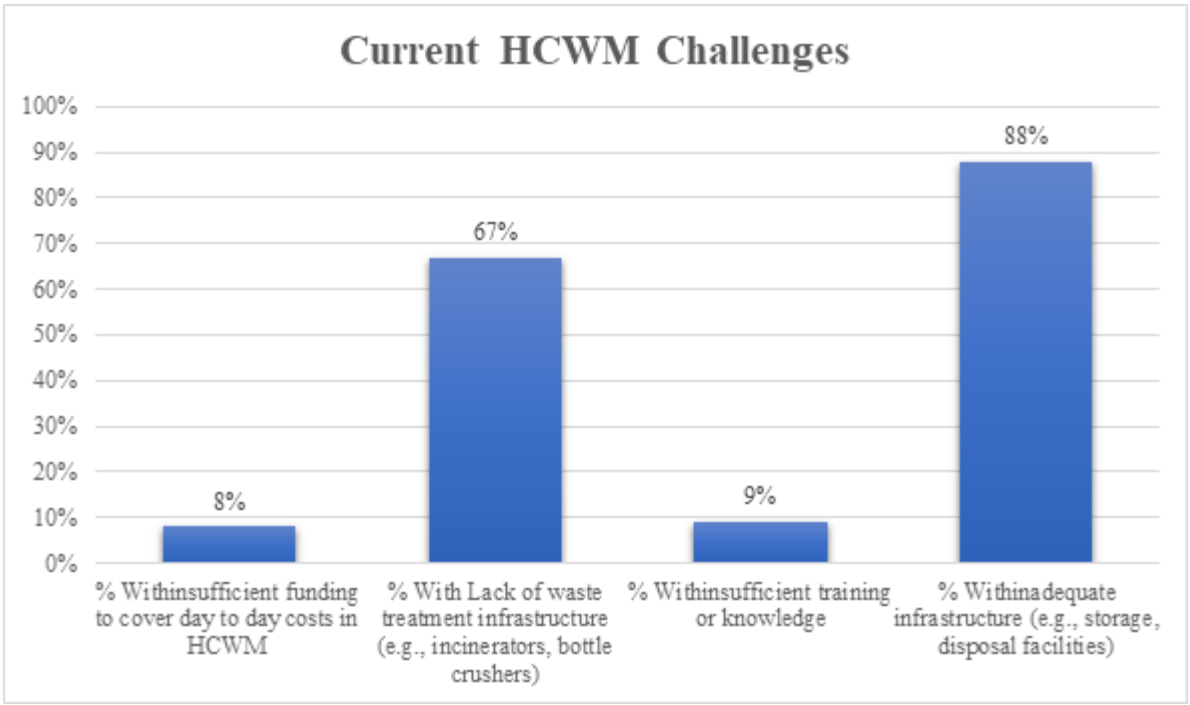

Figure 4.5: Healthcare Waste Management Challenges Reported by Facilities (N=33)

Source: Survey Data, 2024 (Multiple responses were allowed per facility)

Current Financing Practices

Respondents indicated a variety of funding sources for medical waste management, including Government funding, Result-Based Financing (RBF), Private Sector Investment, Public-Private Partnerships, Donor funding, Extended Producer Responsibility and User fees. However, there were mixed opinions on the adequacy of current financing practices for sustainable waste management. While some participants believed the current funding sources were adequate, others expressed concerns about the insufficiency of funds for day-to-day costs and the lack of necessary waste treatment infrastructure.

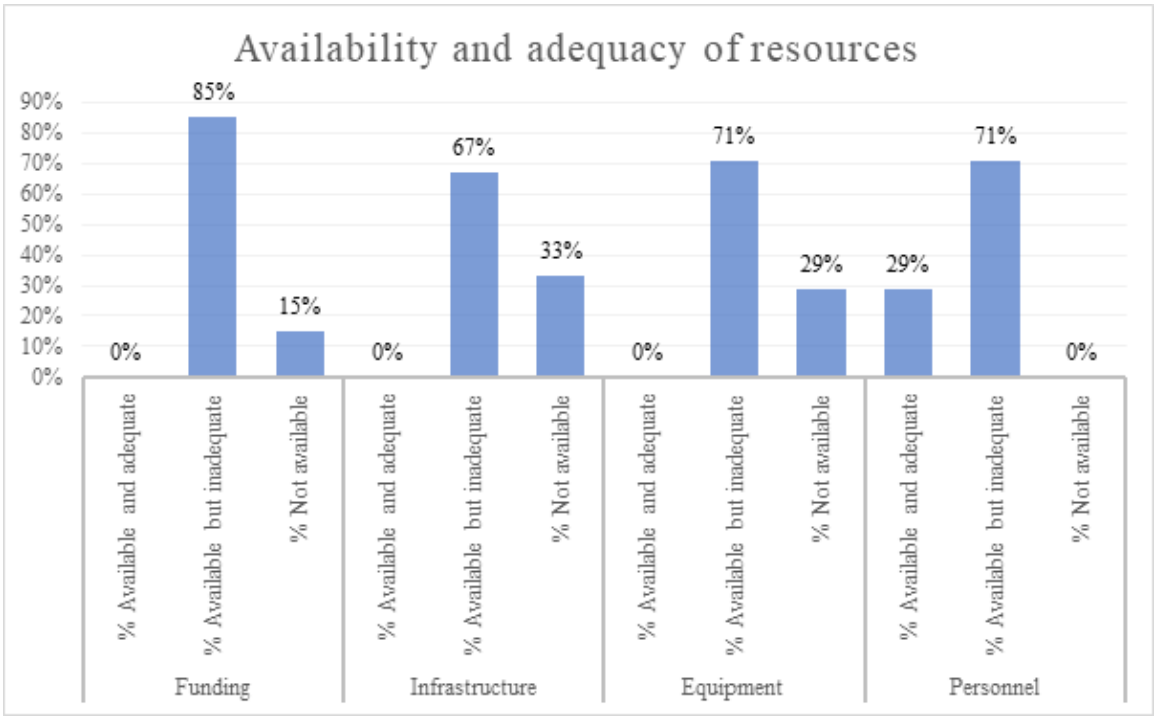

Figure 4.6: Resource Availability and Adequacy Assessment in Healthcare Facilities (N=33)

Source: Survey Data, 2024 (Resources evaluated include funding, infrastructure, equipment, and personnel).

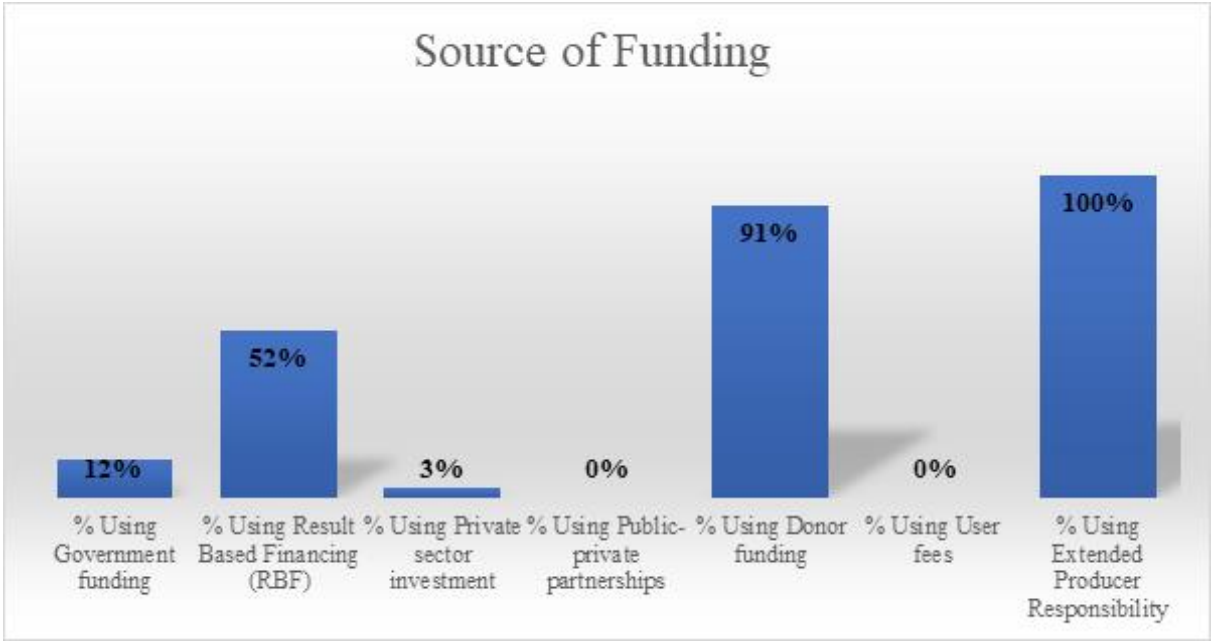

Figure 4.7: Current Sources of Healthcare Waste Management Funding in Mashonaland Central (N=33)

Source: Survey Data, 2024 (Multiple funding sources per facility were recorded - Percentages indicate proportion of facilities utilizing each funding source)

When asked about their recommended funding sources and mechanisms for sustainable waste management, respondents expressed a preference for a combination of government funding, result-based financing, private sector investment, Extended producer responsibility and donor funding. These sources were perceived as potentially effective in addressing the challenges of medical waste management in healthcare facilities in Mashonaland Central. However, there were varying opinions on the feasibility of these proposed financing options, with some respondents expressing confidence in their viability while others remained uncertain.

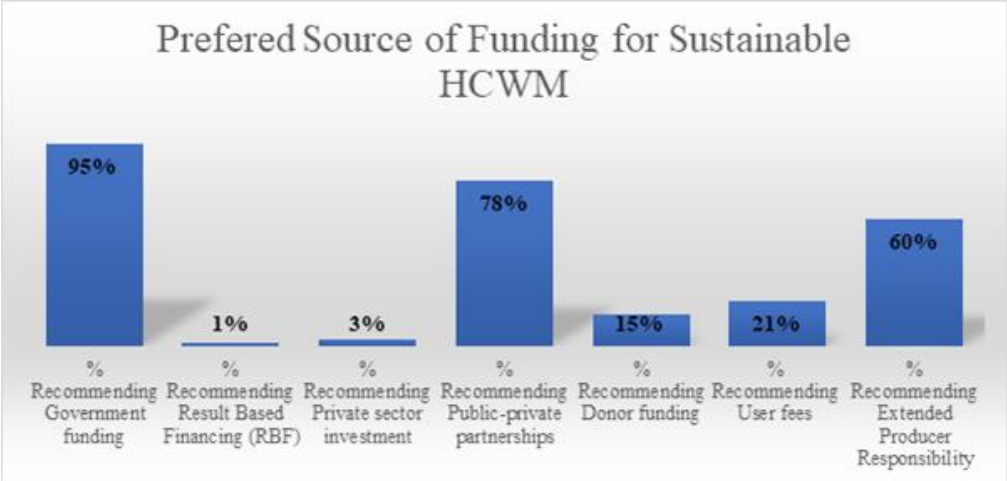

Figure 4.8: Preferred Sources of Funding for Sustainable Healthcare Waste Management (N=33)

Source: Survey Data, 2024 (Respondents could select multiple preferred funding sources - Rankings based on stakeholder preferences and feasibility assessments)

Weighted Scoring Model

To determine the appropriate funding allocation for various attributes of healthcare waste management, a weighted scoring model was utilised. The model considered the significance of each attribute based on their respective percentages and feasibility ratings. The following steps were followed:

a. Assign weights to each attribute based on their percentages
b. Calculate the weighted score for each attribute
c. Identify funding sources and their respective percentages
d. Allocate funding based on the weighted scores
e. Multiply the weighted score for each attribute by the respective funding percentage. This will determine the appropriate funding allocation for each attribute. Funding allocation = (Weighted score) * (Funding percentage)

Decision Matrix: A Weighted Scoring Model

Table 4.1: Decision Matrix - Weighted Scoring Model for Healthcare Waste Management Attributes in Mashonaland Central Healthcare Facilities

Decision Matrix: A Weighted Scoring Model				
Attribute	**Feasibility** (Yes (1) or No (0))	**Availability in Healthcare facilities** (0-1)	**Importance-** (1-10)	**Weighted Score** (Feasibility x availability x importance)
Segregating waste at source	**1**	**0.92**	**10**	**9.2**
Temporary storage facilities	**1**	**0.12**	**8**	**0.96**
Incinerator (with fan and thermo-regulator)	**1**	**0.3**	**10**	**3**
Burner	**1**	**0.79**	**5**	**3.95**
Otway pit	**1**	**0.97**	**2**	**1.94**
Bottle crusher	**1**	**0.33**	**1.5**	**0.495**
Ashpit	**1**	**1**	**10**	**10**

Source: Analysis of Survey Data, 2024

Ashpit has the highest weight of 10, followed by segregation of waste at source while bottle crusher carries the lowest weight.

Decision Matrix-A Weighted Scoring Model for HCWM funding options

Table 4.2: Decision Matrix - Weighted Scoring Model for Healthcare Waste Management Funding Options

Decision Matrix: A Weighted Scoring Model			
	Preferred Source of Funding	**Current Source of Funding**	**Weighted Score (Preferred source x current source of funding)**
Government funding	0.95	0.12	1.140
Result Based Financing (RBF)	0.01	0.52	0.052
Private sector investment	0.03	0.03	0.009
Public-private partnerships	0.78	0	0.000
Donor funding	0.15	0.91	1.365
User fees	0.21	0	0.000
Extended Producer Responsibility	0.6	1	6.000

Source: Analysis of Survey Data, 2024 (Scores calculated based on preferred and current funding sources)

Extended Producer Responsibility has the highest weight of 6, followed by donor funding while user fees and Public-private partnership carries the lowest weight 0.

Decision Matrix: determining the appropriate funding allocation for each attribute

Table 4.3: Decision Matrix - Funding Allocation by Healthcare Waste Management Attribute

Decision Matrix: determining the appropriate funding allocation for each attribute									
Attribute	**Weighted Score (Feasibility x availability x importance)**	Government funding	Result Based Financing (RBF)	Private sector investment	Public-private partnerships	Donor funding	User fees	Extended Producer Responsibility	Funding allocation
Segregating waste at source	9.2	2.14	1.052	1.009	1	2.365	1	7	346
Temporary storage facilities	0.96	2.14	1.052	1.009	1	2.365	1	7	36
Incinerator (with fan and thermo-regulator)	3	2.14	1.052	1.009	1	2.365	1	7	113
Burner	3.95	2.14	1.052	1.009	1	2.365	1	7	149
Otway pit	1.94	2.14	1.052	1.009	1	2.365	1	7	73

Bottle crusher	0.495	2.14	1.052	1.009	1	2.365	1	7	19
Ashpit	10	2.14	1.052	1.009	1	2.365	1	7	376

Source: Analysis of Survey Data, 2024 (Allocation percentages based on weighted scores and funding availability)

Ashpit has the highest weight of 376, followed by segregation of waste at source while bottle crusher carries the lowest weight of 19.

Table 4.4: Overall Weighting Matrix - Healthcare Waste Management Attributes vs Funding Sources

Overall weighting table : HCWM attribute weighted score x Source of fund weighted score										
Attribute	Weighted Score (Feasibility x availability x importance)	(a) Government funding	(b) Result Based Financing (RBF)	© Private sector investment	(d) Public-private partnerships	(e) Donor funding	(f) User fees	(g) Extended Producer Responsibility	Weighted Funding score (*a*b*c*d*e*f*g)*	% Final weight
Segregating waste at source	9.2	2.14	1.052	1.009	1	2.365	1	7	346	31%
Temporary storage facilities	0.96	2.14	1.052	1.009	1	2.365	1	7	36	3%
Incinerator (with fan and thermo-regulator)	3	2.14	1.052	1.009	1	2.365	1	7	113	10%
Burner	3.95	2.14	1.052	1.009	1	2.365	1	7	149	13%
Otway pit	1.94	2.14	1.052	1.009	1	2.365	1	7	73	7%
Bottle crusher	0.495	2.14	1.052	1.009	1	2.365	1	7	19	2%
Ashpit	10	2.14	1.052	1.009	1	2.365	1	7	376	34%
Weighted score *(Fund weight score * number of HCWM attributes)*	30	15	7	7	7	17	7	49	1111	
% Weighted score		14%	6%	6%	6%	16%	6%	45%		

Source: Analysis of Survey Data, 2024 (Matrix shows intersection of attribute importance and funding source viability)

Weights -calculated using standardized scoring methodology (Higher scores indicate stronger alignment between attributes and funding sources)

Table 4.5: Summary Weighting Table - Consolidated Scores for Healthcare Waste Management Financing

Attribute	Government funding	Result Based Financing (RBF)	Private sector investment	Public-private partnerships	Donor funding	User fees	Extended Producer Responsibility	Funding weight per attribute
Segregating waste at source								31%
Temporary storage facilities								3%
Incinerator (with fan and thermo-regulator)		*TOTAL HEALTHCARE WASTE BURDEN*						10%
Burner								13%
Otway pit								7%
Bottle crusher								2%
Ashpit								34%
Weight allocation per Funding Source	14%	6%	6%	7%	16%	6%	45%	100%

Source: Analysis of Survey Data, 2024 (Final weights represent optimized funding allocation recommendations - Percentages indicate proposed contribution from each funding source)

Ashpit, for the 3rd time has the highest % weight of 34%, followed by segregation of waste at source (31%) while bottle crusher carries the lowest weight of 2%. These are the % demands of each waste management attribute from currently available and preferred funding sources. Extended Producer Responsibility, for the 3rd time has the highest weight of 45%, followed by donor funding (16%) while user fees, Result-based financing and Public-private partnership carries the lowest weight 6%. These % weights represent the % contribution by each currently available and preferred funding sources in order for sustainable waste management to occur.

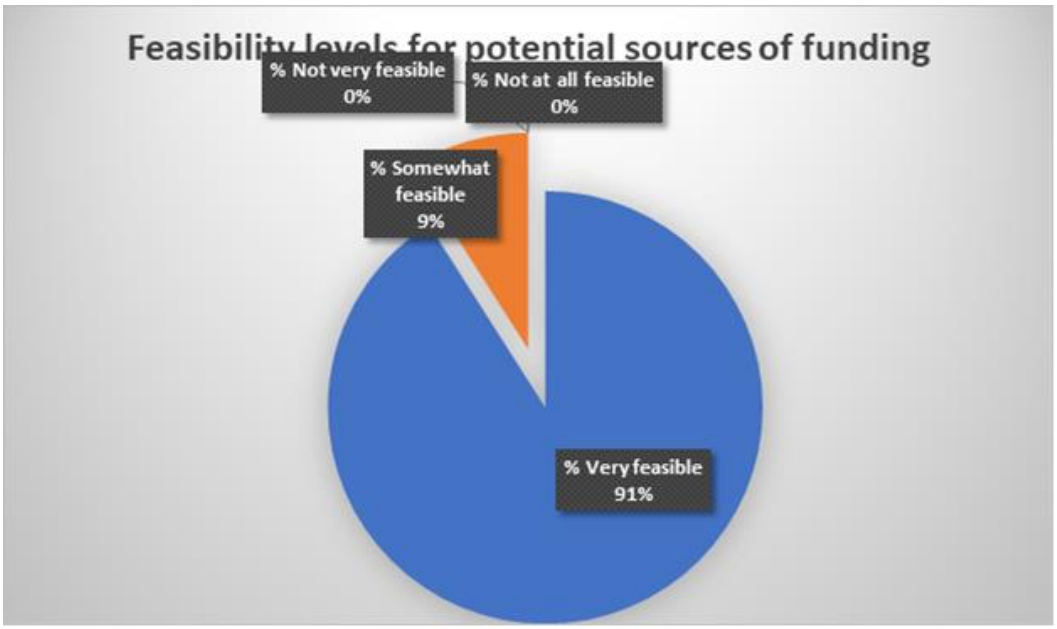

Figure 4.9: Feasibility Assessment of Potential Funding Sources (N=33)

Source: Survey Data, 2024 (Feasibility rated as: Very feasible, Somewhat feasible, Not very feasible, Not at all feasible) Measurement: 4-point Likert scale responses

Sustainability and Impact

The majority of respondents believed that the proposed financing model has the potential to be sustained in the long term. They also anticipated positive impacts on healthcare facilities, waste management practices, and the environment. The model was seen as a catalyst for improved waste management infrastructure, increased funding availability, enhanced training and knowledge, and ultimately, a healthier environment in the province.

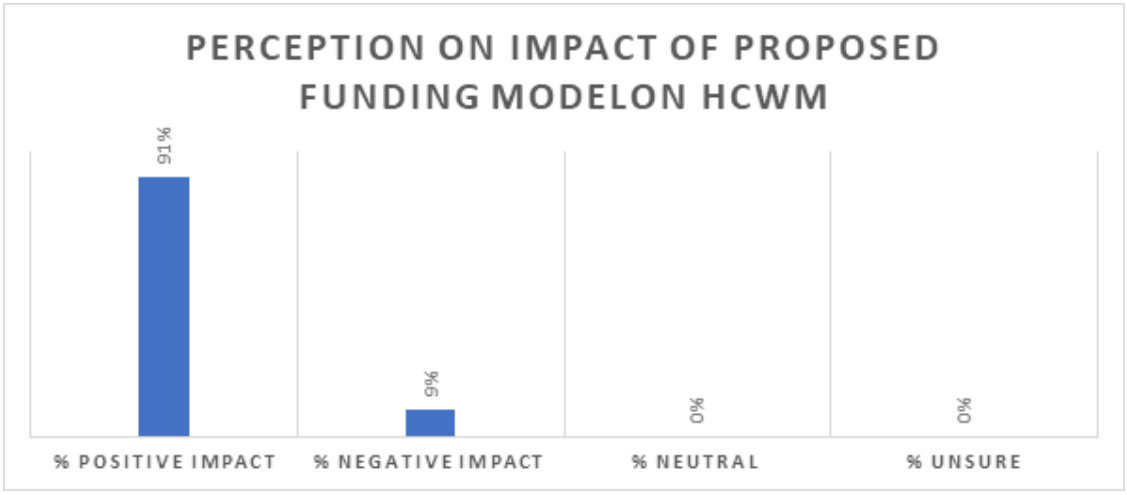

Figure 4.10: Perceived Impact of Proposed Funding Model on Healthcare Waste Management (N=33)

Source: Survey Data, 2024 (Impact assessed as: Positive, Negative, Neutral, Unsure)

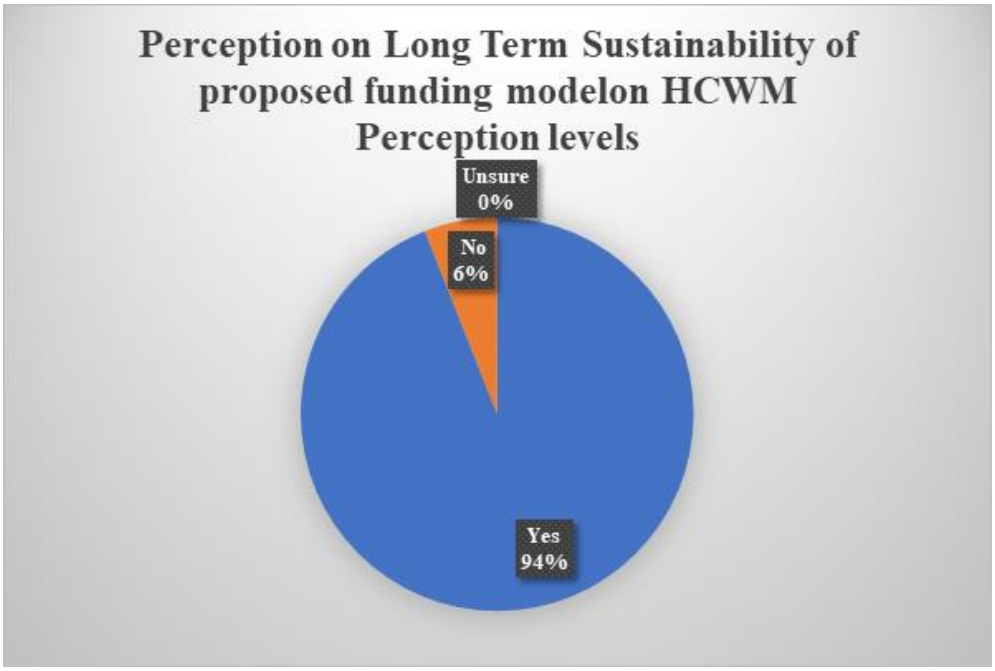

Figure 4.11: Long-term Sustainability Perception Levels of Proposed Funding Model (N=33)

Source: Survey Data, 2024 (Sustainability assessed through stakeholder feedback)

DISCUSSION, CONCLUSION AND RECOMMENDATIONS

Current Financing Mechanisms and Their Effectiveness

The study revealed significant gaps in current HCWM financing, with only 4% of facilities having adequate funding mechanisms. This aligns with findings by (Oleribe et al., 2019) , who reported inadequate budgetary allocation in 11 African countries. The predominant reliance on government funding (67%) mirrors challenges identified in other developing countries (Brown et al., 2023). Key findings on current financing mechanisms: Government funding: 67% (inadequate and irregular), Donor support: 22% (unsustainable), User fees: 11% (insufficient). These findings are parallel to WHO Economics of Health (WHO Council on the Economics of Health for all - Council Brief No. 4, 2023.) where government funding alone proved inadequate for sustainable HCWM.

Infrastructure and Resource Allocation

The study found that 88% of facilities lack adequate HCWM infrastructure, significantly higher than the regional average of 65% reported by (Chisholm et al., 2021). Critical findings include: Only 3% have standard incinerators (compared to regional average of 12%), 71% face critical equipment shortages, 67% lack proper waste treatment facilities. These findings support (Al-Worafi, 2024) assertion that infrastructure deficits represent the primary barrier to effective HCWM in Zimbabwe.

Viable Financing Options

Analysis revealed three primary viable financing options:

1. Extended Producer Responsibility (EPR): - Highest weighted score (45%). This aligns with successful models in Netherlands (Brouillat and Oltra, 2012) which supports sustainable funding through manufacturer responsibility. EPR has increased collection rates, promoted recycling and shifted financial responsibility from municipalities to producers.
2. Hybrid Funding Approach: A combined score of 75% for mixed funding sources reduces dependency on a single funding source.

3. Public-Private Partnerships (PPP): A viability score of 38% corresponds with successful cases in Kenya (De Matteis et al., 2024). This enables resource sharing and risk distribution.

Proposed Financing Model

The study proposes a hybrid financing model incorporating:

Component	Percentage	Justification
EPR	45%	Sustainable manufacturer responsibility
Government Funding	25%	Essential baseline support
Donor Support	16%	Strategic gap filling
User Fees	14%	Operational cost recovery

This model aligns with WHO's (2022) recommendations for sustainable HCWM financing and addresses limitations identified in previous single-source funding approaches.

Implementation Considerations

Success factors identified include:

1. Strong regulatory framework
2. Stakeholder buy-in
3. Clear accountability mechanisms
4. Regular monitoring and evaluation

These factors correspond with success elements identified in similar programs in Rwanda (Mugisha et al., 2023) and Tanzania (Hassan, 2022).

CONCLUSION

This study examined healthcare waste management (HCWM) financing mechanisms in Mashonaland Central Province, revealing critical gaps in current funding models. The research identified that only 4% of facilities maintain adequate HCWM financing, while 88% lack proper infrastructure. The proposed hybrid financing model, incorporating Extended Producer Responsibility (45%), government funding (25%), donor support (16%), and user fees (14%), offers a sustainable solution to address these challenges.

RECOMMENDATIONS

Priority 1: Immediate Implementation (0-12 months)

Establish EPR framework

a. Develop manufacturer responsibility guidelines
b. Create tracking system for medical supplies
c. Set up collection mechanisms

Strengthen existing funding streams

a. Ring-fence HCWM budgets
b. Implement standardized user fee structure
c. Create emergency fund for equipment repairs

Priority 2: Medium-term Actions (1-2 years)

Infrastructure development

a. Install district-level incinerators
b. Establish waste transfer stations
c. Develop transport networks

Capacity building

a. Train facility managers in financial management
b. Develop technical maintenance capabilities
c. Implement monitoring systems

Long-term Sustainability (2-5 years)

Policy integration

a. Incorporate HCWM into provincial health strategy
b. Develop public-private partnership frameworks
c. Establish performance metrics

Future Research

Further investigation is recommended in:

a. Cost-benefit analysis of centralized versus decentralized treatment facilities
b. Impact assessment of EPR implementation
c. Evaluation of technology-based tracking systems

The successful implementation of these recommendations requires strong political will, stakeholder engagement, and continuous monitoring and evaluation.

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APPENDIX

Appendix A

Survey Questionnaire: Sustainable Financing Model for Medical Waste Management in Healthcare Facilities in Mashonaland Central, Zimbabwe

Introduction

My name is Batsirai Ruwiza, currently undertaking an undergraduate Bachelor of Science Honors Degree in Environmental Health AT Chinhoyi University. Thank you for participating in this survey. The purpose of this study is to review current financing practices of healthcare waste management in Mashonaland Central, develop

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a sustainable financing model tailored to the specific context of Mashonaland Central and assess your opinion on the feasibility of a proposed model. Your responses will be kept confidential and anonymous.

Section 1: Facility Information

1. Province: Mashonaland Central

2. District: _____

3. Name of the healthcare facility: _____

4. Type of healthcare facility:

    a. Hospital

    b. Clinic

Section 2: Participant Information

5. Age: _____

6. Gender:

    a. Male

    b. Female

7. Occupation: _____

Section 3: Current HCWM Practices and Challenges

8. Current practices of medical waste management in your facility (tick appropriate):

    a. Are segregating waste at source: Yes/No

    b. Are temporary storage facilities with lock and key available: Yes/No

    c. Waste treatment options available

        i. Incinerator (with fan and thermo-regulator)

        ii. Burner

        iii. Otway pit

        iv. Bottle crusher

        v. Ashpit

    d. Other (please specify) _____

9. Challenges faced by your facility in managing medical waste sustainably (tick appropriate):

    a. Insufficient funding to cover day to day costs in HCWM

    b. Lack of waste treatment infrastructure (e.g., incinerators, bottle crushers)

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c. Insufficient training or knowledge

d. Inadequate infrastructure (e.g., storage, disposal facilities)

e. Other (please specify) _____

10. Availability and adequacy of resources for medical waste management:

a. Funding: Available and adequate/ Available but inadequate/ Not available

b. Infrastructure: Available and adequate/ Available but inadequate/ Not available

c. Equipment: Available and adequate/ Available but inadequate/ Not available

d. Personnel: Available and adequate/ Available but inadequate/ Not available

e. Infrastructure: Available and adequate/ Available and inadequate/ Not available

Section 4: Current Financing Practices

11. How does your facility currently fund medical waste management activities?

a. Government funding

b. Result Based Financing (RBF)

c. Private sector investment

d. Public-private partnerships

e. Donor funding

f. User fees

g. Extended Producer Responsibility (Waste managed by manufacturer/ supplier)

h. Other (please specify) _____

12. Do you believe the current financing practices are adequate for sustainable waste management?

a. Yes

b. No

c. Not sure

Section 5: Financing Model

13. Which potential funding sources and mechanisms for sustainable waste management do you recommend:

a. Government funding

b. Result Based Financing (RBF)

c. Private sector investment

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d. Public-private partnerships

e. Donor funding

f. User fees

g. Extended Producer Responsibility (Waste managed by manufacturer/ supplier)

h. Other (please specify) _____

14. How feasible do you think the proposed financing option/s above is for healthcare facilities for your healthcare facility?

a. Very feasible

b. Somewhat feasible

c. Not very feasible

d. Not at all feasible

15. Do you think the proposed financing options will effectively address the challenges of medical waste management?

a. Yes

b. No

c. Not sure

Section 6: Sustainability and Impact

16. Do you think the proposed financing model can be sustained in the long term?

a. Yes

b. No

c. Not sure

17. What potential impact do you foresee the model having on healthcare facilities, waste management practices, and the environment?

a. Positive impact

b. Negative impact

c. Neutral

d. Unsure

Thank you for your valuable time and input. Your responses will contribute to the development of a sustainable financing model for healthcare waste management in Mashonaland Central, Zimbabwe.