RAPID ASSESSMENT ON HEALTH CARE WASTE MANAGEMENT IN SRI LANKA

Ministry of Health

UNDP

GS ASSOCIATES PRIVATE LIMITED

Rapid Assessment on Health Care Waste Management in Sri Lanka

Submitted to
Project Manager
Biomass Energy Project
United Nations Development Programme, Sri Lanka

BY
GS ASSOCIATES PRIVATE LIMITED
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Acknowledgements

This report on Rapid Assessment of Health Care Waste Management in Sri Lanka is prepared as a fulfillment of a requirement of the task assigned to M/s GS Associates Private Limited by UNDP Sri Lanka on behalf of the Ministry of Health.

It has been prepared by a Consultant Team led by Eng. Gamini Senanayake comprising of Prof Parakrama Karunaratne (Environment Expert), Dr Cyril De Silva (Medical Expert), Eng. Ranjith Pathmasiri (Energy & Technology Expert) and Mr. Michael Cowing (International Consultant) amply supported by Ms. Chathuri Attanayake (Research Assistant) and Mr. Madupa Abeywardane (Project Assistant).

The Consultant Team worked under the guidance of the Technical Working Group headed by Dr. L T Gamlath - DDG, Environment, Health, Occupational Health & Food Safety, Ministry of Health until his retirement followed by Dr. V T S K Siriwardana - Acting DDG, Environment, Health, Occupational Health & Food Safety, Ministry of Health, other representatives of the Ministry of Health, Mr. Ajith Weerasundara - Director, Waste Management Division, Central Environment Authority, Dr. Vegini Mallawarachchi - National Professional Officer, WHO, Mrs. Nilusha Patabandi - WASH Specialist, UNICEF under the overall supervision of Dr. Inoka Suraweera - Consultant Community Physician, Environmental and Occupational Health Directorate, Ministry of Health and Dr. Thusitha Sugathapala - University of Moratuwa as the Technical Advisor.

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Last but not least, we express our sincere thanks and profound gratitude to officials of health care facilities responded to the online survey and facilitated our observation visits despite challenging circumstances due to COVID 19 pandemic, key informants and all those who have readily provided us with information for the successful accomplishment of this task without which this would not have been a reality.

Executive summary

The overall objective of this assignment was to conduct a Rapid Assessment of the prevailing health care waste management systems in Sri Lanka. This Rapid Assessment Report consists of the background of the assignment, methodology adopted for primary data collection, results of the survey including type and amount of health care waste generated in the country, current management practices, gaps in the management practices from the environmental and social safeguard point of view, outcomes of observation visits, Key Informant Interviews and recommendations to improve healthcare waste management in Sri Lanka.

Taking into consideration the need to collect primary data, as in-person data collection was not possible due to the pandemic situation of the country, in order to assure the accuracy of the data collection and to facilitate a rapid assessment, an on-line data collection was used. Several on-line sessions were conducted with the respondents to explain the questionnaire to ensure the clarity of it. Health care facilities were divided into 3 groups; Group 1 – State sector large scale hospitals above base hospitals, Group 2 – State sector small scale hospitals below divisional hospitals and Group 3 – Private health care facilities.

In Group 1, which is the main target group of this survey, 73 have completed the survey questionnaire. In Group 2, though it is not a main target group of this survey, 70 have completed the survey questionnaire. In Group 3, only 2 have filled the questionnaire. As the sample of this group is not adequate to make statistical analysis, recommendations were based on the information collected through 6 observation visits.

The estimated total infectious and sharp wastes generation from Group 1 and 2 is 25.38 tons per day, out of which about 94% is generated in Group 1 HCFs. The specific waste quantities estimated in this study can be used to estimate the waste generation from health care facilities in a particular local authority or a district that would be helpful for the location of centralized treatment facilities.

The waste categories used in segregation show that, in general, infectious waste and sharps have higher emphasis in segregation at the healthcare facilities in both Group 1 and Group 2, while plastic, glass and general waste types too have higher level of segregation. The biodegradable waste has received relatively lower attention in segregation programmes. Few facilities in both categories have indicated the absence of segregation, which needs to be attended in urgent basis due to potential health and environmental hazards.

The Consultant Team visited 40 healthcare facilities and made observations to generate a clear insight of current health care waste management practices and administrative systems with the view to make sound conclusions and recommendations, which will have a practical significance.

Based on the primary data and data collected from observation visits, Consultant Team assessed the quantities of Unintended Persistent Organic Pollutants and Mercury release potential in the health sector. Consultant Team also identified the health and safety risks resulting from inadequate management of healthcare waste.

Proper maintenance of incinerators is very essential to operate them at the recommended conditions and to maintain the recommended emission levels from the stack. However, as maintenance is carried out by health care facility staff themselves in many places, the majority of incinerators do not operate at the recommended level. Short of funds, lack of spare parts, lack of competent persons are some issues directly attributable to poor operation and maintenance.

With regard to hazardous waste treatment, it is evident that Group 1 is comparatively at a better level than Group 2 as out of 73 healthcare facilities responded, only seven facilities burn their clinical wastes in open pits. According to the responses, the amount of clinical wastes disposed through open burning is about 106 tons per year. Another 1,274 tons of clinical wastes is annually treated using Metamizers. The survey reveals that approximately 3,015 tons of waste is sent to a third-party private company for incineration annually by Group 1.

If autoclaved waste in Metamizers is properly disposed in sanitary landfilling, it should result in minimum impact to the environment. However, it was evident during the observation visits that some of the health care facilities do not have access to proper facilities for the disposal of residue wastes from Metamizers.

A total of 17.070 g toxic equivalent (TEQ) per year of Dioxin and Furan are estimated to be released to the environment from burning and incineration of health care waste from Group 1. Though the quantity seems to be very small, compared with the maximum acceptable dilatory intake of $2.5x10^{-7}$ g/year for a person weighing 70 kg , the released amount is very significant. If a high-tech, continuously operated incinerator with sophisticated air pollution control systems is employed, the emission to air drops by a factor of 3,000 compared to that from batch-incinerators with good air pollution control systems.

This emphasises the importance having good, centralised incinerators that receives wastes from several health care facilities so that they can be operated continuously. If all the waste is incinerated in such facilities, the total release of dioxin/furans drops to 1.300 g TEQ. Out of the total waste generated from Group 2, approximately 55% is open burnt, and another 16% is incinerated. A total of 13.36 g of TEQ Dioxin and Furan is estimated to emit from Group 2 annually. Even though Group 2 generates about 6% of clinical waste from government health care facilities, the improper disposal of these waste results in approximately 40% of the total emission of Dioxin and Furan from government HCFs. This indicates the importance of proper disposal of clinical waste from small heath care facilities.

The Ministry of Health has taken steps to phase out mercury containing measuring devices, though some of the old devices used still contains mercury. A total of 179 kg of mercury is released to air annually during the burning and incineration of clinical wastes from Group 1. The estimated mercury emission from Group 2 is 10 kg/y. According to US-EPA, the maximum permissible daily intake of 0.1 g/kg of body weight. Therefore, the permissible maximum yearly intake of mercury for an average person weighing 70 kg is 2.3g. Considering the persistent nature of mercury, though as not severe as Dioxin and Furan emission, the health and environmental impact of mercury emission from healthcare waste management is considerable.

It is apparent that the health and safety aspects including the occupational health and safety of the staff of the healthcare facilities, should receive more attention to develop and implement mitigation strategy and plan for the betterment of the staff as well as other stakeholders including general public. Any plan of this nature would need to be adequately financed and underpinned by comprehensive educational and staff-training initiatives.

In addition to the direct financial cost, it has a huge economic cost arising from negative environmental and social impacts if healthcare waste is not properly managed.

Different stakeholders have different insights and perspectives. Upon comprehending the overall level of importance of stakeholders interviewed, their insights and perspectives, together with the review of the status of the organizations with applicable policy & regulatory environment and institutional frameworks were considered by the Consultant Team when making recommendations for developing the roadmap for health care waste management.

The recommendations were made for the consideration of the healthcare sector stakeholders based on the outcomes of survey results, observation visits and Key Informant Interviews supplemented by literature review under the guiding principle that health care waste management be treated as a national need and a priority but not just as a responsibility of health care facilities alone.

Recommendations were made under the following broad areas; Policy and Regulatory, Finance, Management Information System, Administration, Infection Control Unit, Compliance, Training & Awareness, Education, Standardization, Segregation & Collection, Inhouse storage, e-waste, Clinical waste treatment through Incineration, Clinical waste treatment through non-incineration technologies, Delay tanks for radioactive waste, Placenta treatment, Liquid waste treatment, Mercury, Residue disposal (Bottom ash of incinerators), Residue disposal (Residues of Metamizers) and Procurement of treatment facilities.

To ensure the effective and timely implementation of above recommendations, formation of a high-powered national level multi-stakeholder steering committee for health care waste management is essential. It has to be a well-coordinated and collaborative effort at all levels of the governance system (Central Government, Provincial Councils and Local authorities) including the ministries in charge of health, environment and provincial councils along with environmental regulatory bodies such as Central and Provincial environmental authorities, facilitating bodies such as Western Province Waste Management Authority, National Solid Waste Management Centre and Urban Development Authority.

In addition to making statistical analysis and recommendations, the intention of this survey was to develop a database of health care waste management enabling the Ministry of Health to make informed decisions in the future. Therefore, it is strongly suggested for the Ministry of Health to reach the balance health care facilities and establish a fully-fledged database which could be regularly updated for which purpose, consultant Team will hand over the survey platform used for the online survey.

Abbreviations

AEA	Atomic Energy Authority
APC	Air Pollution Control
APCS	Air Pollution Control System
BH	Base Hospital
BMICH	Bandaranaike Memorial International Conference Hall
BMW	Biodegradable Municipal Waste
CCP	Consultant Community Physician
CEA	Central Environment Authority
CECB	Central Consultancy Bureau
CEO	Chief Executive Officer
CG	Core Group
CMC	Colombo Municipal Council
CMO	Chief Medical Officer
CNO	Chief Nursing Officer
CNTH	Colombo North Teaching Hospital
CSHW	Castle Street Hospital for Women
CST	Cement Solidification Technology
CSTH	Colombo South Teaching Hospital
CT	Consultant Team
DDG	Deputy Director General
DDG E&OH	Deputy Director General Environmental and occupational Health
DDG MS	Deputy Director General Medical Services
DEFRA	Department for Environment, Food & Rural Affairs
DG	Director General
DGH	District General Hospital
DGHS	Director General of Health Services
DRDHS	Deputy Regional Director of Health services
DSEAR	Dangerous Substances and Explosive Atmospheres Regulations
DSHW	De Soysa Hospital for Women
E&OH	Environment & Occupational Health
EPL	Environmental Protection License
FGDs	Focused Group Discussions
G1	Group 1
G2	Group 2
H&S	Health & Safety
HCFs	Health Care Facilities
HCW	Health Care Waste
HCWM	Health Care Waste Management
HDPE	High Density Poly Ethylene
HHCW	Hazardous Health Care Waste
HR	Human Resource
IBA	Incinerator Bottom Ash
ICNO	Infection Control Nursing Officer
IDH	Infectious Diseases Hospital
IED	Industrial Emissions Directive
IFA	Incinerator Fly Ash
JICA	Japan International Cooperation Agency
KIIs	Key Informants Interviews
LA	Local Authority
LC	Life Cycle
LKR	Sri Lankan Rupees
LPG	Liquified Petroleum Gas
LRH	Lady Ridgeway Hospital for Children
MD	Managing Director
MIS	Management Information System
MO	Medical Officer
MO/IC	Medical Officer In-charge

MoH	Medical Officer of Health
MOH	Ministry of Health
MOPH	Medical Officer Public Health
MRV	Monitoring, Reporting and Verification
MS	Medical Superintendent
MSD	Medical Supplies Division
MT	Metric Tone
NHSL	National Hospital of Sri Lanka
NPD	Department of National Planning
OH	Occupational Health
PAH	Poly Aromatic Hydrocarbons
PDHS	Provincial Director of Health Service
PEA	Provincial Environment Authority – Wayamba
PET	Poly Ethylene Terephthalate
PGH	Provincial General Hospital
PHI	Public Health Inspector
POPs	Persistent Organic Pollutants
RDHS	Regional Director of Health Service
RFP	Request for Proposal
RMSD	Regional Medical Supplies Division
SEC	State Engineering Corporation
SMoUDCCWDCC	- State Ministry of Urban Development, Coast Conservation, Waste Disposal and Community Cleanliness
SPSS	Statistical Package for Social Sciences
SWML	Scheduled Waste Management License
TBD	To be decided
TEQ	Toxic Equivalent
TH	Teaching Hospital
TOR	Terms of Reference
TWC	Technical Working Committee
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNICEF	United Nations Children's Fund
uPOPs	Unintended Persistent Organic Pollutants
US-EPA	United States Environment Protection Agency
WHO	World Health Organization
WMAWP	Waste Management Authority Western Province
WtE	Waste to Energy

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1 Introduction

This report is prepared as a fulfillment of a requirement of the task (for the rapid assessment of health care waste management – HCWM in Sri Lanka) assigned to M/s GS Associates Private Limited by UNDP Sri Lanka on 26 August 2020 on behalf of the Ministry of Health (MOH). The report consists of the background of the assignment, methodology adopted for primary data collection, results of the survey, observation visits, Key Informant Interviews (KIIs) and recommendations to improve healthcare waste management in Sri Lanka.

2 Background

The UN system has recently prepared and submitted an advisory note on socio-economic recovery from COVID-19 in Sri Lanka to help inform the country's recovery strategy/plan. The note identifies five strategic priorities to focus on including: Protecting health systems during crisis; Social protection and other basic services; Economic response and recovery; Social cohesion and community resilience and Macro-economic response and multilateral cooperation.

Health care waste management (HCWM) has been identified as one of the key priorities under the first strategic priority, from both a health systems and environmental perspective(s). Poor management of health care waste, in particular the hazardous component, potentially exposes health care workers, waste handlers, patients and the community at large to infection, toxic effects and injuries, and risks polluting the environment. UNDP will therefore leverage its global and regional expertise to support the Government of Sri Lanka to conduct a nationwide rapid needs assessment on HCWM, as well as to articulate a national action plan covering short and medium-term interventions in line with international best practices.

During the COVID 19 outbreak, different types of health care waste is generated at all levels of the health system, including biohazard waste materials. Unsound management of this waste could cause "knock-on" effects on human health and the environment. Safe handling, final disposal of the waste is therefore a fundamental step in the fight against COVID 19 pandemic and whole product sustainability life cycle. Many Low- and middle-income countries are facing challenges of effective management of healthcare waste. Effective management of biomedical and healthcare waste requires appropriate identification, separation, collection, storage, transportation, treatment and disposal as well as sound data management system and comprehensive training of health personnel.

The rapid assessment and subsequent national action plan focus on issues amongst others of exploring holistic waste management techniques including innovative and clean energy solutions technologies in HCWM, capacity building for health care practitioners on best HCWM practices, complying with international conventions and supporting health regulatory authorities on developing and implementing data management scheme with monitoring systems. The findings of the rapid assessment and the action plan developed will be the basis for developing funding proposals to mobilize funding to implement the health care waste management action plan.

The original proposal and the methodology therein submitted by the Consultant Team (CT) at the Request for Proposal (RFP) stage assumed that the secondary data on Health Care Waste Management (HCWM) was available. However, after realizing that the envisaged secondary data with required standard (number of datasets, accuracy, timeliness, etc.) was not available and hence it was decided to collect primary data which is essential for a meaningful rapid assessment.

The second deliverable of this assignment which was the collection of "Primary Data on HCWM" was due to be completed on 15 December 2020 (within 10 weeks of the commencement of the assignment). However, due to the current pandemic situation of the country, with the consent of the client (UNDP Sri Lanka) and Technical Working Committee (TWC), some changes had to be made for the methodology for primary data collection especially by converting a planned series of physical workshops to a couple of virtual briefing sessions for prospective respondents of the Group 1 which is the major target group of this task (Large scale state sector healthcare facilities – HCFs).

3 Overall Objective

The overall objective of this assignment is to conduct a rapid assessment of the prevailing health care waste systems and legal framework and to develop a strategy to improve Health Care Waste Management in consultation with relevant stakeholders.

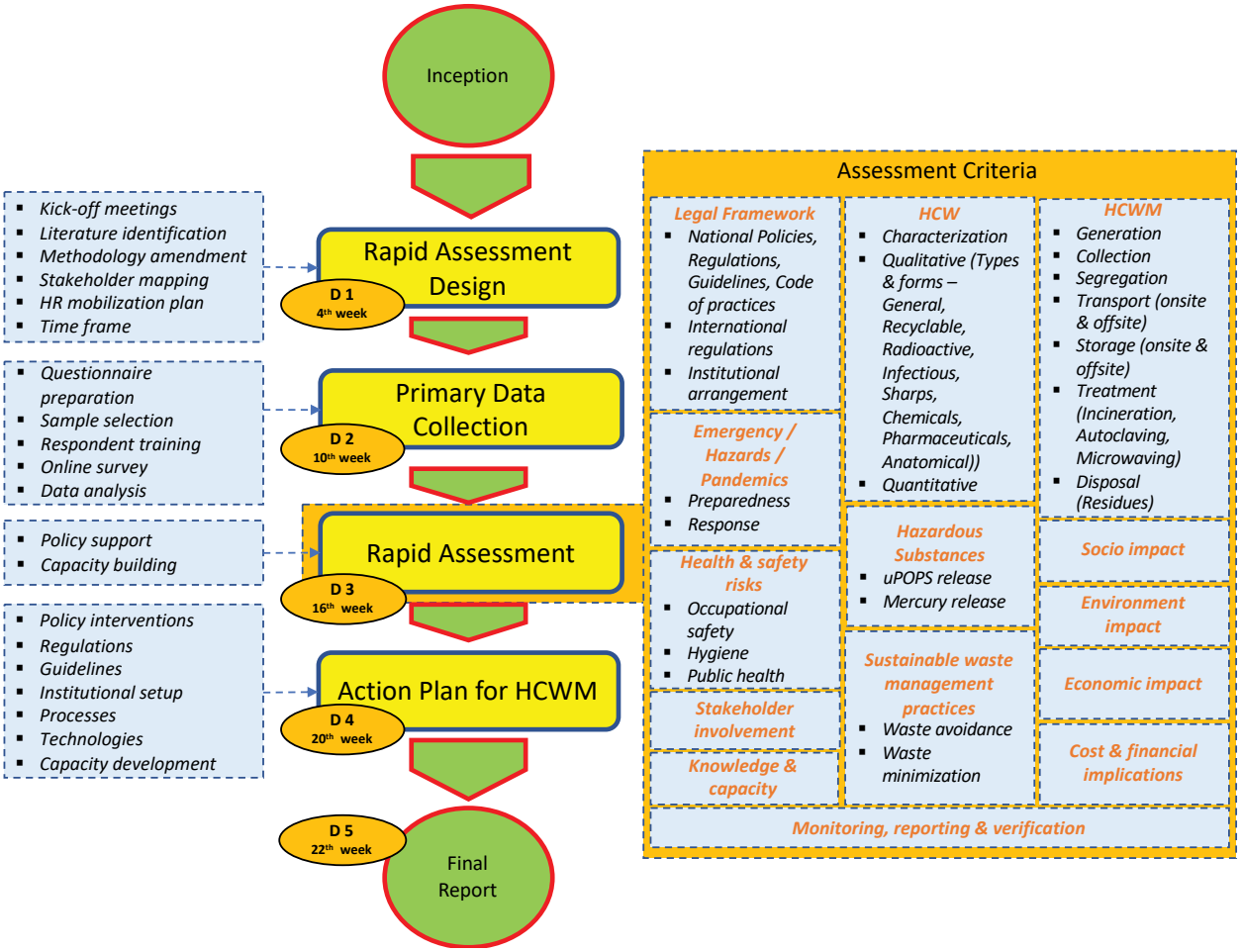
The rapid assessment was expected to assess the type and amount of health care waste generated in the country, current management practices, gaps in the management practices from the environmental and social safeguard point of view and identify a suitable solution package to effectively manage the health care waste generated in a wide spectrum of health care facilities (HCFs) from national to divisional levels, governed by both the public sector and private sector. The assessment also reviews the current legal framework and provides recommendations for policy improvement to implement the developed strategy that meets national and multi-lateral conventions.

The objective of this report is to inform the outcome of rapid assessment to UNDP SL and TWC.

4 Methodology

4.1 Methodology Adopted

Given below is the overview of the methodology adopted in executing this assignment during a period of 5.5 months.



As per the requirements of the Terms of Reference (TOR) and based on the subsequent decisions made at Technical Working Group meetings, Key Activities performed until the completion of the rapid assessment are described below;

Activity 1 - Rapid Assessment Design (Inception Phase)

Upon receiving the contract award from the Client, as the 1st Key Activity, the Consultant Team (CT) prepared the rapid assessment design within a period of 4 weeks as the primary data collection was necessary as an added task.

CT held meetings with the Client, Beneficiary, TWC (Annex 9) and CG (Annex 10) to fully comprehend the overall and specific objectives of this assignment (in addition to the understanding of CT at the RFP stage) and how the outcome of it would either assist or lead to an implementation project in HCWM. Through these discussions, CT (Annex 11) identified Key Stakeholders & other decision-making authorities for further consultations, as given in Annex 3.

CT also identified relevant national as well as international literature for the review with the dual objectives of understanding the present status of HCWM in the country (both state and the private sectors), institutional framework, issues, challenges, constraints for the implementation of an effective HCWM system and future plans to overcome such impediments through various national level studies, research and publications and also to understand the experiences and best practices of other countries. Given in Annex 8 are the literature identified and reviewed;

Thereafter, CT prepared the rapid assessment design report and obtained the approval of the client.

This was treated as the inception phase of this assignment. Therefore, assessment design also consisted of the client endorsed approach and the methodology to conduct the assignment along with a precise timeline and key milestones / deliverables required to accomplish the task (to complete the assignment).

As per the TOR, this was the Deliverables No 1 which was completed within 4 weeks of the commencement of the assignment.

Activity 2 – Primary Data Collection

Taking into consideration the need to collect primary data, CT prepared the survey questionnaire in 3 different versions for 3 target groups and representative samples from each group for the survey as indicated in Sections 4.3 and 4.2 and obtained the approval of the TWC for the same.

As in-person data collection was not possible due to the pandemic situation of the country, in order to assure the accuracy of the data collection and to facilitate a rapid assessment, an on-line data collection was used.

Though it was planned to carry out the online data collection after conducting four survey facilitation workshops (physical) for two groups of respondents covering the entire country, due to the prevailing pandemic situation, a couple of virtual briefing sessions were conducted for prospective respondents.

Ministry of Health (MOH) facilitated the process by issuing authorization & introductory letters for the CT to visit HCFs and HHCW treatment facilities and also by officially requesting all HCFs to cooperate and participate in the survey. Furthermore, MOH issued letters allowing the CT to gain access to the Medical Statistics Unit of MOH and to reach the Director, in charge of private sector HCFs. Having noticed the slow response of HCFs, MOH issued reminding letters too to all HCFs in 2 occasions including Provincial Directors of Healthcare Services (PDHS) and Regional Directors of Healthcare Services (RDHS).

Since the commencement of this assignment, CT made observations wherever possible to have an informal verification of the data and information provided by relevant authorities and key informants. Since the commencement of Activity 2, CT visited selected state & private HCFs (as indicated in Sections 7 & 8) for observations, Focused Group Discussions (FGDs) and Key Informants Interviews (KIIs).

The set of primary data on HCWM collected through the above process was the Deliverable No 2 which was submitted on 1 February 2021; 14 weeks after the commencement of the assignment.

Activity 3 - Rapid Assessment

Upon identification of national as well as international policies, regulations, guidelines, code of practices, etc. under Activity 1, as the 3rd Key Activity, CT reviewed all of them for gaps identification and for compliance. At the same time, CT reviewed existing institutional arrangements and human resource (HR) capacities for HCWM.

The next step was to analyze the primary data obtained through the questionnaire survey in multiple formats. That is, descriptive analytical method was followed in analyzing qualitative data. Statistical and explanatory analytical methods were followed in analyzing quantitative data. The results of FGDs and KIIs results were first written as detail notes. Afterwards, they were coded and organized for descriptive analysis. Along with this analysis, social, environmental and economic impact assessment of HCWM was conducted.

Thereafter, this draft rapid assessment report was prepared for the submission for the client's review and comments including TWG. Rapid assessment report shall be finalized after accommodating client's comments.

The rapid assessment report consists of types[1] and estimated amount of health care waste generated in the country, current management practices including the assessment of the system in place to record HCW movements, gaps in the management practices from the environmental and social safeguard point of view.

Based on the primary data and data collected from HCF observation visits, CT assessed the quantities of unintended Persistent Organic Pollutants (uPOPs) and mercury release potential in the health sector using toolkits prepared under the respective conventions. Information required for these quantifications, such as incinerator type and air pollution control technologies used in the incinerators, was collected during the data collection process. CT identified the health and safety risks resulting from inadequate management of healthcare waste especially during crisis and pandemic situations, such as COVID-19. It also covers review results of the current legal framework.

This is the Deliverable No 3 which was completed within 16 weeks of the commencement of the assignment. Summary of outputs of the rapid assessment is depicted below;

4.2 Sample for HCWM Questionnaire Survey

Survey Population:

All HCFs which generate clinical waste (e.g. government hospitals, private hospitals, specialized hospitals, MOH offices) were the survey population.

Sample Selection:

[1] General, Recyclable, Radioactive, Infectious, Sharps, Chemicals, Pharmaceuticals, Anatomical, etc.

Sri Lanka currently employs a wide range of hospitals spread across the country with different calibers and strengths (Health care services and capacities). As the bed strength and activities / health services vary from hospital to hospital, the amount and type of clinical waste generated differs from each other, except small hospitals and MOH offices.

However, within each category, the hospitals tend to be similar in functionality and activities even though the bed strength may differ. The sample selected covers all categories of the HCFs classified under government and private sector[2]. The total population of national hospitals, teaching hospitals, special institutions and at least one HCF from provinces/districts are selected for the sample.

CT divided all HCFs into 3 groups as follows for data collection purpose by adopting 3 different methodologies;

Group 1 – State Sector Large Scale Hospitals
Group 2 – State Sector Small Scale Hospitals
Group 3 – Private Sector Hospitals

Group 1 – State Sector Large Scale Hospitals

As the HCFs in Group 1 varies in bed strength and amount of clinical waste generated, a small sample will not give the true picture. Therefore, it was suggested to cover the entire population of this group as follows;

Category of Government Hospitals	Number of Hospitals	Proposed sample size	%	Proposed Observation sample
National Hospitals	02	02	100%	02
Teaching Hospitals 1. CSTH (TH Kalubowila) (L) 2. CNTH (TH Ragama) (L) 3. TH Karapitiya (L) 4. TH Ratnapura (L) 5. TH Peradeniya (L) 6. TH Kuliyapitiya (L) 7. TH Anuradhapura(L) 8. TH Jaffna (L) 9. TH Batticaloa (L)	09	09	100%	03 (TBD)
Provincial General Hospitals 1. PGH Kurunegala (L) 2. PGH Badulla (L)	2	2	100%	01
District General Hospitals	20	20	100%	02 (TBD)
Base Hospital – Type A	29	29	100%	02 (TBD)
Base Hospital – Type B	52	52	100%	02 (TBD)
Special Institutions 1. LRH (Teaching) (L) 2. DSHW (Teaching) (L) 3. CSHW (Teaching) (L) 4. National Dental Hospital (Teaching) (L) 5. National Institute for Nephrology Dialysis & Transplantation(L)	16	16	100%	04 (Apeksha, IDH, CSHW, National Institute for Nephrology Dialysis & Transplantation)

[2] Despite many attempts none of the private sector HCFs responded to the online survey questionnaire and hence CT obtained some vital information through observation visits.

Category of Government Hospitals	Number of Hospitals	Proposed sample size	%	Proposed Observation sample
6. National Eye Hospital (L) 7. National Institute of Infectious Diseases (L) 8. Apeksha Hospital, Maharagama (L) 9. National Institute of Mental Health – Angoda (L) 10. Kethumathie Women's Hospital (P) 11. National Hospital for Respiratory Diseases (L) 12. Rehabilitation Hospital Ragama (L) 13. Leprosy Hospital – Hendala (L) 14. SBSCH Peradeniya (Teaching) (L) 15. Rehabilitation Hospital Digana (P) 16. Sri Jayawardane Hospital				
	130	130	100%	16

TBD – To be decided

Methodology for Group 1

1. Data collection was done using online survey questionnaire form (Section 4.3).
2. One officer (Microbiologist / MO Public Health / Infection Control Nursing Officer / PHI) who is responsible was requested to be selected from each hospital as respondents for the sample survey (for data collection). MOH through written communication, officially requested all HCFs to participate in the questionnaire survey.
3. The prospective respondents were trained by conducting virtual briefing sessions on several occasions.
4. Verifications cum observation visits (28 as against planned 16) were done by CT for selected hospitals and units.

Group 2 – State Sector Small Scale Hospitals

These are the small health care units where the generation of clinical waste is not significant and the amount and the type of clinical waste generated are almost same in each category.

In this group, it was suggested to draw the sample as follows;

Category of Government Hospitals	Number of Hospitals	Proposed sample size	%	Proposed Observation sample
Divisional Hospitals – Type A	76	26 (1 per district)	34%	01 (TBD)
Divisional Hospitals – Type B	140	26 (1 per district)	19%	01 (TBD)
Divisional Hospitals – Type C	261	26 (1 per district)	10%	01 (TBD)

MOH Offices	360	78 (3 per district)	22%	02 (01 urban & 01 rural)
Primary Health Care Units (PMUC)	542*	26 (1 per district)	5%	01 (TBD)
Total	1,379	182	13%	06

* Some PMUCs have been upgraded to Divisional Hospitals Type C. Cadre approval has not been given for some PMUCs
TBD – To be decided

Methodology for Group 2

1. A simple and shorter version of the survey questionnaire was prepared for this purpose after finalizing the main questionnaire for the Group 1.
2. Above survey questionnaire form was sent to all hospitals and units of this category via normal mail under registered post (To Heads of the Institutes) with self-stamped envelopes for their convince of responding, faxing and also emailing to HCFs having such facilities.
3. Verifications cum observation visits (6 as against planned 6) were done by CT for selected hospitals and units.

Group 3 – Private Sector Hospitals

Given below are the list of registered private HCFs as per the information of the Private Health Services Regulatory Council of MOH[3]. According to the "Basement Report of the Institution Frame of Private Sector of Western Medicine and State Indigenous Medicine Sector – 2017" of the Medical Statistics Unit of MOH[4], hundred and forty-one (141) private hospitals provide inward patient care services (Western Medicine) in Sri Lanka. It is estimated that there are about 135,000 inward admissions annually in the private sector hospitals. It is around 2% of the total admissions in government hospitals where western medicine is practiced. When considering the bed strength of the private sector hospitals, nearly half of the total bed strength is concentrated in Colombo district.

	Category of Private HCFs	Number of facilities	Proposed sample size	%	Observation sample
1	Private Hospitals, Nursing Homes & Maternity Homes	69	10 (1 from following districts - Colombo, Gampaha, Kalutara, Galle, Matara, Kandy, Ratnapura, Kurunegala, Anuradhapura, Badulla)	14%	02
2	Medical Centres / Screening Centres / Day Care Medical Centres / Channel Consultations	107	-	-	-
3	Medical Laboratories	165	10 (1 from following	6%	02

[3] http://www.phsrc.lk/pages_e.php?id=18
[4] http://www.health.gov.lk/moh_final/english/public/elfinder/files/publications/2019/Private%20and%20indigenous%20medicine%20report%202017.pdf

	Category of Private HCFs	Number of facilities	Proposed sample size	%	Observation sample
			districts - Colombo, Gampaha, Kalutara, Galle, Matara, Kandy, Ratnapura, Kurunegala, Anuradhapura, Badulla)		
4	Other Private Medical Institutions	35	-	-	-
5	Full time General Practices	138	10 (1 from following districts - Colombo, Gampaha, Kalutara, Galle, Matara, Kandy, Ratnapura, Kurunegala, Anuradhapura, Badulla)	7%	02
6	Part time General Practices	230	-	-	-
7	Part time Dental Surgeries	17	-	-	-
8	Full time Dental Surgeries	24	-	-	-
9	Part time Medical Specialist Practices	04	-	-	-
10	Full time Medical Specialist Practices	01	-	-	-
11	Private Ambulance Services	07	-	-	-
	Total	797	30 (out of 372)	8%	06

Source: http://www.phsrc.lk/pages_e.php?id=18

It was suggested to draw the sample only from relevant categories such as Category 1 - Private Hospitals, Nursing Homes & Maternity Homes, Category 3 - Medical Laboratories and Category 5 – Both Full time and Part time General Practices.

Methodology for Group 3

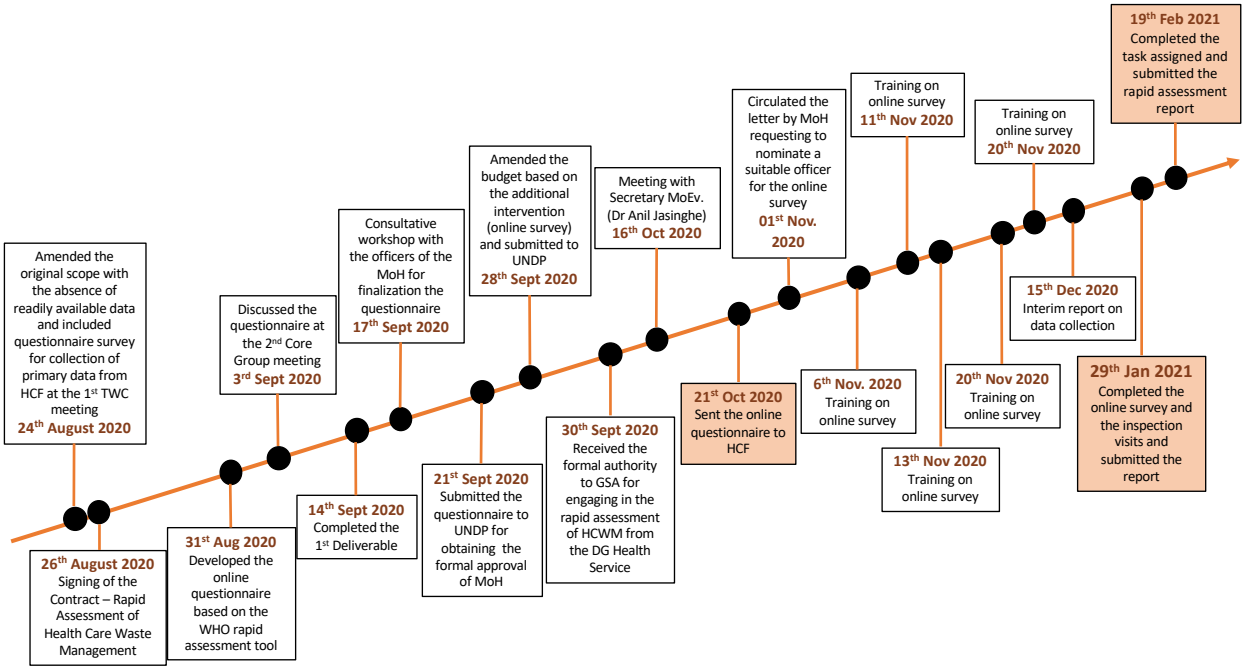
1. The online survey questionnaire was customized for this purpose, after finalizing the main questionnaire for the Group 1.
2. Above online survey questionnaire form was sent to HCFs and units of categories 1, 3 and 5 only (To Heads of the Institutes) of which it was possible to obtain contact details.
3. Verifications cum observation visits (6 as against planned 6) were done by CT for selected Private Hospitals, Nursing Homes & Maternity Homes, Medical Laboratories and Fulltime and Part-time General Practices.

4.3 Questionnaire for the Survey

This online survey questionnaire[5] was designed to gather data and information of HFCs required for the rapid assessment of HCWM in Sri Lanka carried out on behalf of the MOH, Sri Lanka under the technical and financial support of UNDP. The above main questionnaire was customized according to the operations of different HCFs so that HCFs with smaller operations are not overburden with information. Accordingly, the online survey questionnaire had 3 versions; (1) For state sector larger HCFs (2) For state sector smaller HCFs and (3) For private sector HCFs. PDF versions of the questionnaire are given in Annex 12, 13 and 14.

The online survey main questionnaire consisted of 16 sections containing 143 questions altogether. When all information was available with the respondent, it took about 45 minutes to complete the entire survey. However, the respondents were able to save the partially filled questionnaire form so that it was possible to complete it later on.

5 Progress of the Assignment



Depicted above are the key events completed and the major milestones passed since the commencement of the assignment on 24 August 2020 until 19 February 2021. As can be seen, a major part of the time was spent on questionnaire finalization and obtaining the authorization letter from MOH. As such, real survey was commenced on 21 October 2020 and given below is the progress of data collection during a period of 13 weeks.

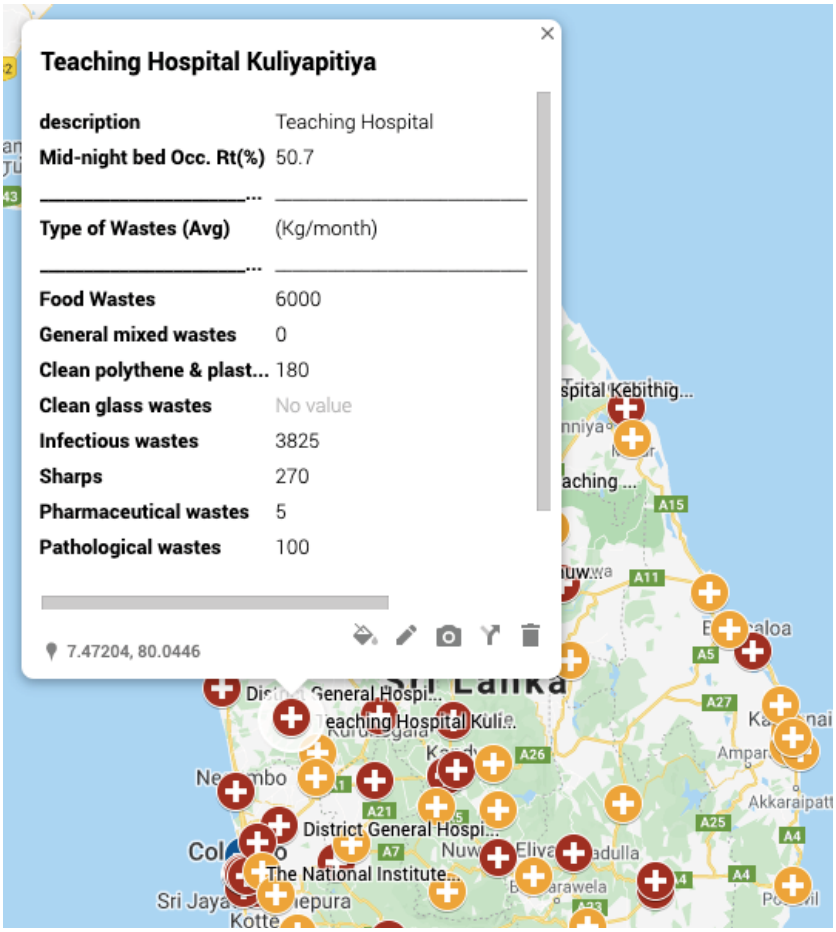
[5] https://www.surveymonkey.com/r/J9LCHRT

6 Progress of Data Collection

Given below is the progress of data collection as at 15 February 2021;

Category	Population	Target		Achievement		
		Sample	%	Contacted	Responded	Response as a % of the target sample
Group 1	130	130	100%	106	73	56%
Group 2	1,399	182	13%	>500	70	38%
Group 3	797	30	8%	15	02	7%
Total	2,326	342	15%	>621	145	42%

Geographical Coverage of Group 1



Geographical Coverage of Group 1

https://www.google.com/maps/d/edit?mid=1PkN7mD6MSmZPhikaIS2vZLxO-fgaXUq_&usp=sharing

In Group 1, which is the main target group of this survey (State sector - Large), 106 HCFs out of 130 were contacted. Of these facilities, 100 nominated the respondents and survey links were subsequently shared with them through emails. Emails were followed up with telephone calls, many times in multiple attempts. CT could not find contacts for remaining 30 HCFs. Out of 100 HCFs contacted, 73 have completed the survey questionnaire. Therefore, as at 15 February 2021, 56% of the target sample has completed the survey which is more than adequate for making statistical analysis and recommendations.

However, in addition to making statistical analysis and recommendations, the intention of this survey was to develop a database of HCWM enabling MOH to make informed decisions in the future. Therefore, CT will continue this effort until the end of this assignment in March 2021 with the expectation of reaching around 70% of the target population through further active interventions of MOH. It is strongly suggested for the MOH to reach the balance and establish a fully-fledged database which could be regularly updated for which purpose, CT will hand over the survey platform now being used for the online survey. Names of the HCFs that have responded to the questionnaire survey is given in Annex 1.

Geographical Coverage of Group 2

https://www.google.com/maps/d/u/1/edit?mid=1LW9-S3zAkK_A9bEfUrM4o38ZkulRCxWI&usp=sharing

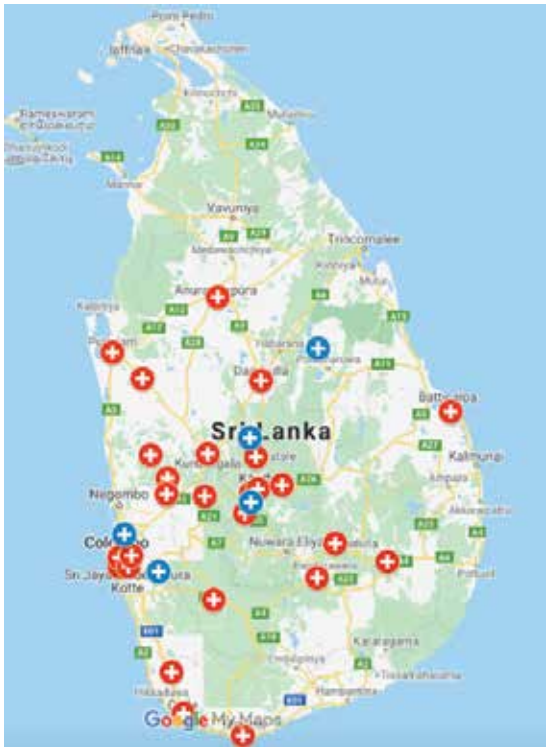
In Group 2, though it is not a main target group[6] of this survey (State sector - Small), more than 500 HCFs out of 1,399 were contacted through regular mails, emails, and faxes. The survey links were shared with HCFs having access to internet and email facilities. Emails were followed up with telephone calls. In addition, reminding letters from MOH was sent to PDHSs, RDHSs and those HFCs of Group 1 that have not responded in 2 occasions. Out of over 500 HCFs contacted, 70 have completed the survey questionnaire. Therefore, as at 15 February 2021, only 38% of the target sample has completed the survey which is also quite adequate for making statistical analysis and recommendations[7]. As in the case of Group 1, CT will continue this effort until the end of this assignment in March 2021 with the expectation of reaching around 40% of the population through further active interventions of MOH. Here too, it is strongly suggested for the MOH to reach the entire population and establish a fully-fledged database which could be regularly updated for which purpose, CT will hand over the survey platform now being used for the online survey. Names of the HCFs that have responded to the questionnaire survey is given in Annex 2.

In Group 3, though it is not a main target group of this survey (Private sector), around 15 HCFs out of 797 were contacted through telephone. The survey links were shared with HCFs having access to internet and email facilities. Only 2 (Asiri Hospitals, Colombo and Lanka Hospital, Colombo) of the Group 3 HCFs have filled the questionnaire form. Therefore, as in the case of Group 1 and 2, CT will continue this effort until the end of this assignment in March 2021 with the expectation of reaching a higher percentage (which is very unlikely) of the population through further active interventions of MOH. As the sample is not adequate to make statistical analysis, recommendations shall be based on the information collected through 6 observation visits made by CT.

[6] These are the small health care units where the generation of clinical waste is not significant and the amount and the type of clinical waste generated are almost same in each category

[7] Out of all HCFs in Group 2, there are 360 MoH offices and 499 primary care health units. All MoH offices are all most same and primary health care units are also very similar and the activities are same.

7 Observation Visits



Geographical Coverage of Observation Visits

https://www.google.com/maps/d/edit?mid=1jd0Txum9smFWeEiYk5Gxx4N8RmKsth5k&usp=sharing

CT commenced the visits in the third week of December 2020 and covered 40 HCFs as against the plan of 28 HCFs (34 from state sector and 06 from private sector) and made observations to generate a clear insight of current HCWM practices and administrative systems with the view to make sound conclusions and recommendations, which will have a practical significance. The map above shows the geographical coverage and the category of HCFs covered through observation visits. Also, through observation visits, CT cross validated the survey responses and helped the respondents to make corrections of data and information where necessary. CT developed a guideline for observation visits which were done by individual members of the team. Annex 4 provides the list of HCFs visited along with observations made which was used in making recommendations.

8 Key Informant Interview (KIIs)

Since the commencement of this assignment, CT has made observations wherever possible for informal verification of the data and information provided by relevant authorities and key informants. As indicated before, CT started visiting selected state & private HCFs for observations, Focused Group Discussions (FGDs) and Key Informants Interviews (KIIs) commencing from the third week of December 2020 and continue until the completion of this assignment. Annex 3 provides the list of KIIs held along with outcomes and findings which were used in making recommendations.

9 Raw Data

The raw data from questionnaires have been extracted and saved in Excel Format for future analyses. The links to these files are given below;

Group 1
https://www.dropbox.com/scl/fi/9pc16ae0xuajvmtol2e8m/Survey-on-Healthcare-Waste-Management-in-Sri-Lanka-Category-1-Govern.xlsx?dl=0&rlkey=s36zrwe1wqh1ix1esab22rm37

Group 2
https://www.dropbox.com/scl/fi/3u4w2jo9rfzqtizu4g6f7/Healthcare-Waste-Management-in-Category-2-Government-HCF.xlsx?dl=0&rlkey=ltcap1ok610vfxlq6sm286xsb

10 Data Analysis

With the consent of TWC, CT acquired a paid-professional version of "Survey Monkey" to conduct the online survey.

The advantage of online surveys using a platform like Survey Money is that data can be viewed and analyzed at any time during the collection process in the "Analyze section" of the survey. Here, one can see a summary view of data; browse individual responses; create and export dynamic charts; use filter, compare, and show rules to analyze specific data views and segments (A paid user could create an unlimited number of rules according to the needs of the rapid assessment); view and categorize open-ended responses, and easily download results in multiple formats. The user can keep an offline copy of survey results, send the exports to others, download individual responses for printing, or export raw data for further analysis.

To analyze data more effectively to have meaningful survey results, following 6 steps were followed;

1. Identify most important questions (as per the objective of the rapid assessment)
2. Filter results by cross-tabulating different categories of HCFs;
    - To analyze and compare different categories of HCFs
    - To filter results based on specific types of respondents of different HCFs,
    - For modelling data
    - To narrow the focus to one category of HCFs by filtering out the others
    - To establish benchmarks, trend analysis for monitoring, reporting and verification (MRV)
3. Code qualitative data
4. Interrogate the data to assess the quality of data and to understand the components of statistical significance
5. Analyze results
6. Draw conclusions

At the time of data analysis, CT felt that the built-in data analysis capabilities of SurveyMonkey was adequate for the purpose.

11 Key Indicators

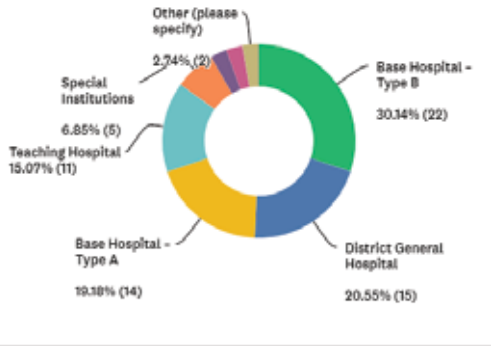
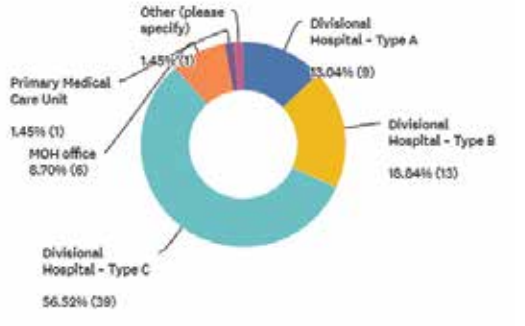
Given below are the key indicators identified based on the "Waste Management Hierarchy" which was useful for the rapid assessment and also to make recommendations;

1. Actions taken to reduce waste generation and their effectiveness.
2. Effectiveness of HCWM systems (Judged from Human resource development, Level of Segregation, handling and storage of HHCW, H&S practices etc.,)
3. Specific indicators of waste generation for different categories of HCFs
4. Onsite treatment facilities
5. Offsite treatment facilities
6. Central treatment facilities
7. Financial implications of different modes of treatments
8. Estimated qualitative and quantitative burden on the environmental from healthcare wastes in Sri Lanka

The survey data was useful to address all aspects mentioned in the TOR. Before the finalization of deliverable 3 (Rapid Assessment Report in Feb 2021), CT performed some important KIIs to incorporate such information to the assessment.

12 Results and Observations

The number of responses received for questionnaires from Group 1 & 2 were indicated in the figure below. The results were analysed using SurveyMonkey, Excel, and other statistical software. Individual responses were scrutinised for consistency and completeness and in case of ambiguities, the respondents were contacted over the phone or during the observations visits to resolve them. Number of responses received from each type of Group 1 & 2 HCFs are given in the graph below.

Group1	Group 2
	
Answered (73)	Answered (69)

Subsequent sections in this report analyse the results of the survey.

12.1 Administrative Setup

12.1.1 Introduction

'Waste' is defined as all unwanted or unusable material, substance or by-product. With the urbanization and development of technology, generation of waste rapidly increased by amount as well as types. Among the types of waste, general waste, polyethene, papers, plastics and most importantly biohazards waste are generated within hospitals and industries. Hazardous waste generated by hospitals are being taken separately due to the toxicity and infectivity and hence termed as 'hazardous health care waste' (HHCW). HHCW include sharps, infectious waste, pharmaceuticals, mercury, pathological waste and liquid waste which are generated at labs and radiology department. In a few hospitals, radioactive drugs and cytotoxic drugs also comes under HCW.

12.1.2 Evolution of HCWM

Two decades ago, the management of clinical waste was a responsibility of the local government institutions. Biohazardous waste of hospitals has become a topic of constant debate resulting in waste management being one of the most important subjects in the country. Local Authorities (LAs) were reluctant to manage hospital clinical waste with increased public awareness on environmental and health risk factors. Therefore, health institutions had to take care of their own clinical waste management which includes collection, segregation, storing, treatment and disposal. This was an additional burden to the hospital which also caused added expenses. Therefore, Ministry of Health (MOH) has taken some steps to streamline the clinical waste management since 2007; allocating of funds from MOH budget line assisted by the World Bank (WB) and World Health Organization (WHO).

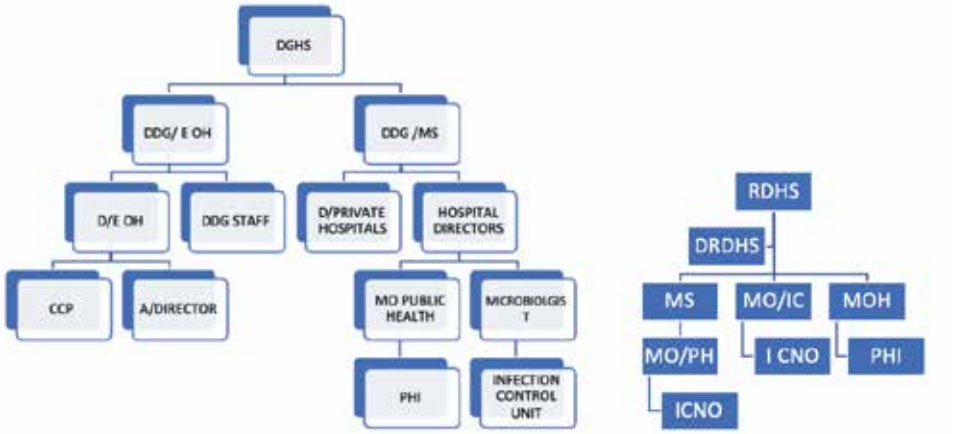
According to MOH, there is a national color-code and guidelines introduced by the Central Environment Authority (CEA) concerning the segregation of clinical waste. In 2006, a General Circular was issued for every institution in the Health Sector, introducing a National Color Code for Segregation of Hospital Waste. Therefore, most of the hospitals started collection and segregation according to the circular. During the last two decades, this process was improved gradually, and negative side effects such as needle prick injuries and hepatitis B were gradually decreased.

However, the problem was the disposal of HCW. In the year 2009, the first autoclave was established in the National Hospital of Sri Lanka (NHSL) by a private company. The operations were

carried out by the same company and National Hospital of Sri Lanka (NHSL) paid for the service per kilo of waste treated basis. Castle Hospital established a shredder and autoclave during the same period, and NHSL used to send the sharps to the Castle hospital. Meanwhile, some private hospitals and Jayewardenepura Hospital also established their own incinerators. Even with the autoclave, the disposal of end-products (residue) was a problem as Colombo Municipal Council (CMC) refused to takeover even though the end-products were not infectious.

There was no alternative for the government other than outsourcing of clinical waste management. Therefore, with the rejection of disposal of clinical waste by local authorities, the MOH outsourced waste disposal to a private company. In 2009, an incinerator was established in the Mulleriyawa area. However, due to public protest and poor hygienic conditions such as smoke and odour, the Courts made a ruling to stop the activities of that company in 2012 and in the same year the said company re-established the operation at Muthurajawella with the permission of MOH and the Central Environmental Authority (CEA). Simultaneously, MOH and provincial administration started establishing their own incinerators and Metamizers (Hybrid autoclaves) in several hospitals in 2013. During the period from 2013 to 2016, MOH has taken steps to establish 20 Metamizers and 5 incinerators throughout the country with a soft loan by the Australian government. Still there are many problems to be addressed including the capacity of incinerators, operation, maintenance of equipment, high cost incurred by disposal equipment and misidentification of clusters before locating disposal equipment.

12.1.3 HCWM Administration



In the late 2000, MOH established the Deputy Director General Environmental & Occupational Health (DDG/E&OH) post and identified it as the focal point of the MOH for the management of clinical waste. Director E&OH and few consultant community physicians were appointed for this purpose under the DDG. Their responsibilities included preparing policies, guidelines, training, monitoring, supervision and supporting financial allocation. Inter sectoral coordination is one of the most important activities of the above unit. So far, the team has performed well and conducted all the tasks but under several resource limitations and constraints.

Director Private Hospital comes under the DDG/MS. DDG/E&OH and Director E&OH coordinates with the Director Private Hospital in regard to clinical waste management of private institutions such as private hospitals, labs and general practitioners. All other stakeholders such as Central Environment Authority (CEA) and local authorities coordinate with the MOH in parallel levels by means of formal and informal communication. Almost all Base hospitals come under the RDHS. Director E&OH coordinates with the RDHS regarding the clinical waste management.

DDG/E&OH and Director E&OH coordinate all issues on HCWM directly with the directors of hospitals which come under the central government. In hospitals where a microbiologist is available, she/he supervises the infection control unit and HCWM. In addition to the microbiologist, Medical Officer (MO) public health PHI/MO infection control are also available for HCWM.

12.1.4 Provincial Administration

With the devolution of power in 1987, health was stated as an entity of provincial councils. However, with the objection of trade unions, medical officers were included in the central government and recognized as an all-island service. Administrative setup was changed with 9

provincial directors for each province and twenty-five regional directors for each district. Medical Officer of Health is a grassroot-level officer who comes under the RDHS, and PHI is the field level officer who looks after the environmental problem of clinical waste management. Almost all the base hospitals and provincial general hospitals come under the provincial administration. All institutes which come under provincial administration are headed by Medical Superintendent or Medical Officer in-charge while preventive health institutions are headed by medical officer of health. MO public health and ICNO are the grassroot level officers in those hospitals responsible for HCWM.

12.1.5 Intersectoral Coordination

HCWM has been linked with a diverse array of stakeholders such as Central Environmental Authority (CEA) and local authorities which hold different responsibilities within the waste management process. As an example, CEA is responsible in issuing permits and licenses for the processes and equipment regards to HCWM. The coordination between these stakeholders is of great importance for its smooth functioning. This coordination is facilitated by the parallel linking of the organization hierarchy with the respective stakeholders at the top level and even maintained at the district level.

12.1.6 Human Resource Allocation and Training

The Infection Control Unit which is the focal point of hospitals was strengthened by increasing the number of nurses and also appointing medical officers such as MO infection control and medical officer public health to larger hospitals where waste disposal is a larger challenge. A circular was issued in 2007 regarding the Infection control committee meetings which is the most important activity in intuitions to discuss the problems of clinical waste. However, these meetings are not given priority by the hospital administration in many institutions as it is not a core function. NHSL has the capacity of training of nurses regarding clinical waste and other relevant subjects, and for the last few years they have trained many nurses for all parts of the country.

Major constraints of clinical waste management at present were identified as limited financial allocation, poor monitoring of the programme by higher authorities, clinical waste management not being recognized as a priority by the institutions, difficulties with the operation and maintenance of the waste treatment equipment and lack of a disposal methods for the toxic residue from incinerators and the residue from Metamizers.

12.1.7 Adequacy of Guidelines & Policies

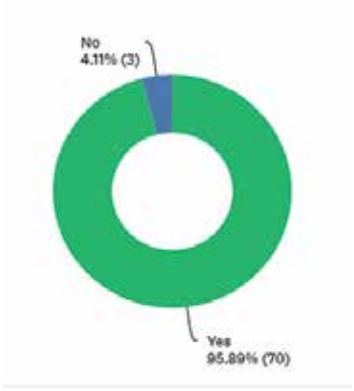
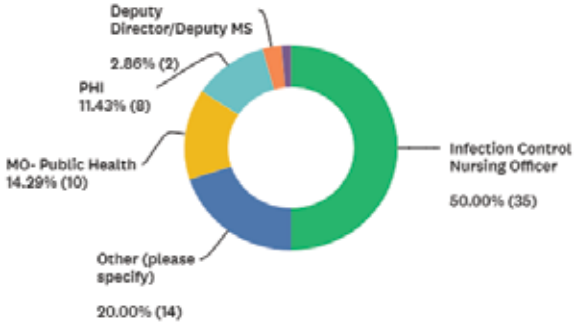
DDG E&OH unit has done a lot of work on developing policies, guidelines and strategic plans for the management of health care waste. This was done in compliance with international policies and standards. However, there is no proper mechanism to follow-up whether these guidelines are practiced in health institutions. Many efforts had been taken to implement the guidelines but due to the lack of resources especially the lack of funds, the outcome is not up to the standards.

There have been many guidelines and polices developed by MoH from time to time. The majority of circulars are focused on technical matters and only a few circulars are available in regard to HCWM & HCW as shown below;

1. Management of Waste Water and Sewage In The Health Sector- 2016
2. Treatment Methodology Hospital Waste Water - 2002
3. National Color Code for The Segregation of Hospital Waste -2016
4. Guidelines to Develop A Procedures to Handle Hospital Liquid Waste Prior To Discharge To Sewer System

During the observation visits, CT identified that institutions have no proper system to keep those circulars and retrieval was very difficult. There is no requirement to revise the present circulars but need to be addressed regarding record keeping (management information system) and monitoring with new guidelines.

Delegation of the responsibility of clinical waste management unit in the hospitals studied

Group 1
Delegation of the responsibility of clinical waste management unit
 Answered (73)
Delegation of the responsibility by category
 Answered (70), Skipped (3)

Survey Results

Out of the total of 73 hospitals, only three (03) hospitals have not delegated the responsibility of clinical waste management to subordinate officers. Among the hospitals which had delegated, majority had delegated to infection control unit (50%). Percentages of 10% and 8% were delegated to MO public health and PHI, respectively. In the case of two hospitals, responsibility was given to DD or Deputy MS. Another significant amount 20% (14 hospitals) have delegated the responsibility to different categories such as Development Officers and subject clerks.

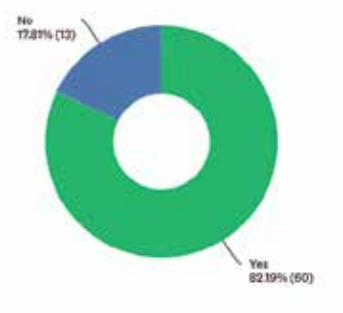
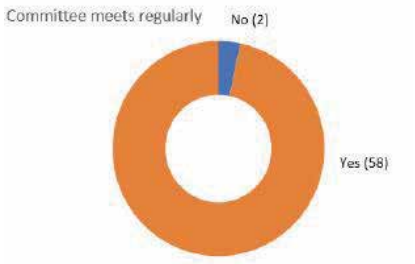
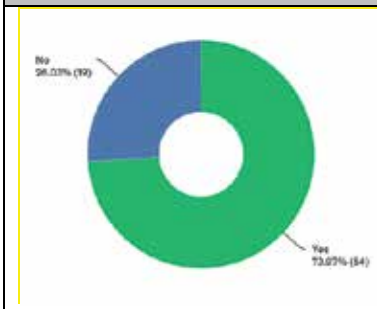
Observation Visit

- Delegation of responsibility was done by administrators without any guideline

Recommendation

- Clear instructions should be given to all hospitals regarding delegation of responsibility of HCWM

12.1.8 Infection Control Committee

Group 1
Availability of an infection control committee
 Answered (73)
Conduction of regular committee meetings
 Answered (43), Skipped (30)
Availability of meeting minutes


Survey Results

- Out of the total of 73 hospitals, 13 hospitals have not established infection control committees
- Committee meetings were not conducted regularly as required by the circular in 51% of the hospitals;
- Even though 49% (29) of hospital have not conducted regularly, they maintained meeting minutes. Only 7 hospitals do not keep meeting minutes.

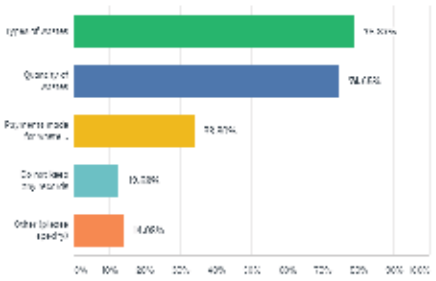
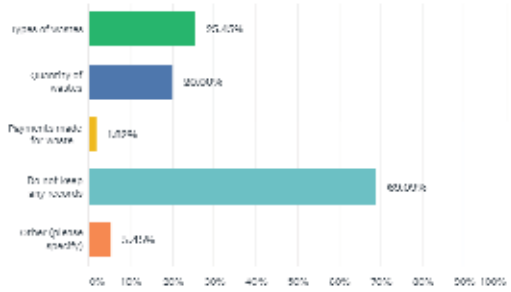
Observation Visit

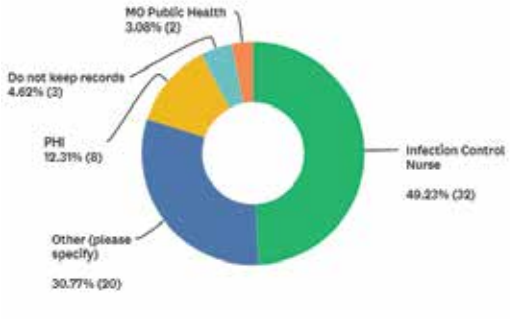
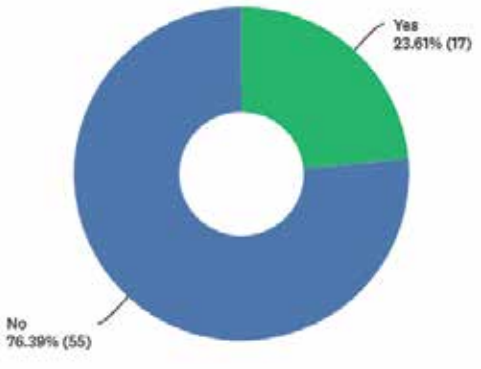
- For the last year, no infection control committee meetings were held due to the COVID situation in most of the COVID related hospitals, but problems were discussed at COVID meetings

Recommendations

- Conducting monthly infection control meeting is not practicable. It is recommended to revise the circular to conduct the meeting once in two – three months and participation of representative from DDG E& Oh unit at least in big hospitals.

12.1.9 Record Keeping

Group 1	Group 2
Categories of information recorded	
	
Answered (71), Skipped (2)	Answered (55), Skipped (15)

Group 1
Responsibility for Record Keeping

Answered (65), Skipped (8)
Reporting to Higher Authorities

Answered (72), Skipped (1)

Survey Results

Majority of hospitals (almost 80%) keeps records on the type of waste and quantity of waste generated. However, only 31% of the hospitals keep records of payments related to waste management services. It is important to note that 13% of the hospitals failed to keep any records of waste management. It can be inferred that each hospital has identified different individuals best suitable for record keeping based on the hospital's functionality. Infection control nurse, MO public health and PHI have been given the responsibility of record keeping in 32%, 2% and 8% of the

hospitals, respectively. A significant proportion of hospitals have identified other categories such as technical officers, developmental officers and subject clerks.

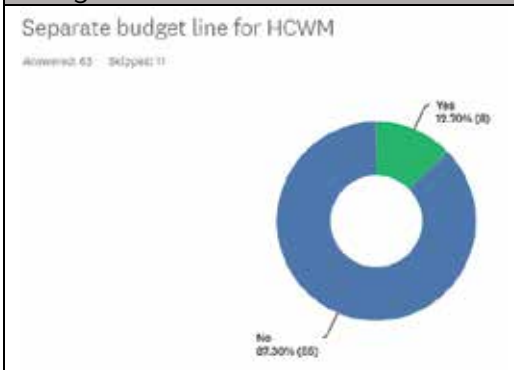
In Group 2 hospitals, majority of hospital (69%) do not keep any records regarding clinical waste.

Observation Visits

- No direction has been sent to the hospitals regarding record keeping
- Out of all categories, meaningful record keeping is typically done by infection control unit, MO public health and PHI
- Information collected by hospitals has not been utilized

Recommendation

- Specific direction should be sent to hospital regarding
    - Issuance of proformas for standardised data collection
    - Type of data to collect
    - When to collect
    - By whom
    - What to do with information

Budget line for HCWM

Answered (73)

Survey Results

- 87% of the hospitals do not have separate budget lines for HCWM

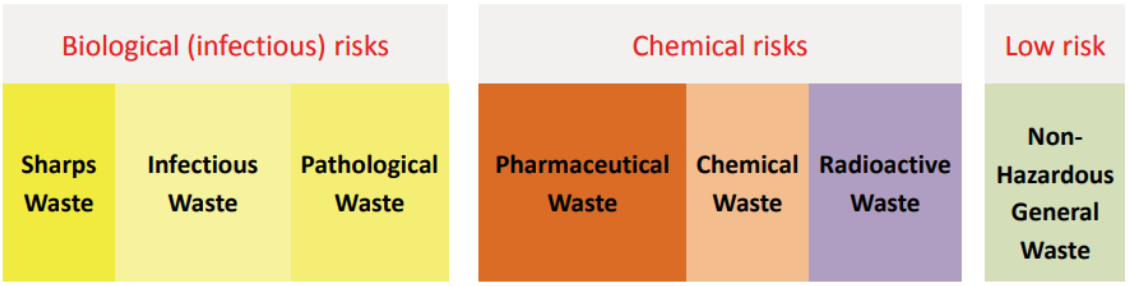
Observation

- No separate budget line was identified but there are some funds allocated through the budget line by DDG/E&OH for capital requirement

Recommendation

- Separate budget line should be identified at least for hospitals above the base hospitals

12.2 Waste Generation

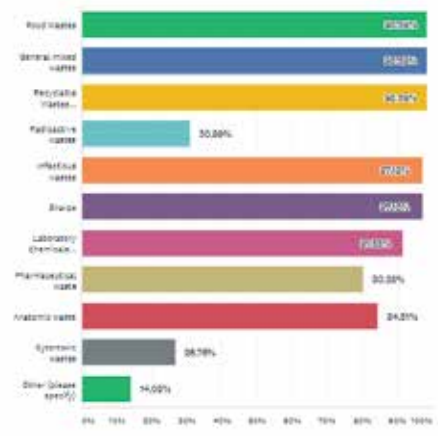
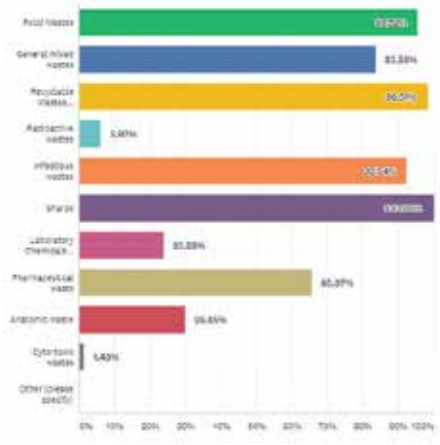


https://www.who.int/water_sanitation_health/facilities/waste/module9.pdf?ua=1

The WHO classifies HCW into seven categories. Accordingly, infectious, and pathological waste categories are related to biological or infectious risks, while pharmaceutical, chemical, and radioactive waste categories can pose chemical risks. The other category of wastes is the general wastes that includes food and other wastes that pose low risks and contributes to about 80% of the waste generated in HCFs.

12.2.1 Types and Quantities of Wastes Generated

Types of waste generated by Group 1 & 2 HCFs are given in graphs shown in Figure 1. Accordingly, almost all these HCFs generate Food, General, Recyclable, infectious and sharps. Radioactive waste is generated by 31% of the responded Group 1 HCFs. Laboratory chemical waste is generated by 91% of Group 1 HCFs while only 23.9% of Group2 HCFs reportedly produce these wastes. Though 80.3% and 65.7% of Group 1 and Group 2 HCFs respectively generate Pharma wastes, the generation seems to be intermittent.

Group 1	Group 2
Types of waste generated	
	
Answered (71), Skipped (2)	Answered (67), Skipped (3)

Total hazardous waste generation from Group 1 and 2 HCFs , quantified based on the responses of the HCFs to the questionnaire, is given in the Table below. The daily waste generation per bed for different categories of HCFs derived from the data collected and these values were used to estimate the total daily waste generation from all Group 1 & 2 HCFs. It was evident that the generation of pharmaceutical waste is intermittent, and their generation has considerably reduced due to online management system of pharmaceuticals that has been introduced by the MOH. Further, the quantification of liquid chemical wastes faces practical difficulties. As such the quantities of these waste cannot be done to a satisfactory level.

Hazardous waste generation from Government HCFs

HCF Category	Infectious kg/day	Sharps kg/day	Pathological kg/day
National Hospitals	2,750	158	143
Teaching Hospitals	4,169	296	411
Provincial GH	2,810	101	24
District GH	3,896	541	414
Special Units	4,756	38	0
BH Type A	2,504	407	385
BH Type B	1,049	278	32
Group 2	1,369	261	-
Total	23,304	2,079	1,409

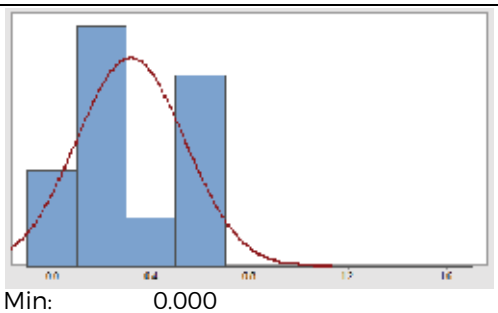
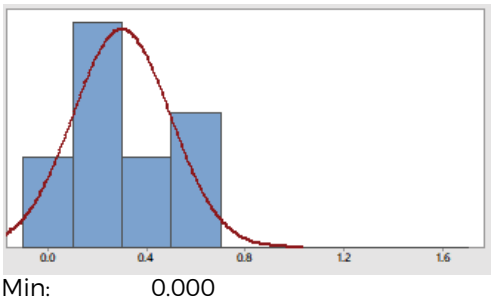
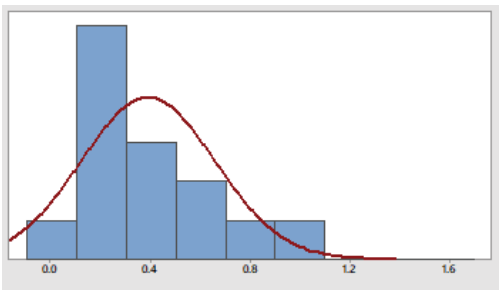
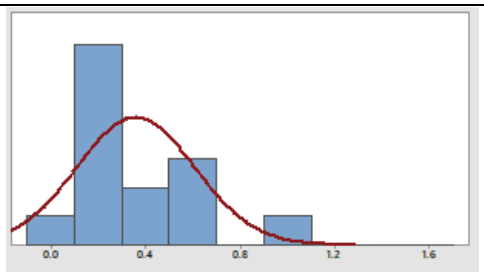
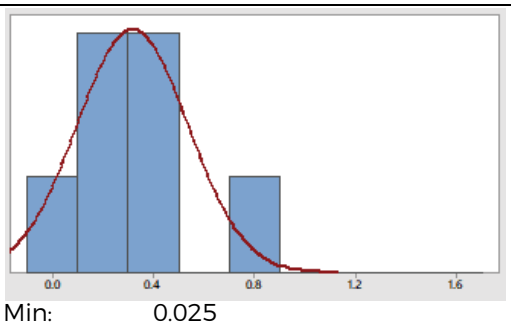
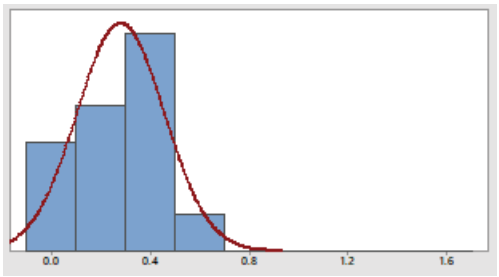
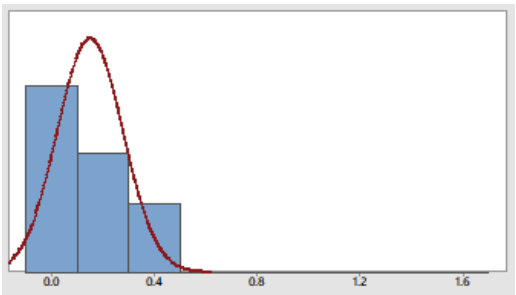
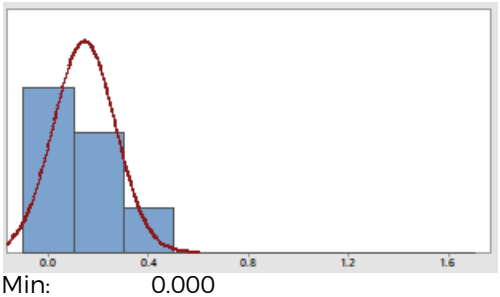
Estimated quantities of daily nonhazardous waste generation from Group 1 and 2 HCFs are given below.

Non-hazardous waste generation from Government HCFs

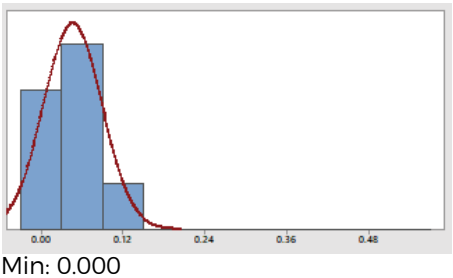
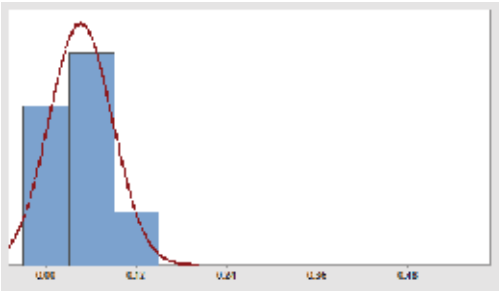
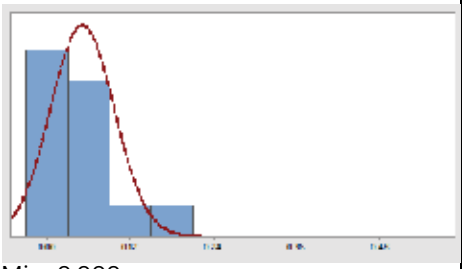
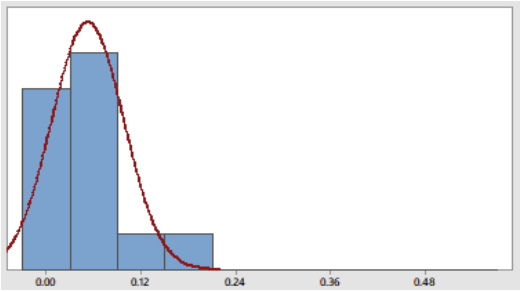
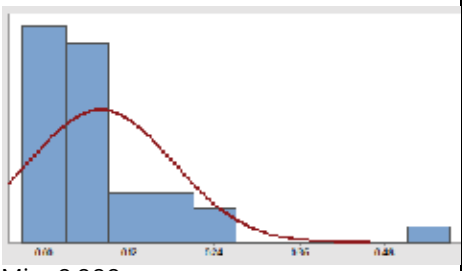
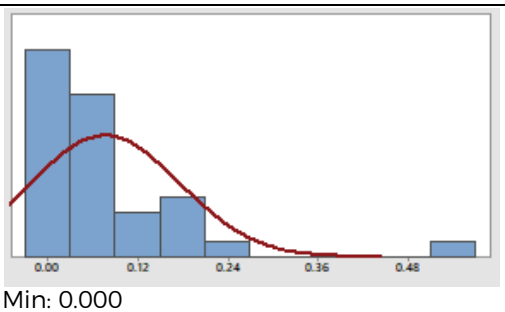
HCF Category	Mixed waste (kg/day)	Food waste (kg/day)	Plastic (kg/day)	Glass (kg/day)
National Hospitals	4,234	2,766	403	29
Teaching Hospitals	6,120	3,767	654	253
Provincial GH	926	905	208	38
District GH	4,157	7,153	1,213	1,088
Special Units	3,567	458	402	156
BH Type A	2,260	2,069	2,198	237
BH Type B	1,199	2,104	373	343
Group 2	1,893	2,518	4,451	1,262
Total	24,357	21,741	9,902	3,406

The variation of hazardous waste generation per bed per day from Group 1 and Group 2 HCFs are given in figures below. The average values of each category, especially Teaching, District General and Base Hospitals, can be used to estimate the quantities of waste generation and the lower values of the distribution can be used as benchmarks for each category of hospitals.

Group 1

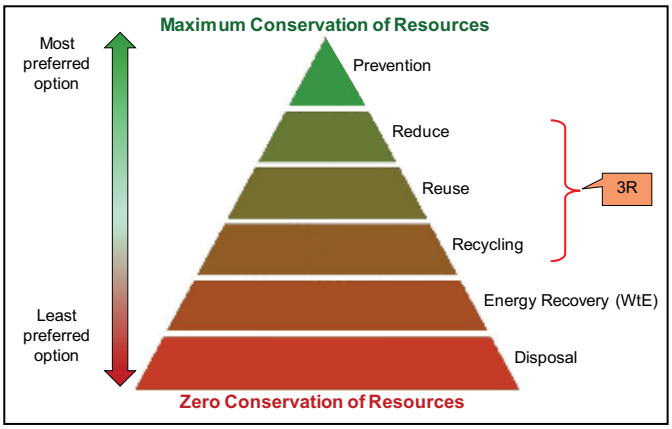
Category of HCF	Hazardous waste generation (including Pharma and Pathological Wastes)	Hazardous waste generation (excluding Pharma and Pathological Wastes)
	kg per day per bed	kg per day per bed
National	Min: 0.149 Avg: 0.346 Max: 0.543	Min: 0.149 Avg: 0.346 Max: 0.543
Provincial General	Min 0.315 Avg: 0.733 Max: 1.150	Min: 0.312 Avg: 0.726 Max: 1.141
Teaching	 Min: 0.000 Avg: 0.318 Max: 0.668	 Min: 0.000 Avg: 0.230 Max: 0.559
District General	 Min: 0.011 Avg: 0.389 Max: 1.029	 Min: 0.008 Avg: 0.359 Max: 0.905
Base Hospital A	 Min: 0.025 Avg: 0.317 Max: 0.755	 Min: 0.021 Avg: 0.281 Max: 0.671
Base Hospital B	 Min: 0.000 Avg: 0.152 Max: 0.426	 Min: 0.000 Avg: 0.144 Max: 0.399

Group 2

Category of HCF	Hazardous waste generation (including Pharma and Pathological Wastes)	Hazardous waste generation (excluding Pharma and Pathological Wastes)
	kg per day per bed	kg per day per bed
Divisional Hospital – Type A	 Min: 0.000 Avg:0.047 Max:0.137	 Min: 0.000 Avg:0.046 Max:0.134
Divisional Hospital – Type B	 Min: 0.000 Avg:0.052 Max:0.160	 Min: 0.000 Avg:0.051 Max:0.160
Divisional Hospital – Type C	 Min: 0.000 Avg:0.079 Max:0.517	 Min: 0.000 Avg:0.077 Max:0.517

12.3 Waste Management Approach

The 'Waste Management' could be defined as management of interventions, activities and resources for proper control of waste streams and materials in preventing, minimizing or reducing the adverse impacts on the environment, society and/or economy. It should encompass all stages of the lifecycle (LC) of a given waste stream, including generation, collection, segregation, handling, storage, transportation, sorting, treatment, recovery and final disposal in an integrated manner, with an emphasis on maximizing resource-use efficiency; and beyond regulatory compliance. Accordingly, the concept of waste management hierarchy, illustrated in the figure, has been emerged as main guiding principle of a holistic solid waste management, including HCW. Here, the approach is the combination of both waste management and waste reduction with the objective of handling HCW streams in the most effective, safe, cost-efficient, and environmentally sustainable manner with due consideration on national circumstances and prevailing capacities of health care

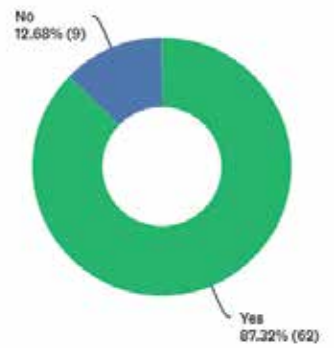
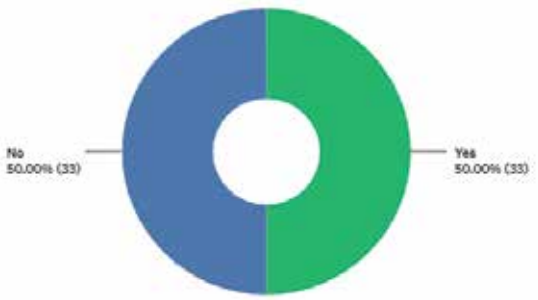


facilities. In fact, this concept has been well-accepted within the healthcare sector in Sri Lanka with the blessing of the relevant authorities and management of individual healthcare facilities.

12.3.1 Minimization

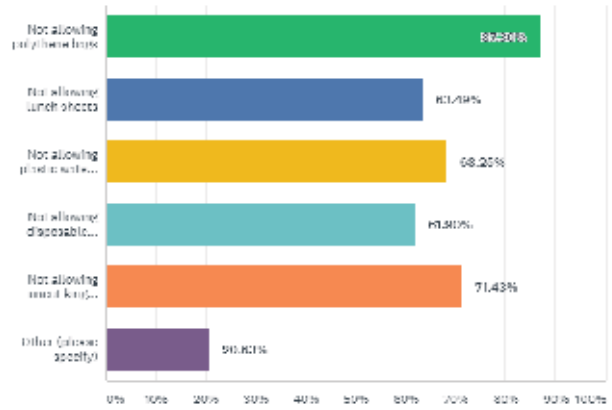
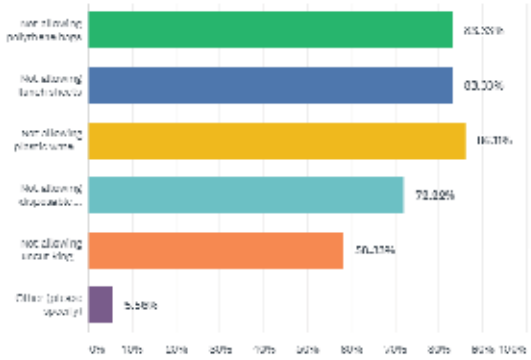
Over the last several years, considerable efforts have been given for the apex elements of the waste management hierarchical system, with regular awareness and training programmes for the staff and other stakeholders, particularly in the government hospitals. Among these, prevention and minimization are considered to be the most effective interventions and specific programmes have been development and implemented in individual facilities. The questionnaire included specific questions to understand the interventions taken by the healthcare facilities for waste minimization programmes, and the feedback received from Group 1 (71 responses) and Group 2 (66 responses) are presented in the following figures.

The results indicate that the majority of the healthcare facilities in Group 1 (87%) have specific programme/s for waste minimization, while that in Group 2 is only 50% indicating the gaps. Even for the case of Group 1, 13% of the facilities do not have specific waste minimization programme signifying the issue of lack of holistic approach in waste management. As the waste minimization is recognized as the top-most element in waste management, these results indicate the need, importance and opportunity for introduction of a more comprehensive waste minimization programme at national level targeting HCW sector.

Group 1	Group 2
Waste Minimization	
	
Answered (71), Skipped (2)	Answered (66), Skipped (4)

The interventions taken by the healthcare facilities for minimization of waste illustrate a range of measures, among which the most common ones are by not allowing polythene bags, plastic water bottles and lunch sheets. Further, considerable number of healthcare facilities do not allow disposable Styrofoam lunch-boxes and uncut king-coconuts to bring into their premises. Some have also introduced alternatives to support these actions, for example by providing/selling reusable bags. In terms of the methods of interventions, no significant difference is seen between Group 1 and Group 2 of the healthcare facilities.

These results also indicate the need for furthering the actions taken by healthcare facilities in minimizing the waste generation within their facilities. Here, the emphasis should be given to the awareness of the staff, patients and visitors, as well as general public, in addition the regulatory interventions.

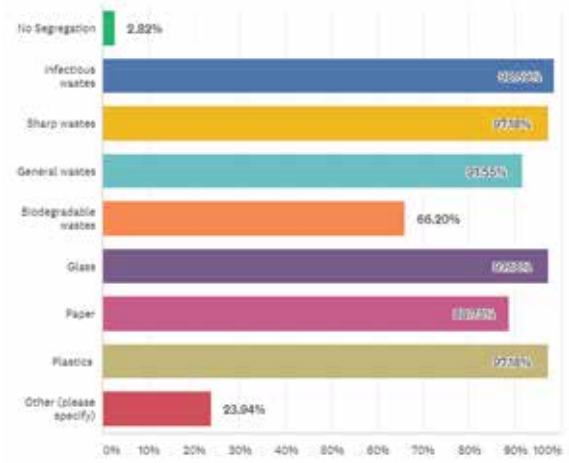
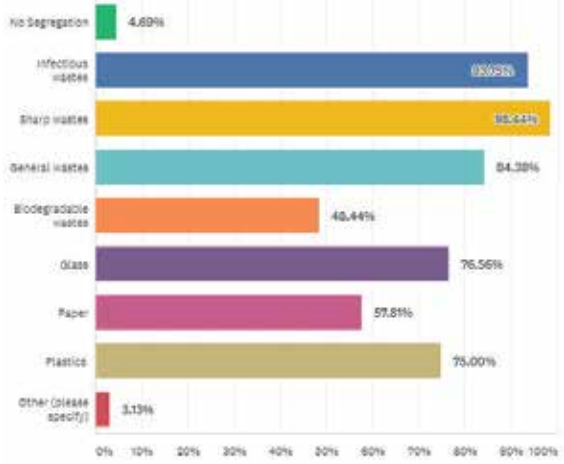
Group 1	Group 2
Methods of Waste Minimization	
	
Answered (63), Skipped (10)	Answered (36), Skipped (34)

12.3.2 Segregation

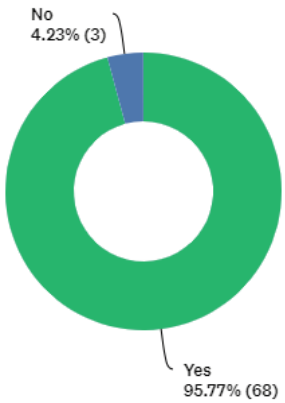
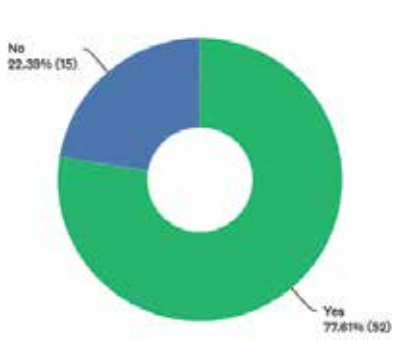
Segregation of HCW is a crucial element in effectuating the waste management hierarchy principle in a holistic waste management system. Every healthcare facility should separate its waste at the source to reduce risk of infection, as well as the cost of handling and disposal. Effective segregation at the point where waste is generated ensures that hazardous waste is treated in a safe and environmentally sustainable way, without risk to healthcare workers and patients. At each point of waste generation, there should be separate, properly labelled and colour-coded containers (as shown in the figure), appropriate for the specified type of waste.

Segregated waste can be managed much better as the management options highlighted in the hierarchical system could be implemented for each waste type more effectively as applicable options depend on the characteristics of waste. In fact, most of the segregated components of the waste become a resource with potential for income generation. Accordingly, the survey of the present study explored the level of segregation at healthcare facilities in the country, and the results are discussed in this section.

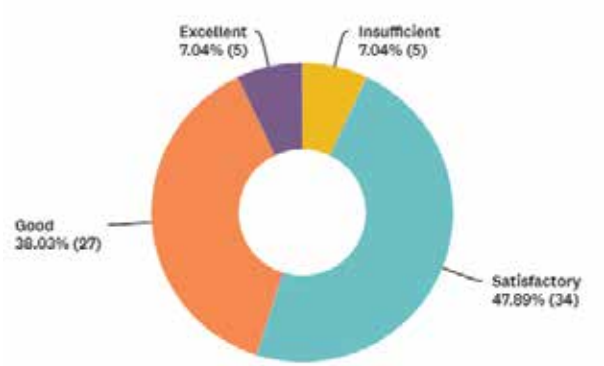
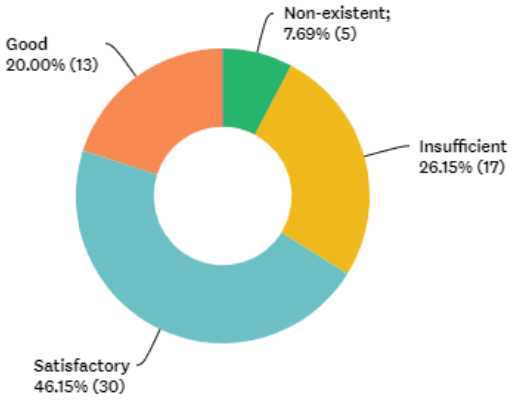
The waste categories used in segregation show that, in general, hazardous waste and sharps have higher emphasis in segregation at the healthcare facilities in both Group 1 and Group 2, while plastic, glass and general waste types too have higher level of segregation. The biodegradable waste has received relatively lower attention in segregation programmes. Few facilities in both categories have indicated on absence of segregation, which needs to be attended in urgent basis due to potential health and environmental hazards.

Group 1	Group 2
Waste segregation categories	
	
Answered (71), Skipped (2)	Answered (64), Skipped (6)

The responses to the use of colour-code system in segregation show a clear difference between the two categories of healthcare facilities, with Group 1 having much higher usage (96%) than Group 2 (78%). This could be partly attributed to the lack for financial resources to purchase waste bins, and partly to the priority given to waste management. As the colour coding is an essential element in effective segregation system, it is important to address this issue.

Group 1	Group 2
Practice of the colour code system	
	
Answered (71), Skipped (2)	Answered (67, Skipped (3)

A similar observation on the differences of the two categories of HCW facilities could be made in relation to the level of satisfaction on waste segregation, where responses indicate relatively higher satisfaction levels in Group 1 than in Group 2. However, there is a significant number of healthcare facilities having inadequate level of satisfaction, indicating the important of addressing the deficient areas even for the present systems in place. In fact, only a few HCW facilities in Group 1has indicated the level of satisfaction as Excellent, which should be the final target to be achieved.

Group 1	Group 2
Level of segregation of wastes	
 Answered (71), Skipped (2)	 Answered (65), Skipped (5)

12.3.3 Collection & Handling

Introduction

Ward Level Collection Bins

Ward Level Collection Bins

Common Collection Bins

Collection Bins for Outdoor Patients

Designated Carts

Standard Sharps Boxes

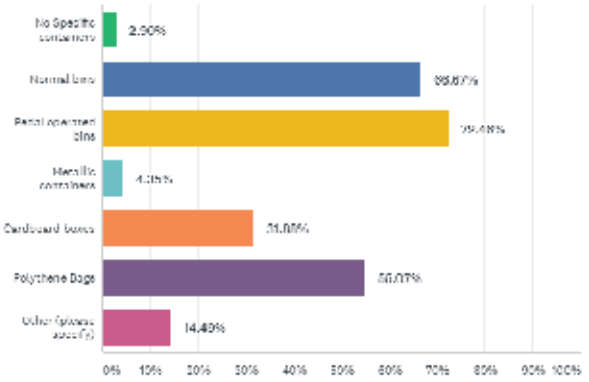
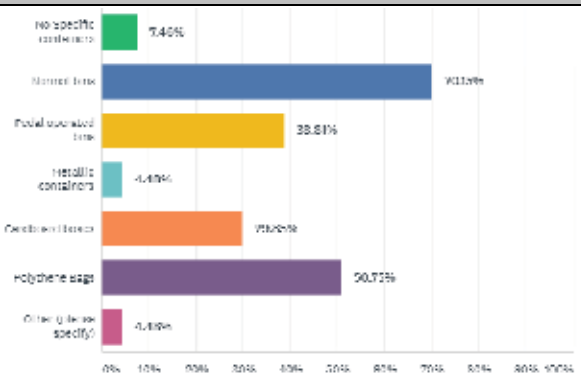
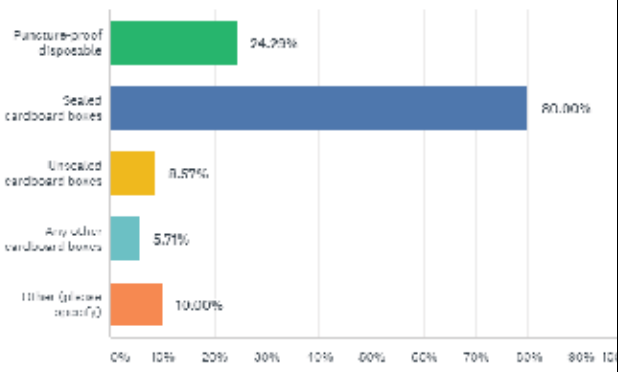
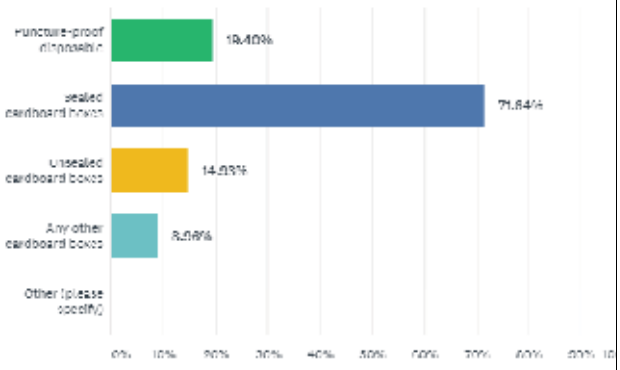
Self-made Sharps Boxes

COVID Boxes

Collection and handling of waste is the second step of healthcare waste management after the segregation at the sources of generation. For this purpose, standard colour coded bins ae used. Either standard boxes or self-made cardboard boxes are used for sharps. Some large scale HCFs have designation carts. HCFs having COVID19 treatments, have especially made bins known as COVID boxes.

Survey Results

Two questions have been included in the survey questionnaire to understand the types of containers used to collect infectious wastes and sharps. Given below are the survey results for 2 groups;

Group 1	Group 2
Types of containers used to collect infectious wastes	
	
Answered (69), Skipped (4)	Answered (67), Skipped (3)
Types of containers used to collect sharps	
	
Answered (70), Skipped (3)	Answered (67), Skipped (3)

Group 1

In Group 1, nearly 73% HCFs use peddle operated bins for infectious waste collection and except around 17%, all other HCFs use some acceptable forms of bins whereas nearly 80% HCFs use sealed cardboard boxes for sharps collection and except around 10%, all other HCFs use some acceptable forms of containers.

Group 2

In Group 2, nearly 39% HCFs use peddle operated bins for infectious waste collection and except around 12%, all other HCFs use some acceptable forms of bins whereas nearly 72% HCFs use sealed cardboard boxes for sharps collection and all other HCFs use some acceptable forms of containers.

Outcome of the Survey Leading to Recommendations

Group 1
- 17% HCFs do not have acceptable forms of bins.
- 10% HCFs do not have acceptable forms of sharp boxes.

Group 2
- 12% HCFs do not have acceptable forms of bins.

Observation Visits Findings

- Collection and handling is somewhat satisfactory in the majority of HCFs.
- Majority of HCFs uses acceptable forms of bins and sharps boxes.
- Colour code is followed either by using coloured bins or with coloured labels with standard symbols and wordings (often in one language and sometimes in bi or tri lingual), occasionally supplemented with easy to understand and recognize simple pictures.
- Standard sharp boxes are too small in size for the need of many HCFs

- Most of the technical staff, both permanent and casual follow operating guidelines and instructions.
- Janitorial categories of some HCFs do not follow operating guidelines and instructions

Key Recommendations

- Standardise bin designs (size, peddle operated lids, wheels for movements, standard colours, stickers with standard symbols and tri lingual wordings, supplemented with easy to understand and recognize simple pictures) in consultation with leading manufactures.
- Standard sharp boxes in 3 standard sizes (small, medium and large) in collapsible form for easy transportation
- Ensure the adherence of operating guidelines and instructions by Janitorial categories
- Need to introduce training and awareness raising programmes particularly for janitorial staff

12.3.4 Transportation

Introduction

Wheeled Carts for Internal Transport

Tractors for Food Waste Transport

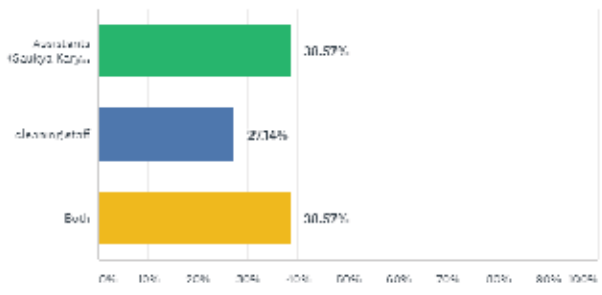
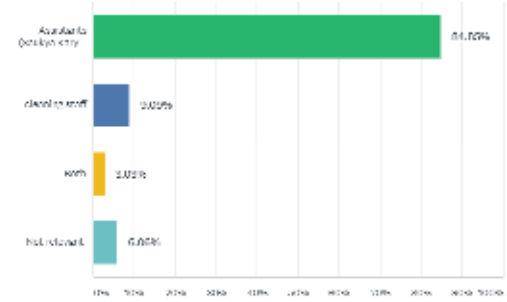
Wheeled Carts for Internal Transport

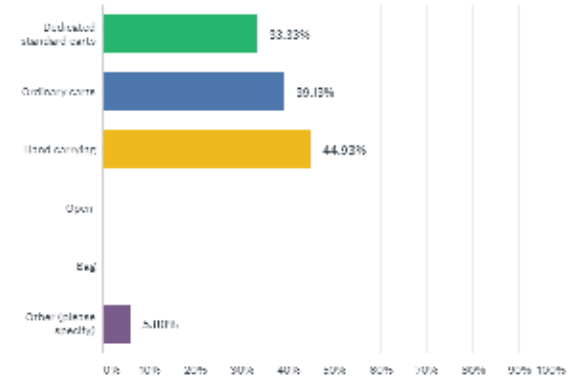
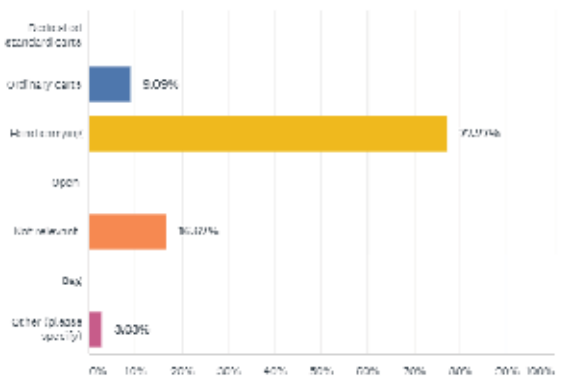
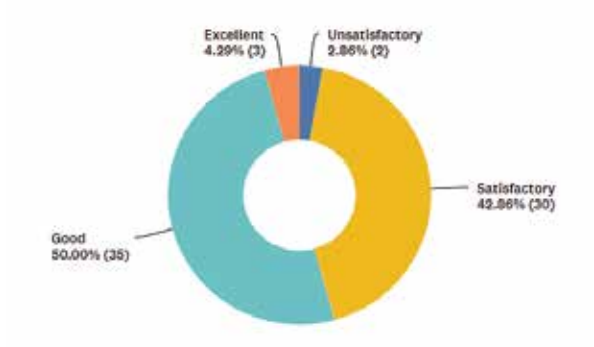
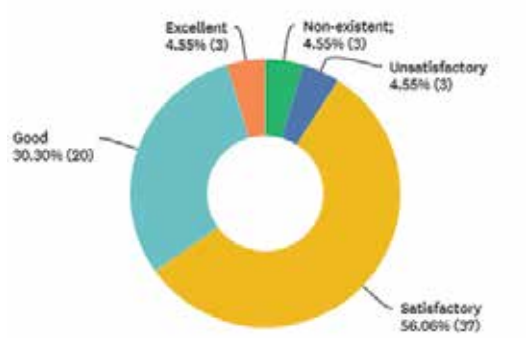
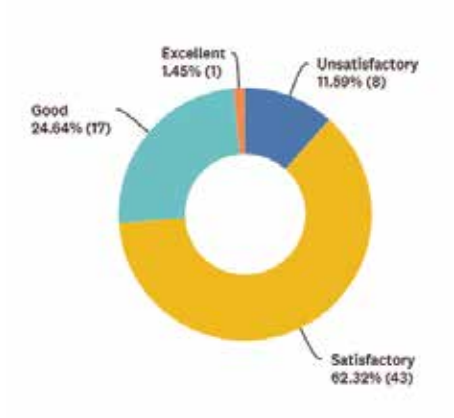
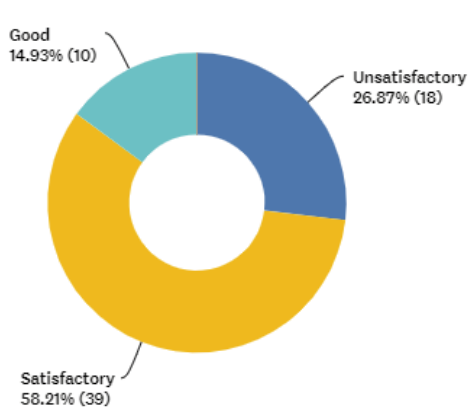
Dedicated Vehicles for External Transport

Transportation of waste is the third step of healthcare waste management. It can be either internal transport (from the points of collection up to the intermediate or central store before being internally treated) or transport for external treatments. For internal transport purpose, various types of carts are used or hand carried. Designated vehicles are used for external transport.

Survey Results

Some questions have been included in the survey questionnaire to understand the manner in which the internal transport of hazardous healthcare waste is done, type of containers used and the safe handling of wastes by both Technical (Medical, Nursing. etc.,) and Non-Technical (Assistants, Cleaning Staff, etc.) staffs. Given below are the survey results for 3 groups;

Group 1	Group 2
Internal transport of hazardous healthcare waste	
	
Answered (70), Skipped (3)	Answered (66), Skipped (4)

Containers used for Internal Transportation of Infectious Wastes	
 Answered (69), Skipped (4)	 Answered (66), Skipped (4)
Safe Handling of Wastes by Technical Staff (Medical, Nursing. etc.,)	
 Answered (65), Skipped (7)	 Answered (66), Skipped (4)
Safe Handling of Wastes by Non-Technical Staff (Assistants, Cleaning Staff, etc.)	
 Answered (64), Skipped (8)	 Answered (67), Skipped (3)

Group 1

In Group 1, the internal transport of hazardous healthcare waste is handled by Assistants (Saukya Karya Mandalaya) and Cleaning Staff. Hand carrying is done in 45% of HCFs and over 72% of HCFs have either ordinary or dedicated carts. Almost 97% of HCFs' Technical Staff (Medical, Nursing. etc.,) handle waste in a safe and satisfactory manner while around 88% of Non-Technical Staff (Assistants, Cleaning Staff, etc.) too handle waste in a safe and satisfactory manner.

Group 2

In Group 2, the internal transport of hazardous healthcare waste is mainly handled by Assistants (Saukya Karya Mandalaya). Hand carrying is done in 77% of HCFs and only about 8% of HCFs have even ordinary carts. Almost 91% of HCFs' Technical Staff (Medical, Nursing. etc.,) handle waste in a safe and satisfactory manner while around 27% of Non-Technical Staff (Assistants, Cleaning Staff, etc.) do not handle waste in a safe and satisfactory manner.

Outcome of the Survey Leading to Recommendations

Group 1

- 97% of HCFs' Technical Staff (Medical, Nursing. etc.,) and 88% of Non-Technical Staff (Assistants, Cleaning Staff, etc.) handle waste in a safe and satisfactory manner.
- Hand carrying is done in 45% of HCFs
- Over 72% of HCFs have either ordinary or dedicated carts

Group 2

- 91% of HCFs' Technical Staff handle waste in a safe and satisfactory manner while around 27% of Non-Technical Staff do not handle waste in a safe and satisfactory manner
- Hand carrying is done in 77% of HCFs
- Only about 8% of HCFs have even ordinary carts

Observation Visits Findings

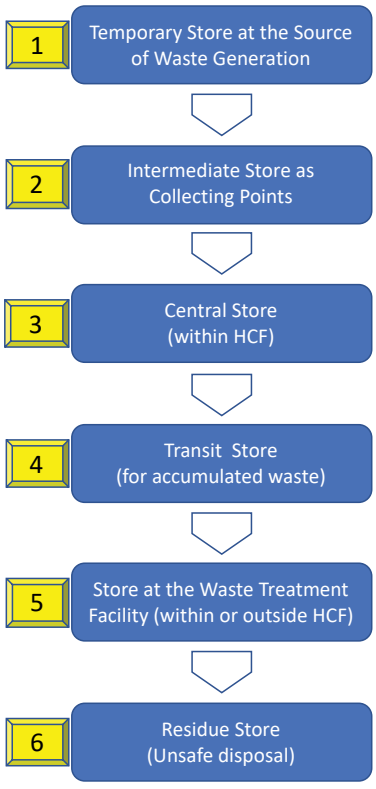
- Internal transportation of waste is satisfactory in almost all HCFs
- In some HCFs, Non-Technical Staff do not follow best practices.
- In some HCFs, there are dedicated vehicles though they are not marked with recommended signage

Key Recommendations

- Ensure the adherence of operating guidelines and instructions by Non-Technical Staff
- Small scale HFCs should also provided with necessary facilities for HCWM
- Enforce need for proper signate on vehicles

12.3.5 Storage

Introduction

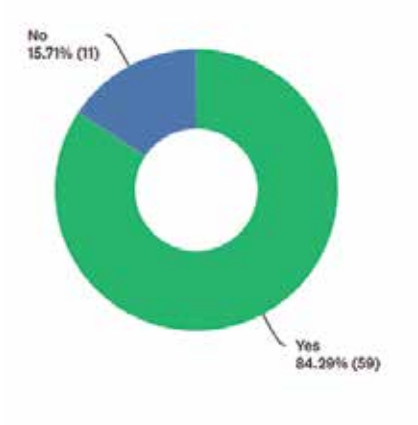
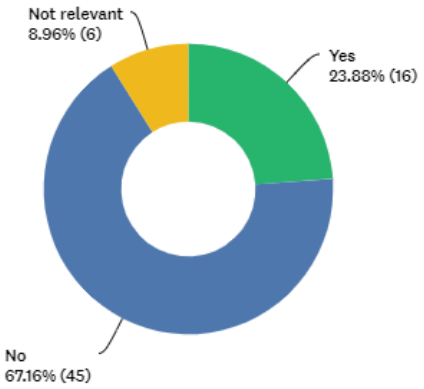
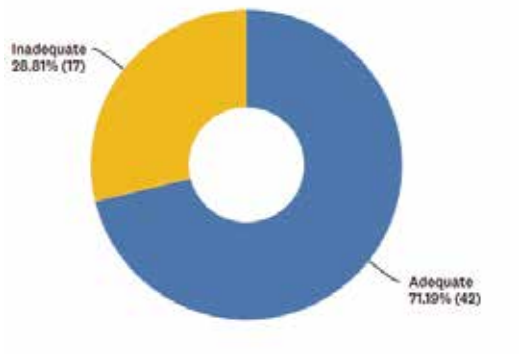
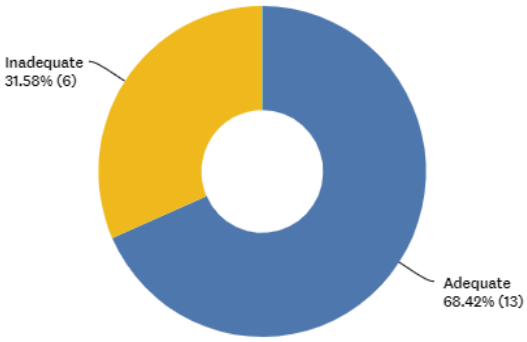
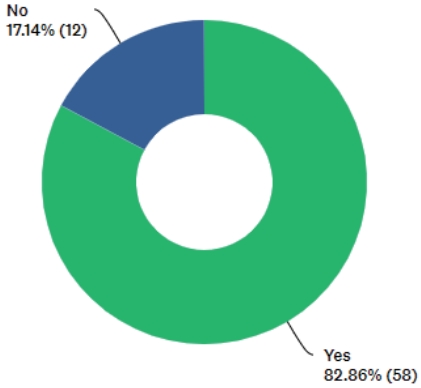
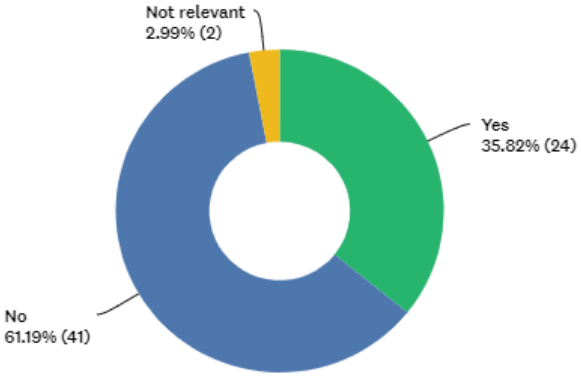


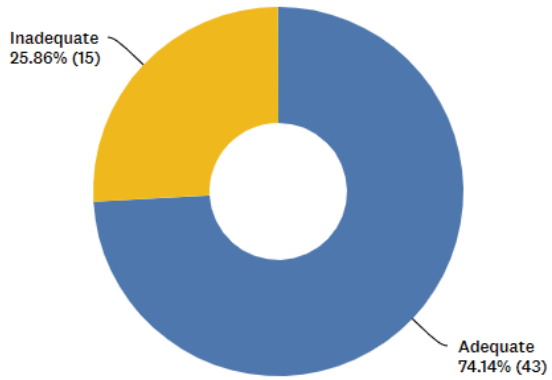
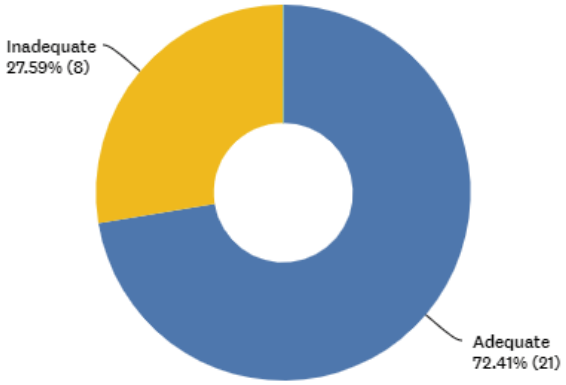
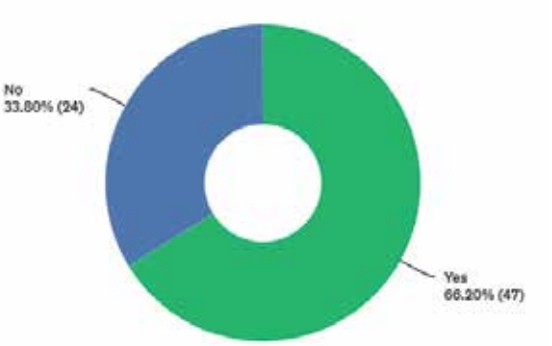
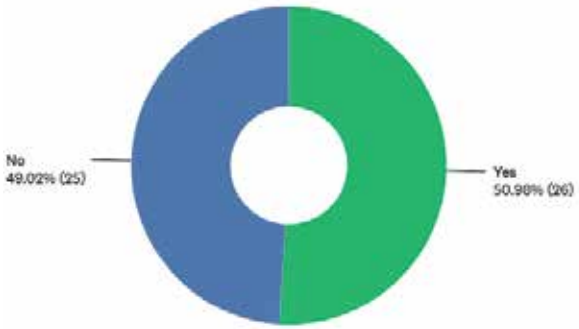
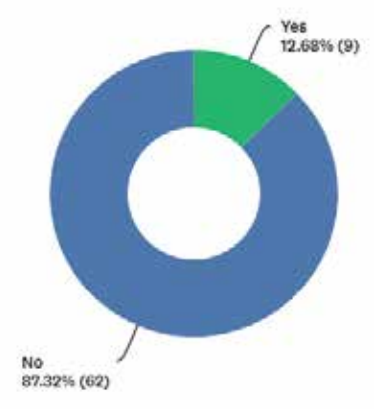
Healthcare waste storage is an essential element of healthcare waste management. Storages of different configurations are required at different stages of the waste management hierarchy from the point of waste generation until the final disposal depending on the type of waste generated such as infectious, sharps and general waste. Residential time (length of stay) of waste storage at different levels vary with the manner in which the next activity of the waste management hierarchy is organized.

Depicted here is the general flow of waste through different storage steps. While steps No 1 (at source) and No 3 (central store) are available at all levels of HCFs, No 4 (transit stores) are available only in some large scale HCFs (some are in sealed containers as shown and in other cases in open areas) when there are issues with internal or external waste treatments. Some HCFs have intermediate temporary stores (No 2) as collection points and even with weighing facilities. Many treatment facilities have little storage facilities (No 5) either in dedicated containers in Metamizers and in normal stores in incinerators. Many HCFs are saddled with the issue of residue disposal and are compelled to have it in unsafe open dumps (No 6) though these should not be treated as accepted storage.

Survey Results

Some questions have been included in the survey questionnaire to understand the availability of storage facilities (No 3 level only) for infectious waste, sharps, radioactive waste, their adequacy and the accessibility for unauthorized personnel. Given below are the survey results for 3 groups;

Group 1	Group 2
Availability of Stores for Infectious Waste	
 Answered (70), Skipped (3)	 Answered (67), Skipped (3)
Adequacy of Infectious Waste Store	
 Answered (59), Skipped (14)	 Answered (19), Skipped (51)
Availability of Stores for Sharps	
 Answered (70), Skipped (3)	 Answered (67), Skipped (3)

Adequacy of Sharps Stores	
 Answered (58), Skipped (15)	 Answered (29), Skipped (41)
Restricted Access to Waste Stores	
 Answered (71), Skipped (2)	 Answered (51), Skipped (19)
Availability of Radioactive Treatment	
 Answered (71), Skipped (2)	

Availability of Delay Tanks	
 Answered (10), Skipped (63)	
Adequacy of Delay Tanks	
 Answered (7), Skipped (66)	

Group 1

In Group 1, over 80% HCFs have store facilities for infectious waste, sharps and also for general waste though nearly 29% of them do not have adequate capacities. Nearly 34% of stores have not restricted the access of unauthorized personnel.

Only about 13% has radioactive treatments and only around 50% of them have delay tanks. Around 43% of those who have delay tanks do not have adequate capacities.

Group 2

In Group 2, over 61% HCFs do not have store facilities for infectious waste, sharps and also for general waste and of them over 28% of them do not have adequate capacities. Nearly 49% of stores have not restricted the access of unauthorized personnel.

No radioactive treatments in Group 2.

Outcome of the Survey Leading to Recommendations

Group 1

- 20% HCFs do not have store facilities.
- 29% of stores are under capacity.
- 34% of stores have not restricted access.
- Only 50% have delay tanks where there are radioactive treatments.
- Around 43% of delay tanks are under capacity.

Group 2

- 61% HCFs do not have store facilities.
- 28% of stores are under capacity.
- 49% of stores have not restricted access.

Observation Visits Findings

- Storages become inadequate not mainly because of their built capacity but due to the issues in waste treatments.
- Under capacity of storage results in keeping waste in unsafe places and under the sun and rain creating environmental, social and health issues.
- Some stores are built in very sensitive areas.
- Unavailability of a proper system for the safe disposal of residues (residues from Metamizers and ash from incinerators) creates enormous environmental, social and health issues.

Key Recommendations

- Finding a lasting solution to waste treatment and residue disposal by treating it as a national problem with the involvement of Central Government, Provincial Councils and Local Authorities
- Provision of store facilities to all HCFs that do not currently have such facilities and enhance the capacities of existing ones where necessary.
- Prevention of unauthorized entry to all types of stores.
- Provision of delay tanks with adequate capacities to all HCFs having radioactive treatments.
- Issuing clear guidelines for siting stores.
- Issuing clear guidelines for store constructions.

12.4 Treatment of Waste Generated in HCFs

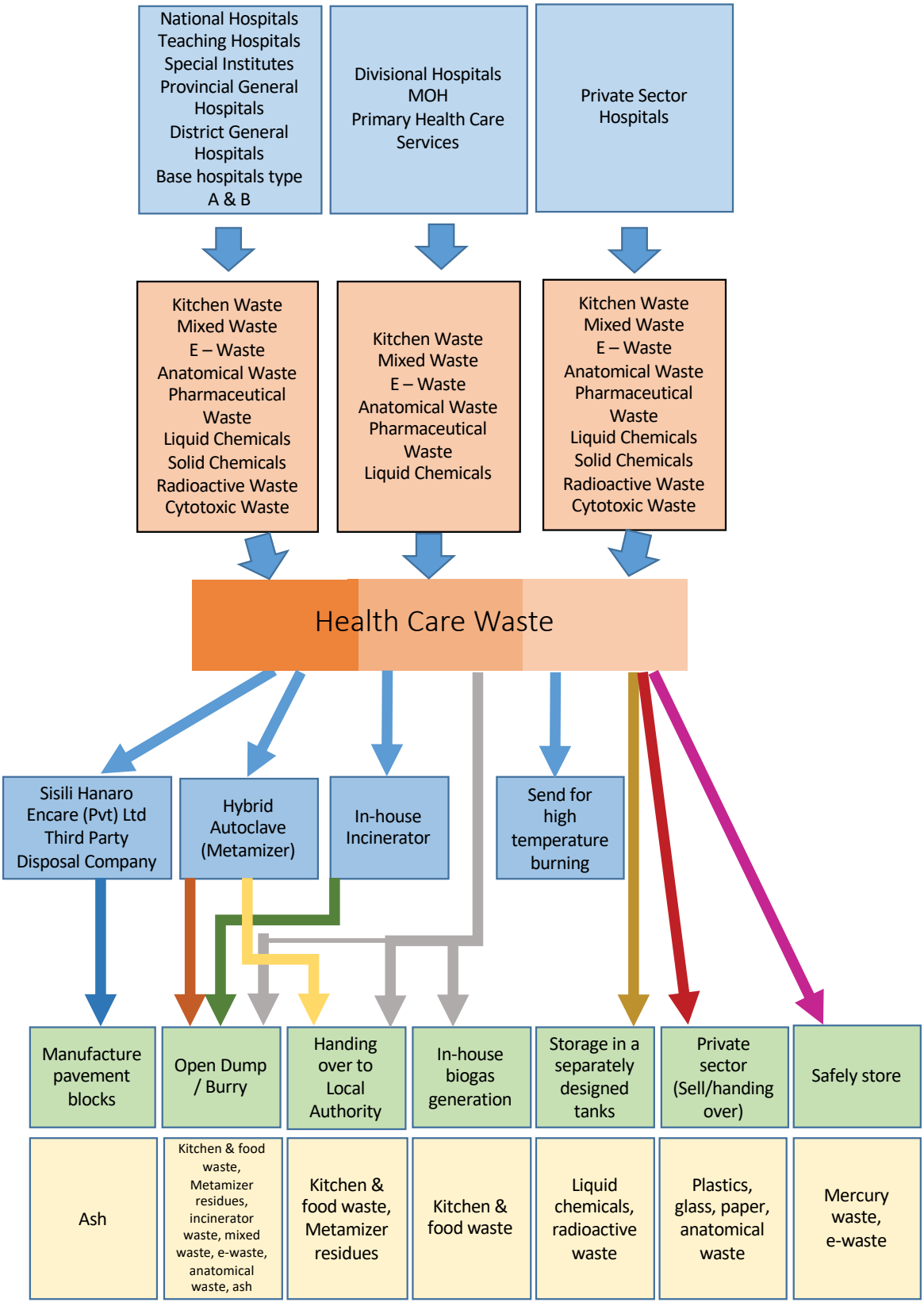
Maintaining a clean and hygienic environment is very essential in health care facilities since the main objective of such institutions are to address the public's health problems. In general, the "Waste" management practices in the country have to be improved in many ways and it has been observed that the management of health care waste needs even more attention as it has higher potential for infection and injury than any other type of general waste.

The HCF management is totally responsible for health care waste management. Waste recycling, treatment and final disposal are three major areas coming under the waste management. Treatment of clinical waste and disposal are done both internally and externally. The treatment techniques and disposal methods are dependent on the types and the quantities of waste generated.

Twelve waste categories have been identified in healthcare sector depending on the source of waste generated, characteristics of waste and the treatment techniques adopted, and the list of such categories are given in the following table.

No.	Waste Category	No.	Waste Category
01	Kitchen waste	07	Solid chemicals (Culture media)
02	Mixed waste including garden waste	08	Radioactive
03	e-waste	09	Cytotoxic
04	Anatomical waste	10	Mercury
05	Pharmaceutical waste	11	Infectious waste
06	Liquid chemicals (lab + radiology)	12	Sharps

Plastics, PET bottles, glass bottles, cardboards and food waste are sellable materials and it has been observed that most of the hospitals sell these materials to outsiders. Different waste treatment methods which are being adopted in HCFs for the above mentioned twelve different waste types are discussed in this section. The details given below are based on the information gathered from both survey questionnaire and observation visits.



Overall Structure of Waste Management

12.4.1 External Treatment Facilities

Out of the total sample, about 44% of hospitals obtain the services of third-party private companies for clinical waste treatment and disposal.

Group 1

Services taken from private companies for the final disposal of clinical wastes

Answered (73)

12.4.2 Onsite Treatment Facilities

Around 44% hospitals in Group 1 do not have onsite treatment facilities and therefore, send the waste to respective local authorities or to private treatment facilities for treatment and disposal. Others are equipped with treatment facilities such as incinerators, autoclaves or hybrid autoclaves (Metamizer) or combinations.

Operation of Incinerators

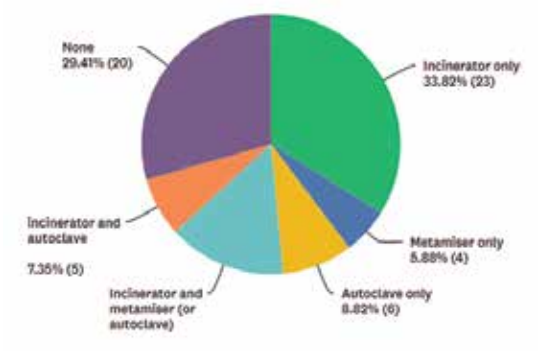
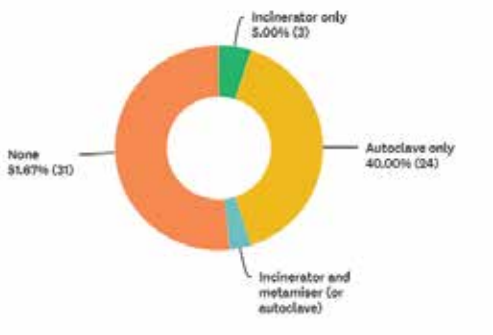
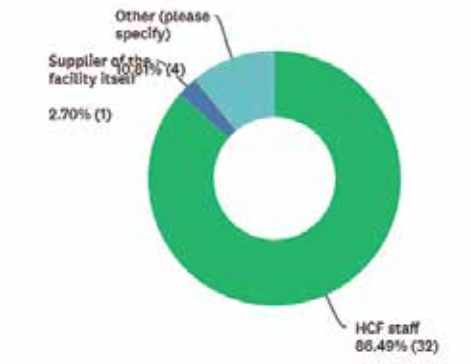
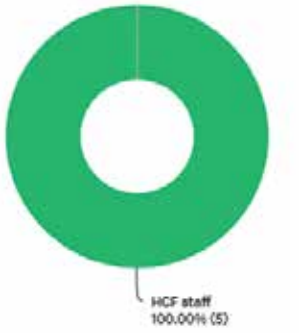
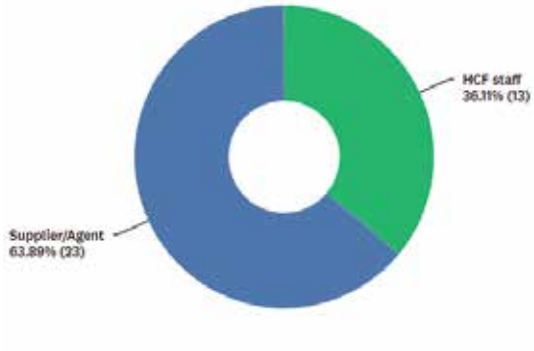
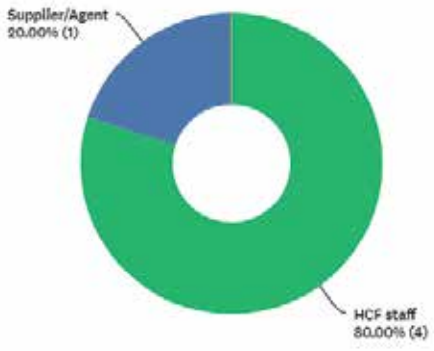
Most of the incinerators (around 86% in Group 1 and 100% in Group 2) are operated by health care facility staff and the rest are operated by respective suppliers or by third-parties. Proper maintenance of incinerators is very essential to operate them at the recommended conditions and to maintain the recommended emission levels from the stack. However, as maintenance is carried out by health care facility staff themselves in many places, the majority of incinerators do not operate at the recommended level. Short of funds, lack of spare parts, lack of competent persons are some issues directly attributable to poor maintenance. In addition, frequent power failures and public resistance are some operational issues faced by health care facilities.

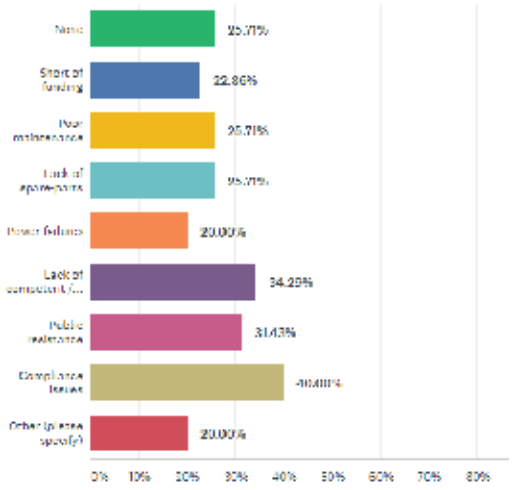
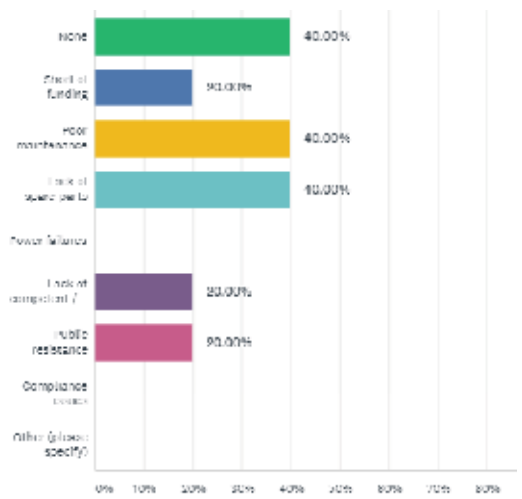
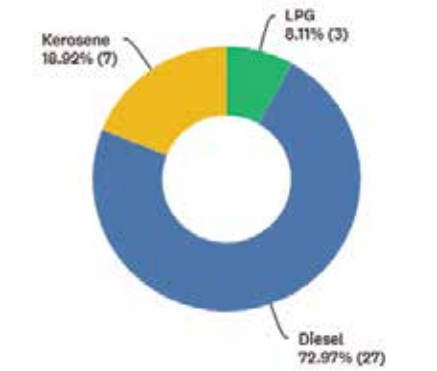
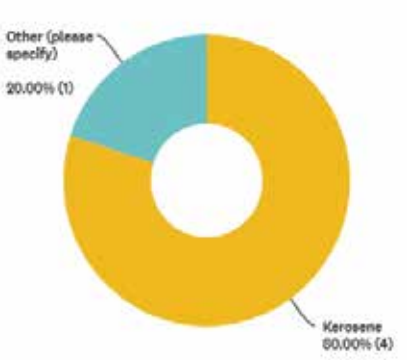
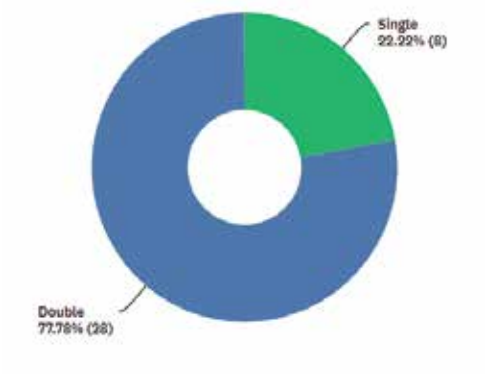
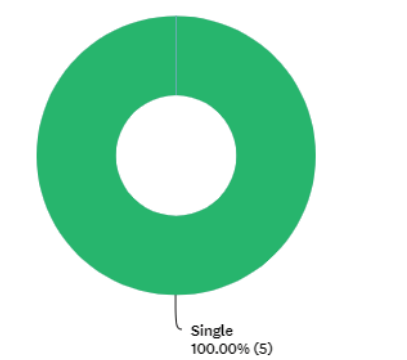
There is a considerable number of single chamber incinerators (about 23% in Group 1 and 100% in Group 2) and as per the Stockholm Convention, use of single chamber incinerators is not recommended. Most of the incinerators are manually operated (around 97% in Group 1 and 100% in Group 2) and out of which around 32% in Group 1 and 75% in Group 2 are not equipped with proper temperature control facilities and therefore, meeting the required environmental parameters is a challenge. Most of the incinerators are equipped with cyclone separators, flue gas filters or water scrubbers for dust emission control but around 40% in both groups do not have any such control systems.

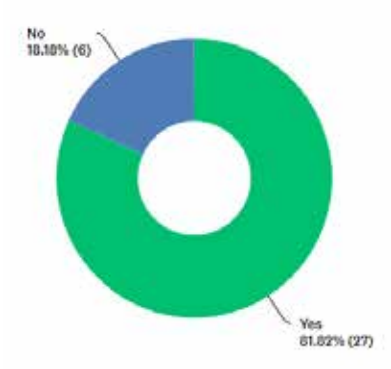
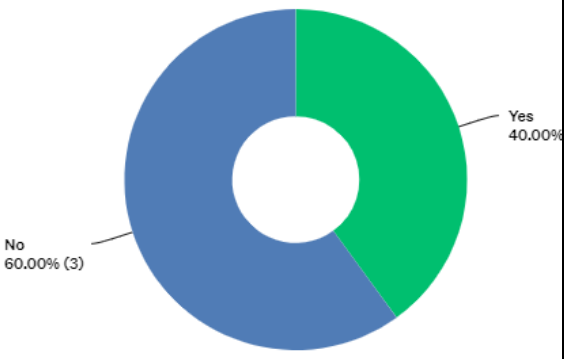
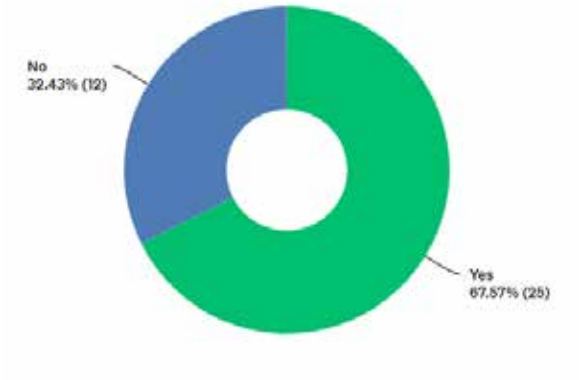
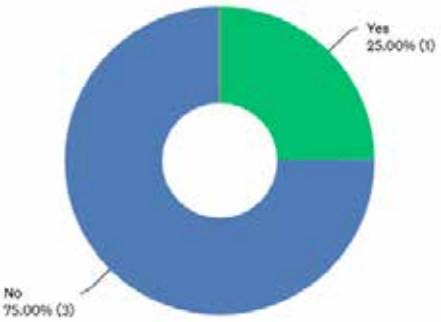
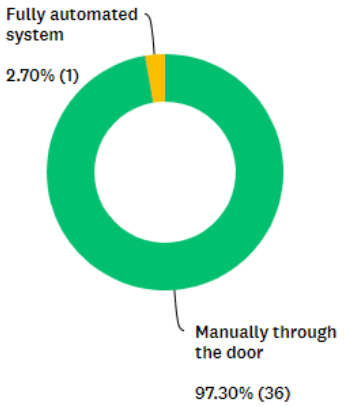
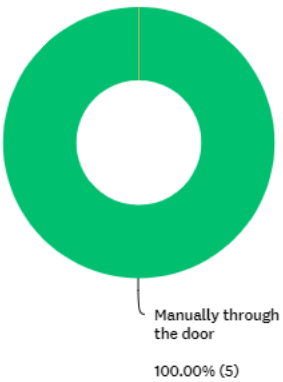
The bottom-ash from incinerators is buried within HCF premises, sent to respective local authorities, sent to secure landfills or placed in ash pits as final disposal. Annex 7 provides internationally accepted incinerator ash disposal practices.

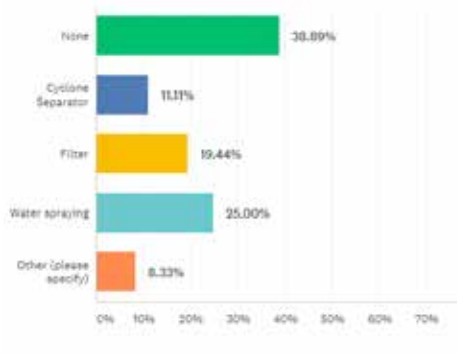
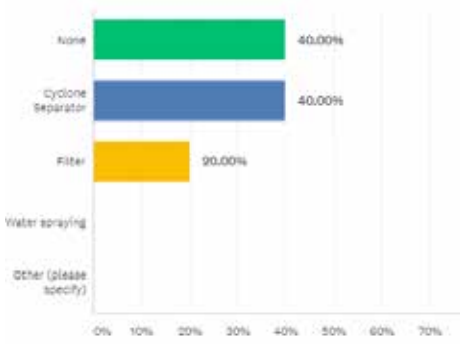
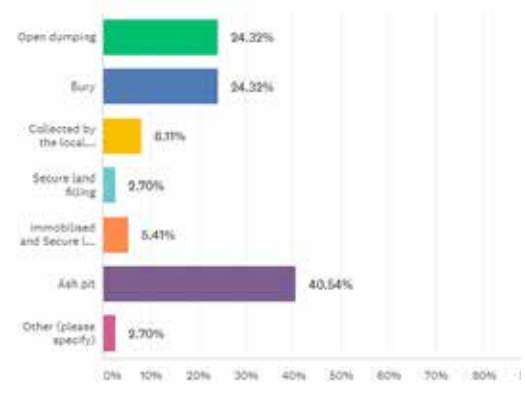
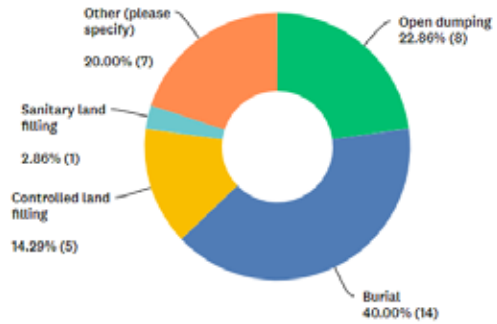
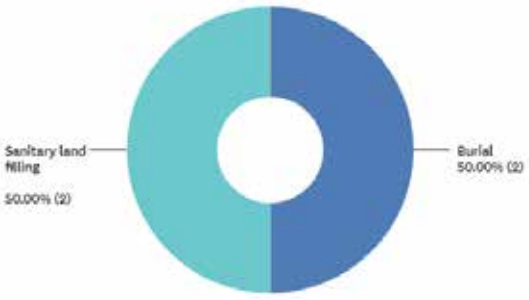
New Incinerator in Badulla Hospital

Very old Incineration Technology

Group 1	Group 2
Onsite Treatment Facilities	
	
Answered (68), Skipped (5)	Answered (60), Skipped (10)
Responsibility of Incinerator Operation	
	
Answered (37), Skipped (36)	Answered (5), Skipped (65)
Maintenance of on-site Incinerators	
	
Answered (37), Skipped (36)	Answered (5), Skipped (65)

Operational Problems Related to Onsite Incineration	
	
Answered (35), Skipped (38)	Answered (5), Skipped (65)
Type of Fuel Used	
	
Answered (37), Skipped (36)	Answered (5), Skipped (65)
Numbers of Chambers in Incinerators	
	
Answered (36), Skipped (37)	Answered (5), Skipped (65)

Availability of After-burners	
 Answered (33), Skipped (40)	 Answered (68), Skipped (5)
Provision for Temperature Control in Incinerators	
 Answered (37), Skipped (36)	 Answered (4), Skipped (66)
Type of Feeding Mechanism in Incinerators	
 Answered (37), Skipped (36)	 Answered (5), Skipped (65)

Types of Air Pollution Control (Fly-ash Collection) Systems in Incinerators	
 Answered (36), Skipped (37)	 Answered (5), Skipped (65)
Disposal Mechanism of Bottom-ash from Incinerators	
 Answered (37), Skipped (36)	 Answered (5), Skipped (65)
Disposal of Sharps Remaining after Incineration	
 Answered (35), Skipped (38)	 Answered (4), Skipped (66)

12.4.3 Operation of Hybrid Autoclave (Metamizer)

Hybrid autoclave technology has been introduced for treating clinical waste in the state sector health care facilities in late 2016 and out of the total number of installations until late 2018, about 85% is currently in operation. Metamizer is the brand name of this hybrid technology and the country of origin is Australia. The container capacity of this unit is 240 liters and 50kW hydraulic pump is there for system operation. In general, around 30 to 40 kWh of electricity is consumed for one-hour operation.

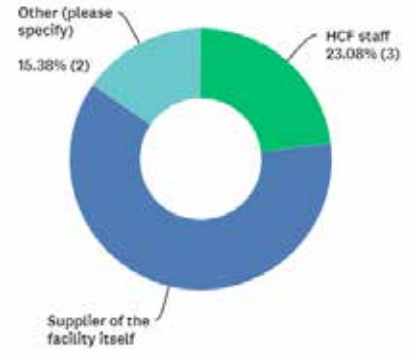
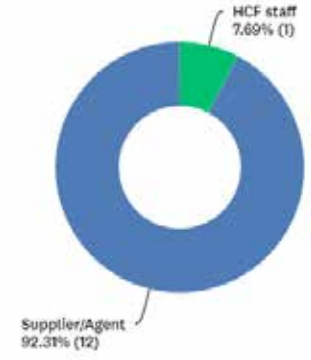
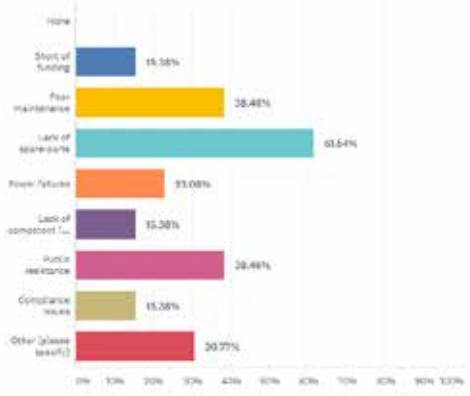
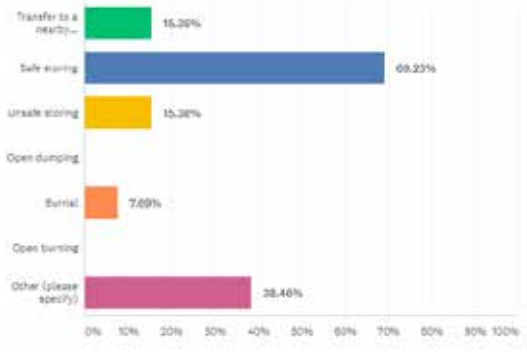
Metamizers are operated by both the supplier (Local agent) and HCF staff and maintenance is undertaken by the supplier. Lack of spare parts and lack of competent operators are some issues affecting the maintenance of this equipment. When the Metamizers are out of operation, either

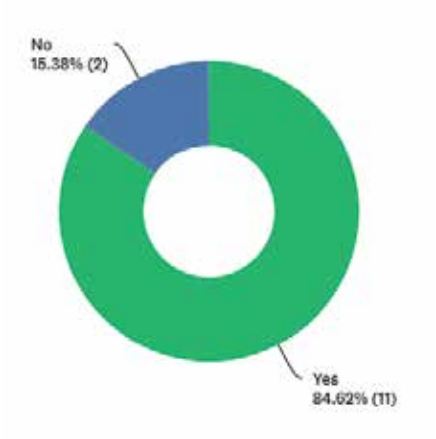
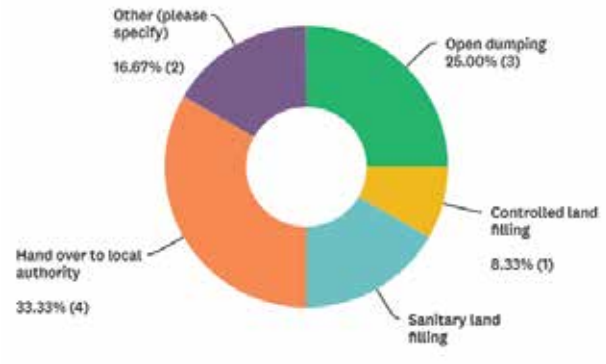
the waste is transferred to nearby HCFs or store in the site itself until the machines are put back into operation. Sometimes, it is buried in HCF premises due to lack of spaces for storage.

After treating the waste, the remains are sent to landfilling, open dumping or handed over to local authorities.

In Group 2, there is one Metamizer, but they haven't responded to the relevant questions.

In Group 1, Metamizers are available in 13 hospitals out of 70 responded and the results below are given based on the details provided by these hospitals.

Group 1	
Operational Responsibility of On-site Metamisers	Maintenance of On-site Metamisers
 Answered (13), Skipped (60)	 Answered (13), Skipped (60)
Operational Problems of the On-site Metamisers	When On-site Metamiser Not Functioning
 Answered (13), Skipped (60)	 Answered (13), Skipped (60)

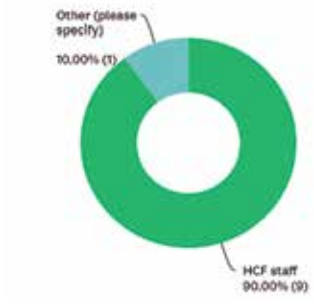
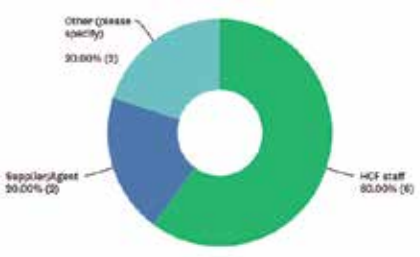
Metamisers Currently in Operation	Waste Disposal After Metamising
	
Answered (13), Skipped (60)	Answered (12), Skipped (61)

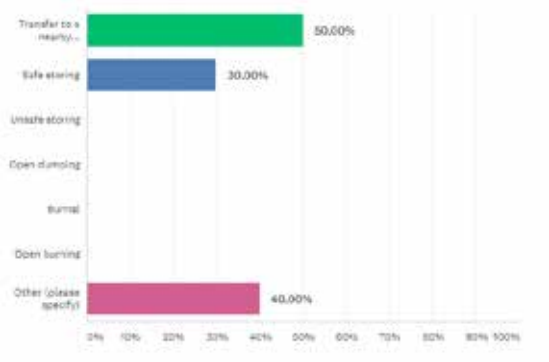
Operation of Autoclaves

Autoclaving is not a new technology for HCFs. Autoclaves are used for both waste treatment and laboratory applications. As per the survey response, about 90% of HCFs use autoclaves for waste treatment which is a misunderstanding of respondents about the use of autoclaves as they are being used only in laboratories and for sterilization in operating theaters.

No autoclaves are available in Group 2.

In Group 1, autoclaves are available in 10 out of 70 hospitals and the results below are given based on the details provided by these hospitals.

Group 1	
Operational Responsibility of On-site Autoclaves	Maintenance of On-site Autoclaves
	
Answered (10), Skipped (63)	Answered (10), Skipped (63)

Operational Problems of On-site Autoclaves	When On-site Autoclave Not Functioning
 Answered (10), Skipped (63)	 Answered (10), Skipped (63)
Autoclaves Currently in Operation	
 Answered (10), Skipped (63)	

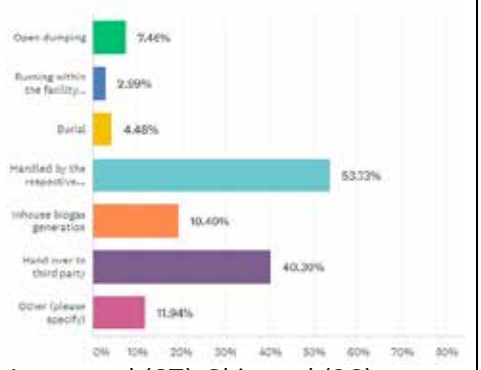
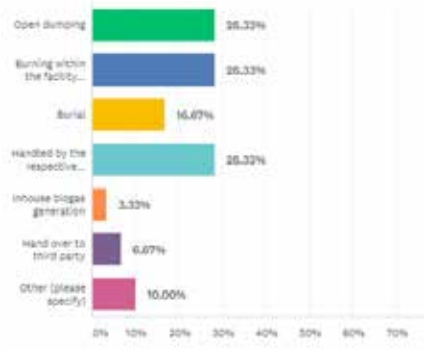
Observations Visit Findings

- All HCFs are taking their maximum effort to manage waste with available facilities to maintain a clean and safe environment.
- It has been observed that in many situations, desired practices such as continuous monitoring and preventive maintenance are not implemented in the operation of hybrid autoclaves like Metamizers and therefore, frequent breakdowns are prevalent.
- However, smooth operation of such equipment should not be expected from HCF staff as it is not their core competencies.
- Even though some HCFs have indicated autoclaving as one of the waste treatment technologies in the survey response, it has been noticed that autoclaves are not used for waste treatment but in laboratories and for sterilization needs of operating theatres.

12.4.4 Disposal of Waste

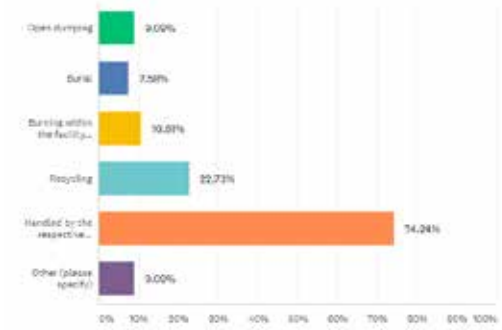
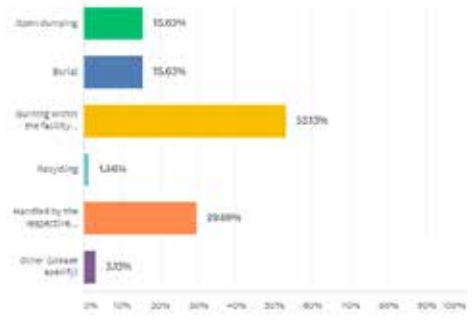
Disposal of Kitchen Waste

More than 50% of HCFs in Group 01 and about 30% in Group 02 hand over the kitchen waste to respective local authorities for disposal and around 40% hand over to third parties for animal feed (eg. Piggeries). In-house biogas generation is also popular to a certain extent in Group 01 (about 20% of the sample) and it has been noticed that the lack of space for installation of biogas units is the major constraint for not having such systems.

Group 1	Group 2
Methods of Food & Kitchen Wastes Treatment	
	
Answered (67), Skipped (06)	Answered (60), Skipped (10)

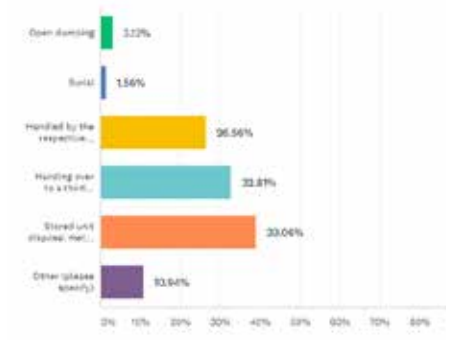
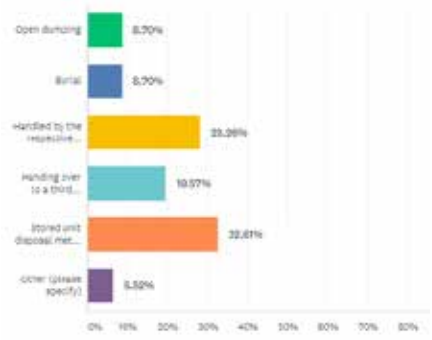
Disposal of Mixed Waste

Mixed waste comprises of food waste from wards, plastics and pet bottles, glass bottles, cardboards, etc. It has been observed during the site visits that most of the hospitals sell cardboards, glass bottles, plastics and pet bottles and other waste is handed over to respective local authorities for disposal. Similar situation can be observed in this sample, but around 10% of the Group 01 and over 50% in Group 02 dump waste openly, buried or burn in open pits. Such practices are not acceptable as safe disposal methods and therefore, needs proper attention in the future.

Group 1	Group 2
Methods of General Waste (Mixed Waste) Treated	
	
Answered (66), Skipped (07)	Answered (64), Skipped (6)

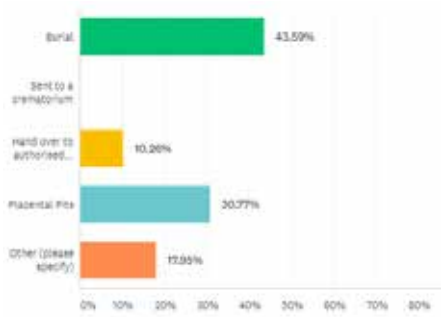
Disposal of e-waste

In general, there is no proper system or mechanism in place for disposing the e-waste in Sri Lanka yet and hence, no one can expect an ideal solution from HCFs. Most of the hospitals store e-waste until a proper mechanism is introduced and at times hands over to third parties or to respective local authorities. The alarming situation is that about 5% of HCFs, either open dumps or bury the e-waste which is very harmful to the environment.

Group 1	Group 2
E-waste management procedure	
	
Answered (64), Skipped (9)	Answered (46), Skipped (24)

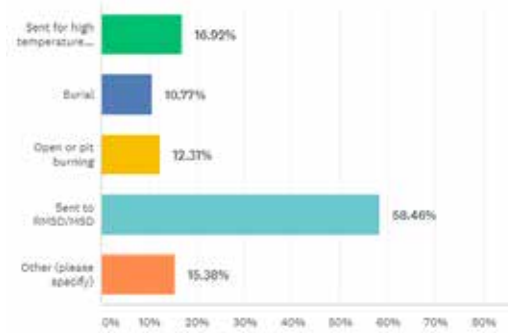
Disposal of Anatomical Waste

About 43% of HCFs in Group 01 and about 10% in Group 02 hand over the anatomical waste to authorized agencies and about 30% to 47% HCFs dispose placenta in placenta pits available within hospital premises. The hospitals where only small quantities of anatomical waste is generated bury the waste.

Group 1	Group 2
Method of Anatomical Waste Disposal	
	
Answered (65), Skipped (8)	Answered (39), Skipped (31)

Disposal of Pharmaceutical Waste

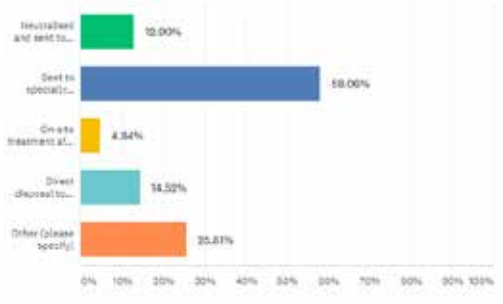
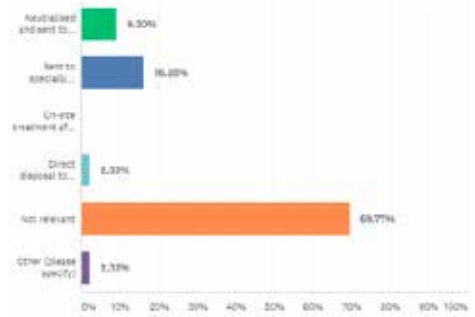
About 60% of HCFs send the pharmaceutical waste to RMSD/MSD in both categories for disposal as per the defined standard and about 18% used to send these wastes to high temperature incineration in a cement factory. About 10% to 15% HCFs burry pharmaceutical waste and around 12% in Group 01 and 25% in Group 02 burn in open pits. These two practices are not acceptable and therefore, needs proper attention to introduce sanitary disposal methods.

Group 1	Group 2
Pharmaceutical Waste Management Methods	
	
Answered (65), Skipped (08)	Answered (57), Skipped (13)

Management of Liquid Chemicals

About 71% of HCFs in Group 1 send liquid chemicals (both lab and the radiology) to specially designed safe containers with or without neutralizing and about 5% directly send it to water stream after treating on-site. However, around 15% directly discharge to open drains.

In Group 2, about 17% of HCFs in Group 1 send liquid chemicals (both lab and the radiology) to specially designed safe containers with or without neutralizing. However, around 2% directly discharge to open drains.

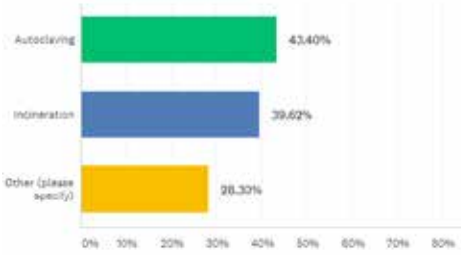
Group 1	Group 2
Management of Liquid Chemicals Waste	
	
Answered (62), Skipped (11)	Answered (43), Skipped (27)

Management of Solid Chemicals

Majority of the hospitals use autoclave and incineration technology for disposing solid chemicals (e.g. culture media) and about 29%, in Group 1 dump or burry.

Group 1

Management of Solid Chemicals



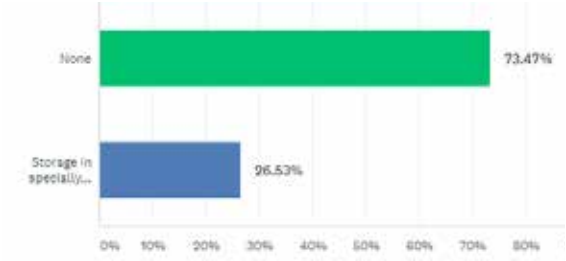
Answered (53), Skipped (20)

Management of Radioactive Waste

In Group 1, radioactive treatments are available in 30% of HCFs and all of them store these waste in specially designed safe containers/tanks.

Group 1

Management of Radioactive Wastes



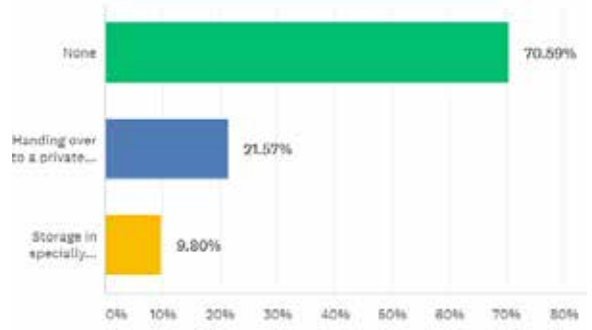
Answered (49), Skipped (24)

Management of Cytotoxic Waste

In Group 1, cytotoxic waste is not treated in-house and hence either hand over to a third-party private company for treatment or store in specially designed and built containers or tanks in HCF premises.

Group 1

Management of Cytotoxic Wastes



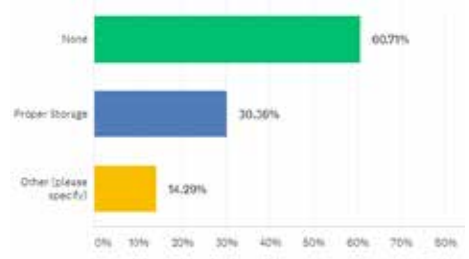
Answered (51), Skipped (22)

Management of Mercury Waste

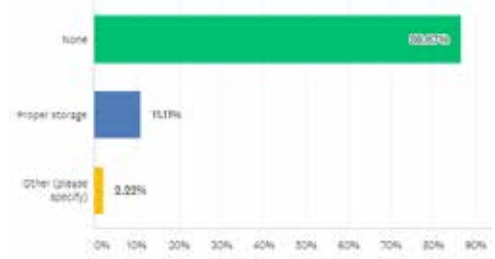
Even though the Ministry of Health has taken a decision to phase out the use of medical equipment containing mercury in hospitals, still there are few items (Blood pressure measuring apparatus and thermometers) available in some hospitals. Most of them handover the damaged items to condemning units but are not aware of what happens thereafter. In a few cases, it was reported that they are compelled to burry these wastes due to the absence of a proper disposal method.

Group 1 Group 2

Management of Mercury Wastes



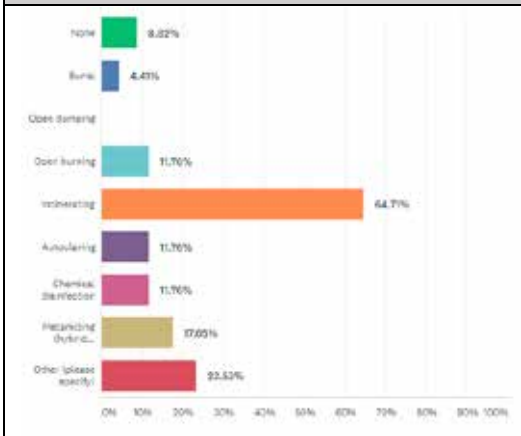
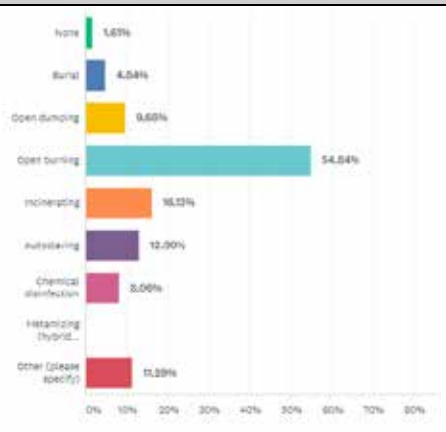
Answered (56), Skipped (17)



Answered (45), Skipped (25)

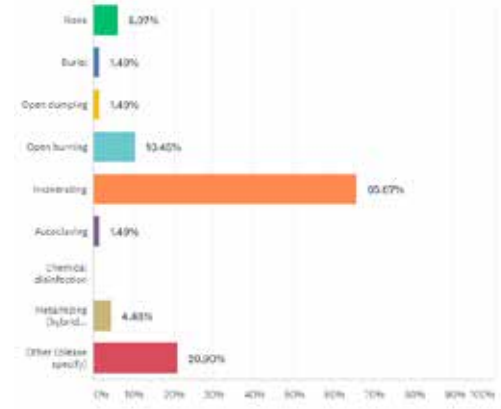
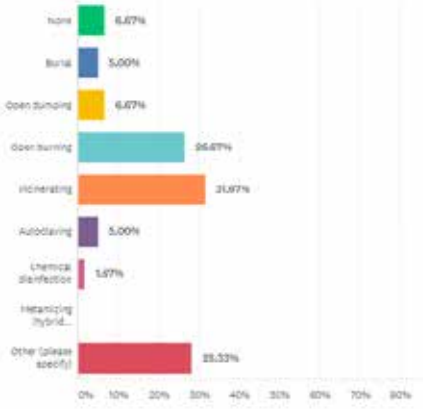
Management of Infectious Waste

In Group 2, majority of HCFs either use incineration, autoclaving, hybrid autoclaving (Metamizers), chemical disinfection as on-site-treatment techniques or hand over to a private company for off-site-treatment. However, in Group 1, over 17% of HCFs, either burry or open burn while in Group 2, more than 54% hospitals burn openly and more than 9% open dump these wastes which is very harmful since there is a grave risk of air pollution in addition to surface and ground water contamination.

Group 1	Group 2
Treatment of Infectious Waste	
	
Answered (68), Skipped (05)	Answered (62), Skipped (08)

Management of Waste Sharps

Similar to infectious waste, in Group 2, majority of HCFs either use incineration, autoclaving, hybrid autoclaving (Metamizers) as on-site-treatment techniques or hand over to a private company for off-site-treatment. However, in Group 1, over 13% of HCFs, either burry or open burn while in Group 2, more than 26% hospitals burn openly and more than 6% open dump these wastes which is very harmful since there is a grave risk of injuries in addition to surface and ground water contamination.

Group 1	Group 2
Treatment of sharps	
	
Answered (67), Skipped (08)	Answered (60), Skipped (10)

Observations Visit Findings

General solid waste, especially the coconut shells from kitchens can be effectively utilized for hot water generation to partially fulfil the hot water needs of kitchens and the wards. Locally made biomass fired hot water generators are available. This technology has been successfully adopted by Monaragala and Kurunegala hospitals and thereby the usage of LPG has been drastically reduced.

Hot water generator in Monaragala Hospital

Observations / Visit Findings

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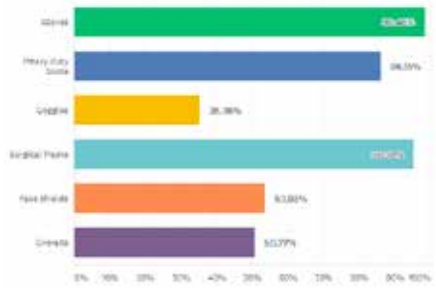
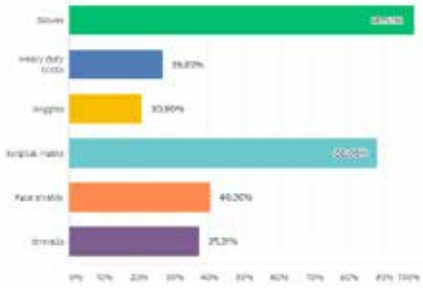
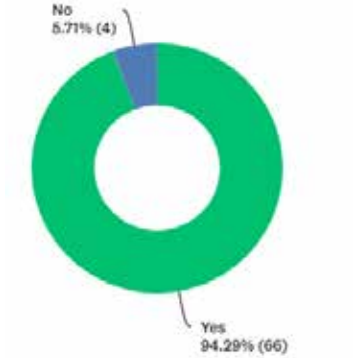
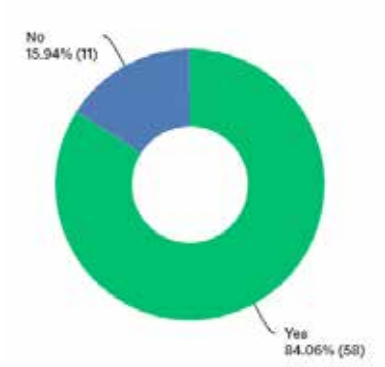
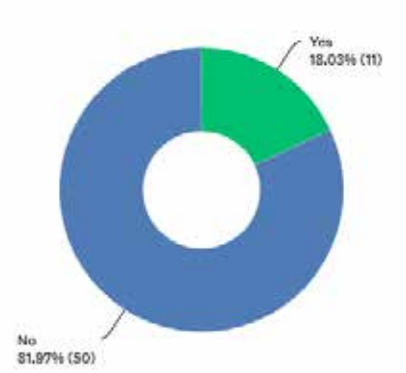
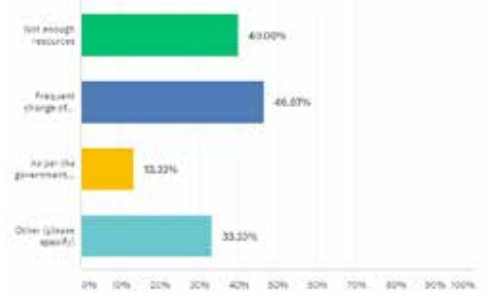
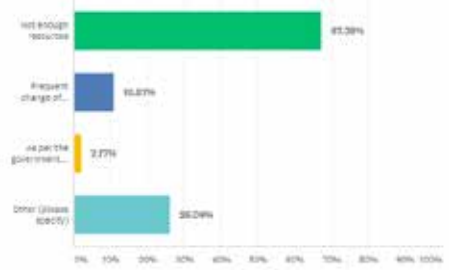
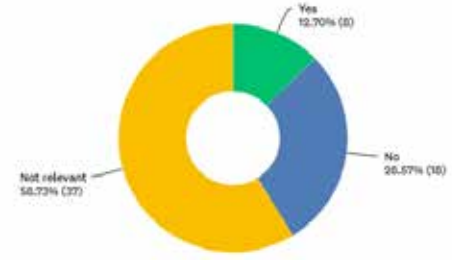
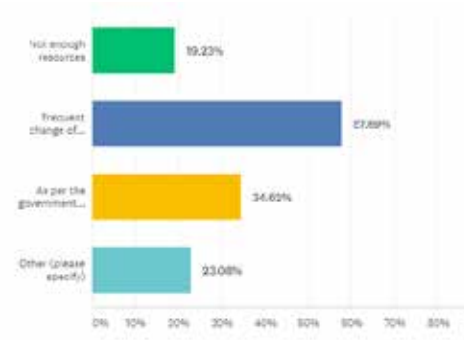
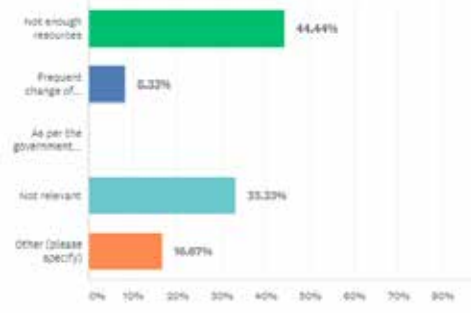
Biogas Unit in Karapitiya Hospital

There are few hospitals like Monaragala, Karapitiya, etc. where the perishable kitchen waste is used for biogas generation. Though the biogas unit in Karapitiya hospital is designed only for the kitchen waste, its capacity can be enhanced to handle all other biodegradable waste

12.5 Occupational Health and Safety

Group 1	Group 2
PPE Used by Medical Staff	
 Answered (70), Skipped (03)	 Answered (67), Skipped (03)
Incident Reporting System	
 Answered (70), Skipped (03)	 Answered (67), Skipped (03)

Vaccination Against Hepatitis B for Permanent HCF Staff	
 Answered (70), Skipped (03)	 Answered (67), Skipped (03)
Vaccination Against Hepatitis B for Casual HCF Staff	
 Answered (70), Skipped (03)	 Answered (67), Skipped (03)
Reasons for not Vaccinating Casual HCF Staff	
 Answered (15), Skipped (58)	 Answered (46), Skipped (24)
Vaccination Against Hepatitis B for Cleaning Workers	
 Answered (69), Skipped (4)	 Answered (63), Skipped (07)

Reasons for Not Vaccinating Cleaning Workers	
	
Answered (24), Skipped (48)	Answered (36), Skipped (34)
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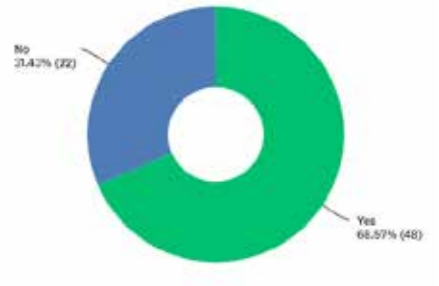	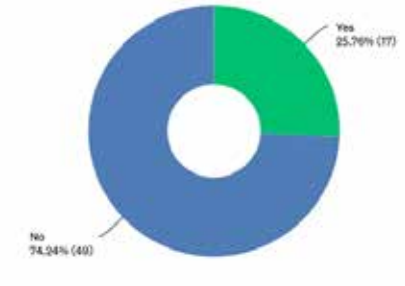
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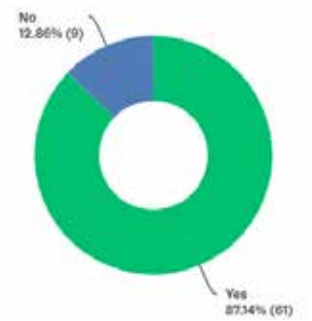	
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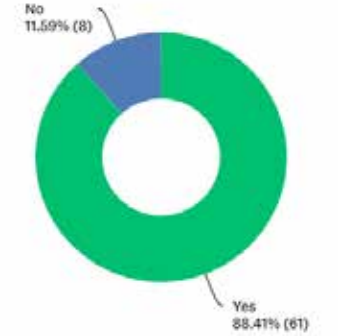	
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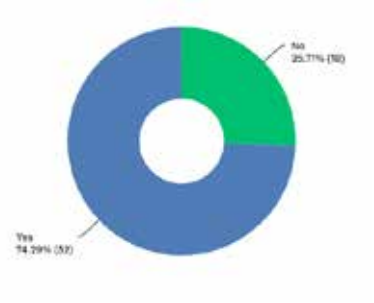
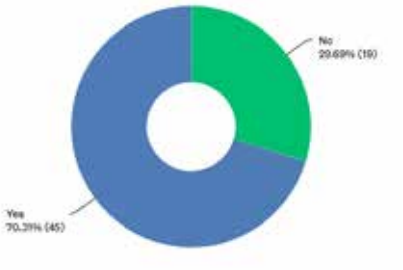
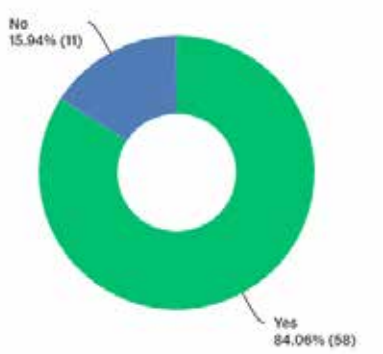
 Answered (70), Skipped (03)	 Answered (64), Skipped (6)
Training related to HCWM During COVID-19	
 Answered (69), Skipped (04)	 Answered (70), Skipped (03)

Outcome of the Survey Leading to Recommendations

Group 1

- 6% HCFs do not provide vaccination against hepatitis B for permanent HCF staff
- 16% HCFs do not provide vaccination against hepatitis B for casual HCF staff
- 37% HCFs do not provide vaccination against hepatitis B for cleaning workers

Group 2

- 63% HCFs do not provide vaccination against hepatitis B for permanent HCF staff
- 82% HCFs do not provide vaccination against hepatitis B for casual HCF staff
- 82% HCFs do not provide vaccination against hepatitis B for cleaning workers.
- Lack of resource is the main reason for not providing vaccination against hepatitis B for HCF staff

12.6 Impact of Present Healthcare Waste Management

12.6.1 Environmental Impact

Poor Healthcare Waste Management can result an array of environmental and public health issues. They range from the generation of unpleasant odour due to improper storage and disposal to more sever issues like production of highly toxic compounds such as dioxins and furans from burning and incineration of wastes under sub-optimal conditions. Further, disposal of chemical and infectious waste in unsound manner can lead to contamination of soil and water bodies. Similarly, disposal of pharmaceutical waste into the environment can results in risks such as increasing microbial drug resistance and contamination of waterbodies with emerging pollutants that are difficult to remove through treatment. Based on the results of the survey and observations made during the visits to selected HCFs, this section analyses the environmental impact.

Waste treatment

Table below indicates the estimated quantities of infectious and sharps (which are termed as clinical waste, hereafter) treated/disposed off different methods by waste generated from different types of Group1 HCFs. According to the information gathered from the survey, it is evident that the HCWM in Group 1 HCFs is comparatively at a better level than in Group 2 HCFs. Out of 73 HCFs

responded, only seven facilities burn their clinical wastes in open pits. According to the responses, the amount of clinical wastes disposed through open burning is about 106 tons per year. Another 1,274 tons of clinical wastes is annually treated using Metamizers. The survey reveals that approximately 3,015 tons of waste is sent to a third party private company for incineration annually by Group 1 HCFs. For the estimation of environmental impacts, it was assumed that the rest of the waste is incinerated in facilities with little or no controlling of air pollution. Accordingly, the quantities of waste generated using different waste treatment/disposal methods are given in Table below.

Estimated quantities of waste generation from Group 1 HCFs

Method of treatment	Quantity (kg/d)
Open burning	898
Autoclaving in Metamizers	3,490
Incineration in third part facilities	8,260
Onsite Incineration	11,930
Open dumping	805
Total	25,383

Quantities of waste managed using different treatment/disposal methods

If autoclaved waste in Metamizers is properly disposed in sanitary landfilling, it should result in minimum impact to the environment. However, it was evident during the observation visits that some of the HCFs do not have access to proper facilities for the disposal of residue wastes from Metamizers.

Emission of Toxic compounds from burning and incineration of healthcare wastes

Dioxin and Furan

Burning or incineration of waste results in generation of various pollutants and toxic compounds that can affect the human health and the environment. Their level of impact will depend on the conditions maintained during the combustion, air pollution control devices incorporated, and the method of residue disposal.

Among the toxic compounds generated from the incineration or burning of wastes, dioxin and furan are considered to be the most harmful to the human health. Presence of halogenated compounds in the wastes would result in formation of these compounds during the combustion. Larger portion of these compounds are released to the atmosphere with flue gas, while a fraction will be adsorbed on the ash generated during the combustion process.

Uncontrolled open burning would result in the highest emission of these compounds, while continuously operation of properly designed incinerators with good air pollution control facilities will results in the lowest level of emission. However, the collected fly ash generated by the air pollution control devices and bottom ash remaining in the incinerator after combustion must be disposed in properly constructed ash pits or immobilized in concrete or other suitable media.

The quantity of dioxins and furans released due to the burning and incineration was estimated using the toolkit developed by the UNEP and presented in Table below. Accordingly, a total of 17.070 g toxic equivalent (TEQ) per year of dioxin and furan are estimated to be released to the environment from burning and incineration of HCW from Group1 HCFs. These compounds are persistence in nature and as result, they accumulate in the environment Though the quantity seems to be a very small, compared with the maximum acceptable dilatory intake of 2.5x10-7 g/year for a person weighing 70 kg , the released amount is very significant.

Estimated Dioxin/Furan emission from Group 1 HCFs

Combustion Technology	Emission Factor (µg TEQ/t)			Quantity of waste treated (t/y)	Released to air (g TEQ/y)	Adsorbed on to Fly ash (g TEQ/y)	Adsorbed on to bottom ash (g TEQ/y)
	Air	Fly Ash	Bottom Ash				
Open burning	40,000		200	106	4.241	0.000	0.021
Batch incineration on site	3,000		20	4,275	12.825	0.000	0.086
High tech, continuous, sophisticated APCS in Sisli Hanora	1	150	2	4,380[a]	0.004	0.657	0.000
Total release					17.07	0.657	0.107

Estimated dioxin and furan emission from HCW burning and incineration ([a] This quantity include waste sent to offsite incineration by private HCFs as well)

As can be judged from the emission factors, improving air pollution control and proper disposal of ash can reduce the impact significantly. However, if a high-tech, continuously operated incinerator with sophisticated air pollution control systems is employed, the emission to air drops by a factor of 3,000 compared to that from batch-incinerators with good air pollution control systems. This emphasises the importance having good, centralised incinerators that receives wastes from several HCFs so that they can be operated continuously. If all the waste are incinerated in such facilities, the total release of dioxin/furans drops to 1.300 g TEQ.

Group 2

Based on the responses from the Group 2 health care facilities, per bed waste generation was estimated to be 0.064 kg/day.bed. The total number of beds in Group 2 is estimated to be 23,038. Accordingly, a total of 537 tons of clinical waste is generated from these HCFs in addition, 58 tons of wastes is generated from MOH offices. This was estimated based on per capita waste generation from MoH offices that was derived from the survey results. Out of the total waste generated from Group 2, approximately 55% is open burnt, and another 16% is incinerated. As indicated in Table below, a total of 13.36 g of TEQ dioxin and furan is estimated to emit from Group 2 HCFs annually. Even though Group 2 HCFs generate about 6% of clinical waste from government HCFs, the improper disposal of these waste results in approximately 40% of the total emission of dioxin and furan. This indicates the importance of proper disposal of clinical waste from the small HCFs.

Estimated Dioxin/Furan emission from Group 2 HCFs

Combustion Technology	Emission Factor (µg TEQ/t)			Quantity of waste treated (t/y)	Released to air (g TEQ/y)	Adsorbed on to Fly ash (g TEQ/y)	Adsorbed on to bottom ash (g TEQ/y)
	Air	Fly Ash	Bottom Ash				
Open burning	40,000		200	327	11.880	0.000	0.059
Batch incineration on site	3,000		20	95.5	0.260	0.000	0.002
Total release					12.140	0.000	0.061

Mercury

Mercury is present in some measuring devices, medicines, preservatives, and other items used in HCFs and can be ended up in waste. When these wastes are burnt or incinerated, mercury is released into the environment. The amount released will depend on the mercury content in waste and taking actions to prevent mercury ending up in waste is the best way to prevent mercury emission during the waste burning. The Ministry of Health has taken steps to phase out mercury containing measuring devices, though some of the old devices used in HCFs still contains mercury.

The quantity of mercury released from healthcare waste burning and incineration was estimated using the toolkit developed by the Minamata Convention. An average emission factor of 24 g Hg/ ton of waste incinerated was used for the estimation. Accordingly, a total of 179 kg of mercury is released to air annually during the burning and incineration of clinical wastes from Group 1 HCFs. The estimated mercury emission from Group 2 is 10 kg/y.

According to US-EPA, the maximum permissible daily intake of 0.1 g/kg of body weight. Therefore, the maximum permissible yearly intake of mercury for an average person weighing 70 kg is 2.3 g. Considering the persistent nature of mercury, though as not severe as Dioxin emission, the health and environmental impact of mercury emission from healthcare waste management is considerable.

Outcome of the Survey Leading to Recommendations

Group 1

- 12% responded HCFs burn healthcare wastes.
- 18% of incinerators do not have a secondary burner.
- 38% of incinerators do not have any air pollution control facilities.
- More than 90% of HCFs with incinerators do not have proper ash disposal facilities.
- A total of 17.070 g TEQ of UPOPs is released to the environment from clinical waste incineration from Gruop1 HCFs
- Moving into centralised incinerators that have good air pollution control devises and operate continuously can reduce the dioxin and furan emission significantly

Group 2

- 55% of Group 2 HCFs use open burning as the means of clinical waste disposal
- 16% of the waste is incinerated
- Though Group 2 HCFs generate only 6% of the total clinical waste from government HCFs, they contribute to 40% of dioxin/furan emission

Observation Visits Findings

Group 1

- Siting of some incinerators has not done properly as in some cases emissions from incinerators seem to affect wards and nearby buildings.
- No proper disposal mechanism for disposal of ash from incinerators
- Capacities of some of the chemical septic tanks are not sufficient due to increasing number of patients
- Access to some waste storage facilities is not restricted.

Key Recommendations

Group 1

- Finding a lasting solution to waste treatment and residue disposal treating is a national problem requiring the involvement of Central government, Provincial Councils and Local Authorities.
- Properly designed and constructed ash-pits.
- Urgent review and if required, relocation of inappropriately located incinerators.

12.6.2 Social Impact

The environmental consequences of poor HCWM practices deliberated in the previous section also have a social dimension too, as the degraded environment could cause harm to anyone who comes into contact with the waste (or waste by-product such as smoke) during its entire stages of the lifecycle.

This may include patients, healthcare workers, waste handlers, processors, disposers and also the general public – especially those living in close proximity to disposal/treatment facilities. In

addition, safety issues could also arise, for example needles and sharps that have been incorrectly handled or disposed of may cause an injury that could be serious – possibly fatal. For example, it could spread the infection of conditions like hepatitis and HIV/AIDS. In the broader context, pollution of air, water and soil due to emission of a variety of pollutant streams associated with improper management and treatment of HCW will have adverse health consequences on a lager section of the community/society.

In order to address the health and safety risks caused by healthcare waste, the emphasis should be given to the holistic waste management concept within the principle of waste management hierarchy. In particular, the selection of appropriate HCW treatment becomes a critical factor for mitigating the social (and environment) impacts, as the observational visits made by the consultant team revealed that not only the use of improper technics (such as open burning and open dumping) and technologies/equipment (such as sub-standards equipment), but also the operational issues arisen from lack of technical knowledge and skills. In particular, the emission of toxic compounds from burning and incineration of healthcare wastes (such as dioxin and furan) and mercury estimated in the previous section signify the importance of the use of proper technologies and operational/management systems for HCW. Another issue identified is the lack of option for the HCFs to dispose the residues properly leading to unsafe disposals within the facility premises.

Although the scope of this study does not include a comprehensive social impact assessment, the responses to the number of questions in the questionnaire, particularly in the Section: Occupational Health and Safety, and the observation visits emphasis in potential health and safety issues in the HCWM sector, are briefed in the following subjections.

Factors contributing to health issues:

- Level of segregation – Though there is a considerable improvement in this aspect over the years, still there are unsatisfactory levels leading to potential contaminations and corresponding health risks/impacts;
- Handling and transport – Lack of proper collection, transport and storage of infectious wastes, resulting exposure of the healthcare workers, particularly the waste handlers, to pollutants and resulting risks. For example, types of containers used to collect infectious wastes given earlier clearly indicate the unsafe situations in some HCFs. Further main mode of internal transportation of infectious wastes is by hand, which too poses risk on waste handlers;
- Storage – Lack of storage facilities too is a factor that contributes to health risk. In particular, this is more significant in HCFs in Group 2, where about 2/3rd do not have adequate storage facility;
- Treatment – The responses to the series of questions related to the HCW treatment clearly show that the major gaps in the HCWM lie in this stage, with a variety of challenges. Lack of treatment facilities, use of improper and sub-standard equipment/technologies, limited technical knowhow/skills, operational and management issues, inadequate pollution control capabilities, lack of acceptable disposal options are some common features. The degradation in environmental quality (air, water and soil) would be the major health risk factor in the HCWM sector, affecting a wide sector of the society.
- Vaccination – The feedback received on vaccination against Hepatitis B indicates the inadequate emphasis on occupational health aspects, particularly in the HCFs in Group 2.

Factors contributing to Safety issues:

- Sharps – Inadequate facilities for handling of sharps is apparent in a significant number of HCFs. For example, though a majority of HCFs use puncture-proof disposable and sealed cardboard boxes for handling and storage, others do not have acceptable methods leading to high safety risks for the waste handlers. About 1/4th of HCWFs do not have adequate storage facilities for the sharps.
- PPE – A relatively low usage of PPE in HCFs in Group 2 compared with those in Group 1 highlights the inadequacy and corresponding health risks for the staff.
- General – The lack of proper HCWM system in some HCFs indicates potential safety risks for staff handling the waste in each stage of the lifecycles.

Accordingly, it is apparent that the health and safety aspects in the HCWM sector, including the occupational health and safety of the staff of the HCFs, should receive more attention to develop and implement mitigation strategy and plan for the betterment of the staff of the HCFs as well as other stakeholders including general public. Any plan of this nature would need to be adequately financed and underpinned by comprehensive educational and staff-training initiatives.

12.6.3 Financial Implication

In addition to the direct financial cost, it has a huge economic cost arising from negative environmental and social impacts if healthcare waste is not properly managed. However, the estimation of environment and social cost is quite complex to be dealt with in a rapid easement of this nature and hence, only the financial cost has been estimated.

The financial cost of HCWM depends on the amount and type of waste generated (clinical as well as general) which is directly linked to the health care services provided and the size of healthcare facilities. In the waste management hierarchy, commencing from minimizing of waste generation, handling, segregation, collection, internal transportation and up to storage will have to be performed irrespective of whether waste treatment is done internally or externally. This critical segment of waste management has both a capital cost and an operational cost. However, it should be noted that appropriate attention paid to waste reduction and proper waste segregation can reduce both costs.

For the budgetary allocation of recurrent expenditure of all categories of state sector HCFs, based on the survey results of clinical waste generated and treated, the following projected estimate has been done for 3 methods of treatments; (1) Internal treatment through incineration without air pollution control systems (2) Internal treatment through hybrid autoclaving (3) External treatment through incineration with air pollution control systems.

- LKR 227 million - Internal treatment through incineration without air pollution control systems (based on 4,370** t/y @ LKR 52 per kg based on different values provided by equipment suppliers and HCFs ranging from LKR 25-80 per kg)

- LKR 158 million - Internal treatment through hybrid autoclaving (Metamizer operation) (For 1,274 t/y based on 20 HCFs' operational expenditure of around LKR 200,000 per month, LKR 12.8 million per year for labour cost of the supplier and USD 7,635 per year for spares)

- LKR 336 million - External treatment through incineration with air pollution control systems (based on 3,015 t/y @ LKR 111.24 per kg including 8% VAT)

- Total = LKR 721 million per year for total waste treatment 8,670 t/y

- Per kg expenditure = LKR 83/kg based on total waste generation 8,670 t/y
  * * This includes 4,275 MT/yr of clinical waste internally treated in Group 1 HCFs and 95 t/y of clinical waste internally treated in Group 2 HCFs.

The above cost does not include consumables (Disposable polythene bags, sharp boxes, PPEs, cleaning chemicals, detergents, sanitizers, etc.) and replacement items (Bins, carts, etc.).

It is suggested to validate this estimate by comparing with the actual expenditure as such information was not available to the consultant team.

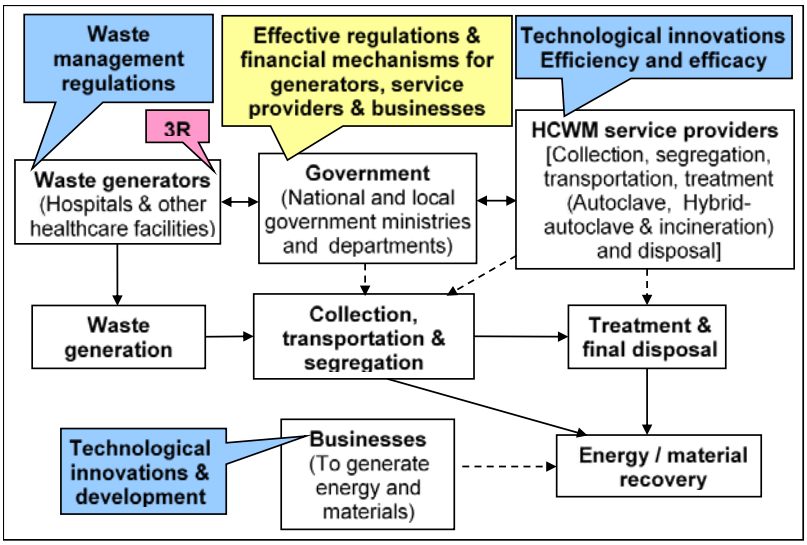
13 Stakeholder Mapping

As the HCWM is a complex task, it requires engagement of relevant stakeholders in its entire scope of activities for the purpose of achieving intended results and outcomes. In this process, it is expected to shape the positions, decisions or actions of the stakeholders in relation to a problem, opportunity or outcome associated with the HCWM. This requires stakeholder analysis and mapping, in which qualitative information are gathered and analyzed systematically the information about different types of actors, their resources and constraints and helps design a strategy on how to engage with them to foster coalitions for better HCWM.

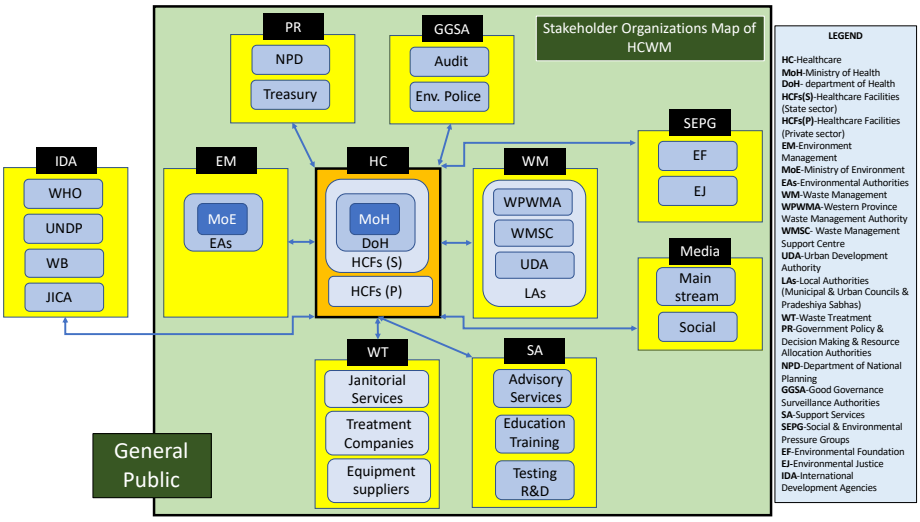
The stakeholders (or actors) in this assessment represent individuals as well as organizations having impact/s on an intervention in HCWM or affected by HCW. They may have direct or indirect interest in the activities of HCWM, or affected directly or indirectly by the impacts of HCW, with regular or occasional interactions. Stakeholders can be diverse (Government institutions, regulators,

customers, beneficiaries, local community, general public, academia, researcher, technology providers, media, development agencies), with a range of functionalities or characteristics.

One effective entry point for stakeholder mapping is to interpret HCWM system with stakeholder perspectives, as illustrated in the following figure;



In line with the above framework, the stakeholder organizational map applicable to the healthcare sector in Sri Lanka have been formulated by CT, as depicted in the following figure, with the specific details of the relevant staff for consultation and engagement.



The potential of stakeholders (both individuals and organizations) to impact on HCWM depends partly on their influence (or power) and interest (or attentiveness) related to the key subjects/affairs and other engagements. The other important aspects are the human resources & information and Physical & financial resources of the organization as well as awareness and competencies (knowledge, skills and attitudes) of the individual staff members to accomplish the responsibilities and tasks in the employment. The sum of individual competencies would reflect as capacities of the organizations, as individual competencies affects the ability to achieve shared goals.

Accordingly, the questionnaires and the interview questions were formulated to get information for establishment of the position of the organizations together with their staff in relation to HCWM. Upon completion of questionnaires and interviews, following criteria was proposed in the assessment to establish the hierarchical levels (overall level of importance) of HCWM stakeholders (both organizations and their staff as a common entity).

(a) Level of Influence

The influence characterizes the power of the HCWM stakeholder to impact upon actions of others. Three levels of significance in relation to this character are defined here as:

1. High influence - having characters/attributes such as direct authority in HCWM, well-connectivity (strong contacts) with other agencies/stakeholders and proven capacities/ competencies/resources.
2. Moderate influence - having characters/attributes such as some specific authority in HCWM, some-connectivity (certain contacts) and evident capacities/competencies/ resources.
3. Little influence - having character/attributes such as low/no specific authority in HCWM, limited connectivity/contacts and constrained capacities/competencies/ resources.

(b) Level of Interest

The interest portrays the relevancy and focus of the objectives, functions and scope of activities of the HCWM stakeholder, which in turn signifies the potential to support and facilitate relevant interventions. Three levels of significance in relation to this character are defined here as:

1. Primary interest – directly related to the objectives and functions of the stakeholder institution/group and reflected through regular and planned actions related to HCWM.
2. Secondary interest – no direct relevance to the objectives and functions of the stakeholder institution/ group, but frequent contributions are made under collective actions and/or specific programmes/projects related to HCWM.
3. Little/no interest – little/no relevance to the objectives and functions of the stakeholder institution/ group, and contributions made under collective actions and/or specific programmes/projects related to HCWM are rare/none.

Due to the time limits and the scope of activities, a detailed stakeholder mapping was not conducted in this rapid assessment. However, the essential attributes were comprehended through (i) consultation of literature on policies & regulations, the institutional mandates, action plans and programmes implemented, and (ii) key informant interviews (KIIs). In particular, the purpose of the KIIs was to understand the present status of HCWM in the country (both state and the private sectors), issues, challenges, constraints for the implementation of an effective HCWM system and future plans to overcome such impediments.

Different stakeholders have different insights and perspectives. Upon comprehending the overall level of importance of stakeholders interviewed, their insights and perspectives, together with the review of the status of the organizations with applicable policy & regulatory environment and institutional frameworks were considered by CT when making recommendations for developing the roadmap for HCWM.

Compendium of Treatment Technologies

The variations in the qualitative and quantitative characteristics of HCW materials, relevant regulatory requirements and presence of different types of management techniques, treatment technologies and processes pose challenges for the selection of suitable management method/technology as there are differences, not only in technical performances, but also with regards to the socio-economic and environment outputs, outcomes and impacts.

Thus, there is a need to consider a more holistic approach in assessing, prioritizing and selecting a technology for HCWM. Such appraisal essentially requires in-depth information on the available processes and technologies, particularly their technical, financial and environmental performance characteristics and level of commercialization and deployment internationally, regionally and locally. This section is devoted to present such information, in the form of compendium of treatment technologies.

One basic approach for the treatment and disposal of HCW is to group the listed material classes into three broader categories as:

- Waste sharps;
- Infectious and cytotoxic wastes;
- Organic wastes (such as blood and body fluid wastes, human anatomical waste).

Within these categories, there are wide range of equipment designs to cater for specific requirements of a particular HCW stream, as determined by, among others, the composition, physical, chemical and thermal properties, quantity, level of treatment needed, and regulatory compliance requirements, as listed in the table below:

Criteria and indicators for selection of HCWM technologies

A. Financial Criteria and Indicators
Equipment purchase cost
Installation and commissioning costs
Annual operating costs, including preventive maintenance, testing and repairs
Cost of transport and storage
Disposal cost of treated waste
Decommissioning costs of the plant
B. Technical Criteria and Indicators
Type or category of waste to be treated
Characteristics of waste (Composition, physical, chemical, thermal)
Characteristics of treated waste / residues
Capacity of the system, particularly quantity of wastes for treatment and economic outputs (energy, material)
Quantity of wastes for disposal
Flexibility in relation to quantity and quality of waste
Technology capabilities and requirements of the HC Facility
Capability of the HC facility to handle the quantity of waste
Local availability of treatment options, technologies and spare parts
Installation requirements
Available space for equipment
Infrastructure requirements
Operation and maintenance requirements
Location and surroundings of the treatment site and disposal facility
C. Environmental Criteria and Indicators
Environmental releases (gaseous, liquid, solid, sludge, thermal/heat, noise & vibration)
Pollution control technologies incorporated
Monitoring and measurement capabilities
Treatment efficiencies
Volume and mass reduction
Options available for final disposal
D. Social Criteria and Indicators
Occupational health and safety considerations
Consideration on visual impacts / aesthetic aspects
Consideration on odor control
Skills needed to operate and repair of the technology / sub-systems
Emergency preparedness
Opportunities for awareness and knowledge creation
Public acceptability

An overview of process and technology options for treatment and disposal of main categories of HCW is given in Annex 5. More details of each of the treatment technologies commonly used and commercially available for treatment of HCW are given in Technology Factsheets in Annex 6.

14 Recommendations

Following recommendations are made for the consideration of the healthcare sector stakeholders based on the outcomes of survey results, observation visits and Key Informant Interviews supplemented by literature review under the guiding principle that HCWM be treated as a national need and a priority but not just as a responsibility of HCFs alone.

This requires a well-coordinated and collaborative effort at all levels of the governance system (Central Government, Provincial Councils and Local authorities) including the ministries in charge of health, environment and provincial councils along with environmental regulatory bodies such

as Central and Provincial environmental authorities, facilitating bodies such as Western Province Waste Management Authority, National Solid Waste Management Centre and UDA. The above could be addressed by the formation of a high-powered national level multi-stakeholder steering committee for HCWM.

Policy and Regulatory

- Introduce either new regulations or Better implementation the existing regulations to bring HCWM of all private sector HCFs under strict control of MOH and amend if there are gaps
- Formalize the present way of clinical waste disposal by private practitioners including Ayurveda treatment centres with a payment system imposed upon the waste generators.
- Strictly enforce the prohibition of open burning of clinical waste introducing suitable arrangements for waste treatment of HCFs not having inhouse treatment facilities

Finance

- Dedicated and appropriate budget line for HCWM in government HCFs based on bed strength (for bigger HCFs & RDHS)

Management Information System (MIS)

- Introduce a proper MIS on "Build, Operate and Transfer" basis for HCWM
- Convert the online survey database (of UNDP funded RA of HCWM project) into a fully-fledged database by removing inaccuracies of responses if any and reaching out to non-responsive HCFs in both government and private sector with provision for regular updates
- Look into the possibility of merging with the data-base currently being developed by Waste Management Authority Western Province and the existing database of CEA used for EPL/ SWML purpose
- Digitalize the data management operation with a daily data entry system (similar to "Indoor Mortality and Morbidity Registry" - IMMR which is daily updated with data such as admissions, discharges, birth, death, etc.) so that higher authorities in the system (In charge of HCFs, RDHS, PDHS, Ministry of Health, etc.) can make informed decisions in the future
- Merging the above with properly function existing systems if possible and feasible.
- Using the MIS, based on bed strengths of HCFs, set benchmarks and targets for vital indicators such as types and quantities of waste generated, waste treated, cost of treatment, etc.

Administration

- Improve health & safety aspects of treatment facilities – including distribution and use of PPE and regular training initiatives.
- Introduce a certificate system for incinerator operators until such time waste treatment facilities of HCFs are fully withdrawn / phased out.
- All new purchases of chemicals discharging equipment to be equipped with chemical neutralizing facilities
- Implement colour coded liquid waste and chemicals piping as per the regulations
- Introduce a central system for sellable segregated general waste such as bottles, cardboard, etc.
- Remove existing administrative and financial barriers allowing the use of proceeds from sellable general waste for the purpose of inhouse environmental improvements and employee motivation.

Infection Control Unit

- Regularize the functions and empower the Infectious Control Units
- Identify (Officer with adequate knowledge and position power should be made responsible for HCWM related work including data management and reporting) and formally appoint / designate focal points of HCFs with proper authority (Similar to the MoH focal point - DG E&OH)

Compliance

- Educate the responsible officers of the Infectious Control Units of the compliance requirement of EPL and SWML
- Ensure the adherence of operating guidelines and instructions by Janitorial categories;
- Make hepatitis B vaccination mandatory for janitorial staff

Training & Awareness

- General awareness, education and certification for all categories (Medical and non-medical) in HCFs (Government and private) and MOH on HCWM and its health, safety, social, environment and financial implications (to be made mandatory at orientation programmes)
- Special training and certification for all categories (Medical and non-medical) in HCFs (Government and private) those who are directly involved in HCWM
- Special training and certification for the operators of treatment facilities of HCFs (Government and private) with the involvement of maintenance units of HCFs (If available)
- Conduct CPD programmes (virtual & physical) to make them updated with new developments

Education

- Include HCWM in curricula of medical education (Medical and para-medical) – Undergraduate and Postgraduate levels

Standardization

- Strictly Implement the standards for waste collection polythene bags in terms of colour coding, material and size, waste collection bins (size-3 standard sizes; small, medium and large, peddle operated lids, wheels for movements, standard colours, stickers with standard symbols and tri lingual wordings, supplemented with easy to understand and recognize simple pictures) in consultation with leading manufactures and sharp boxes in terms of colour coding and size (in 3 standard sizes; small, medium and large) in collapsible form for easy transportation and waste transport trolleys
- Introduce the above standards to prospective manufacturers
- Have a semi central procurement system to get price advantage with clear specifications

Segregation & Collection

- Ensure near 100% segregation of clinical waste at the point of generation (wards, clinics, labs, etc.) to prevent operational problems at waste treatment facilities
- Provide with easy to use weighing facilities for recording and documenting of waste generated and segregated and treated

Inhouse storage

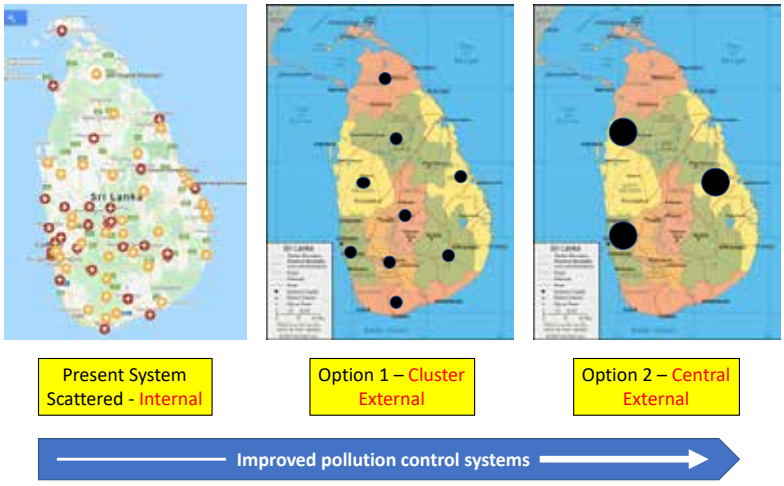
- Standardize the store design to have different waste types with provision to properly isolate infectious waste with general waste.
- Introduce clear guidelines to locate stores to completely avoid the possibility of ground and water contamination
- Provision of store facilities to all HCFs do not currently have such facilities and enhance the capacities of existing ones where necessary.
- Storage facilities to meet minimum requirements in terms of signage, natural ventilation, lighting, washable surfaces, access to water, etc.
- Prevention of unauthorized entry to all types of stores.

e-waste

- Introduce a proper system for e-waste management

Clinical waste treatment (Incineration)

- Phase out existing inhouse treatment facilities (within a period of 10 years) with a proper transition programme along with a prohibition of installing new inhouse treatment facilities:



Option 1

- Introduce cluster-based treatment systems (either newly built or relocation of idling or under-utilized existing inhouse treatment facilities) based on the locations of HCFs, quantity of waste generation, availability of sites to establish treatment facilities, distance to the treatment site from HCFs in the catchment area (transport) with fully fledged pollution control systems and completion of ESIA.
- Use of new or relocated incinerators with pollution control mechanisms will require urgent attention on the topic of toxic ash (bottom and fly) disposal facilities and procedures.
- Exact number of treatment sites to be decided after the analysis of the above.
- Identify suitable sites for central systems (such as Kawashima composting sites)
- Operation, maintenance and repairs should be outsourced to the supplier of the facility or to a competent private party
- This has to be supplemented with proper transport arrangement for waste collection and with intermediary store facilities
- Do not locate such centres within HCF premises
- Gradually relive HCF staff completely from the operation of inhouse treatment systems
- Implement a proper transition system and implementation plan from inhouse treatment to external treatment
- Consider hybrid systems of non-incineration and incineration technologies in central treatment facilities to minimize environmental issues
- Introduce a system to serve the clinical waste management need of private practitioners including Aurvedic treatment centres

Option 2

- As an alternative, invite at least another party to have an operation similar to the existing one with fully fledged pollution control systems to prevent possible monopoly situation in the future and to introduce competition into the market-place which will ultimately have a positive impact on service and prices.

Clinical waste treatment (Non-incineration technologies)

- As an alternative to incineration, maximize the utilization of existing non-incineration technologies such as hybrid-autoclaving by overcoming current issues such as operation and residue disposal.
- In future, when purchasing hybrid-autoclaves, buy models/designs which have waste chipping/shredding before waste enters the treatment chamber – NOT within the chamber.

Delay tanks for radioactive waste

- Provide delay tanks with adequate capacities to all HCFs having radioactive treatments.

Placenta treatment

- Introduce improved designs for placenta treatment pits (such as water sealed flushing systems like in toilets instead of manholes to prevent harmful gasses and noxious odours escaping.
- Place waste in above ground level in concrete tanks where water table is high

Liquid waste treatment

- Rehabilitate malfunctioning waste-water treatment systems including sewage treatment where there are no central systems

Mercury

- Implement a speedy phasing out system of mercury-based apparatus (thermometers and blood pressure) as some HCFs (especially small scale HCFs in the periphery) still use such devices

Residue disposal (Bottom ash of incinerators)

- Introduce properly designed in-house ash-pits for the use in the transition period
- Liaise with the State Ministry of Urban Development, Coast Conservation, Waste Disposal and Community Cleanliness (SMoUDCCWDCC) and Urban Development Authority to ensure the conversion of one out of 5 cells of Aruwakkalu sanitary land fill site to dispose the residues of clinical waste by end 2021

Residue disposal (Residues of Metamizers)

- Regular testing of Metamizer residues and issuing of certificates acceptable to Local Authorities so that these residues can be handled as general waste (hazardous and infectious free)

Procurement of treatment facilities

- Develop proper specifications for specific needs.

15 Way Forward

Given below are the suggested steps with timeline for the completion of this assignment;

1. Assist MOH to develop an action plan with the active participation of key stakeholders (From 0900 hrs on 19, 23 or 24 March 2021 through a physical meeting – full day)
2. Assist MOH to get the action plan validated at a session with the participation of same stakeholders who participated in developing the same (From 0900 hrs within one week after preparing the action plan through a virtual meeting – half a day)
3. Submit the Final report (Before 31 March 2021)
4. Debrief the TWC to conclude the assignment (At 1500 hrs on 31 March 2021 through a physical meeting)

Establishment of a Fully-fledged Database

As an immediate step to ensure the successful implementation of the proposed action plan, it is strongly suggested for the MOH to reach the balance of HCFs (both state as well as private sector) and establish a fully-fledged database which could be regularly updated.

For this purpose, CT will hand over the survey-platform used for the online survey. This would be very useful for MOH to make informed decisions in the future and also to closely monitor the progress of the action plan implementation.

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ANNEXES

Annex 1 – Respondent of Group 1 Healthcare Facility Responses to the Survey Questionnaire

Category of Healthcare Facility	Name	Number of Respondents
National Hospitals	1. National Hospital, Colombo	2
	2. National Hospital, Kandy	
Provincial General Hospitals	3. Provincial General Hospital, Badulla.	2
	4. Provincial General Hospital, Kurunegala	
Teaching Hospitals	5. Colombo North Teaching Hospital, Ragama	12
	6. General (Teaching) Hospital, Peradeniya	
	7. Teaching Hospital, Rathnapura	
	8. Sri Jayewardenepura General Hospital	
	9. De Soysa Hospital for Women	
	10. Teaching Hospital Batticaloa	
	11. Colombo South Teaching Hospital, Kalubovila	
	12. Teaching Hospital, Jaffna	
	13. Teaching Hospital - Kuliyapitiya	
	14. Lady Ridgeway Hospital	
	15. Teaching hospital, Anuradhapura	
	16. Castle Street Hospital for Women, Colombo 08	
District General Hospitals	17. District General hospital, Kalutara	15
	18. District General Hospital, Negombo	
	19. District General Hospital, Hambantota	
	20. District General Hospital, Polonnaruwa	
	21. District General Hospital, Matale	
	22. District General Hospital, Embilipitiya	
	23. District General Hospital, Mannar	
	24. District General Hospital, Monaragala	
	25. District General Hospital, Trincomalee	
	26. District General Hospital, Kegalle	
	27. District General Hospital, Gampaha	
	28. District General Hospital, Nuwara Eliya	
	29. District General Hospital, Avissawella	
	30. District General Hospital, Chilaw	
	31. District General Hospital, Matara	
Special Facilities	32. Medical Research Institute	6
	33. National Cancer Institute, Maharagama	
	34. National Institute of Nephrology Dialysis and Transplantation	
	35. National Institute of Mental Health	
	36. National Dental Hospital (Teaching) Sri Lanka	
	37. Sirimavo Bandaranaike Specialized Children's Hospital	
Base Hospital Type A	38. Weera Denzil Kobbekaduwa District Base Hospital	14
	39. Base Hospital, Sammanthurai	
	40. Medical Superintendent Base Hospital, Horana	
	41. Base Hospital, Kalmunai (North)	
	42. Base Hospital, Valaichchenai	

	43. Base Hospital, Kaluwanchikudy	
	44. Base Hospital, Puttalam	
	45. Base Hospital, Kamburupitiya	
	46. Base Hospital, Dehiattakandiya	
	47. Base Hospital, Muttur	
	48. Base Hospital (Teaching) Gampola	
	49. Base hospital, Dickoya	
	50. Base Hospital, Homagama	
	51. Ashraff Memorial Base Hospital, Kalmunai	
Base Hospital Type B	52. Base Hospital, Wellawaya	22
	53. Base Hospital, Hingurakgoda	
	54. Base Hospital, Bibile	
	55. Base Hospital, Deniyaya	
	56. Base Hospital, Pottuvil	
	57. Base Hospital, Kahawathatha	
	58. Base Hospital, Galgamuwa	
	59. Base Hospital, Dambadeniya	
	60. Base Hospital, Mankulam.	
	61. Base Hospital, Mirigama	
	62. District Base Hospital, Theldeniya	
	63. Base Hospital, Welimada	
	64. Base Hospital, Eravur	
	65. Base Hospital, Nintavur	
	66. Base Hospital, Udugama, Galle	
	67. Base Hospital, Anamaduwa	
	68. Base Hospital, Tissamaharama	
	69. Base Hospital, Walasmulla	
	70. District Base Hospital, Medirigiriya	
	71. District Base Hospital, Rikillagaskada	
	72. Base Hospital, Kebithigolleawa	
	73. Colombo East Base Hospital, Mulleriyawa	

Annex 2 – Respondents of Group 2 Healthcare Facility Responses to the Survey Questionnaire

District Hospitals

1. DH Ambalanthota
2. DH Ankumbura
3. DH Annamalai
4. DH Arayampathy (Type-A)
5. DH Bentota
6. DH Canaveralla, Kotugahathenna
7. DH Cheddipalayam
8. DH Dodangoda, Kalutara
9. DH Ettampitiya
10. DH Galagedara
11. DH Galamuna, Polonnaruwa
12. DH Girandurukotte
13. DH Glenanore, Haputhale
14. DH Godakawela
15. DH Hambegamuwa
16. DH Hasalaka
17. DH Hinguralakanda, Dehiowita

18. DH Ilavali
19. DH Imaduwa
20. DH Induruwa
21. DH Jambugahapitiya, Aluthgama
22. DH Kapugollewa
23. DH Karandeniya
24. DH Kathiravelly, Batticoloa
25. DH Kerulees
26. DH Kiriporuwa
27. DH Kuchchaveli, Trincomalee
28. DH Madipola, Matale
29. DH Madulkalle
30. DH Mahiladithivu
31. DH Mampitiya, Handessa
32. DH Maruthankerny
33. DH Mathugama
34. DH Mawarala
35. DH Morawaka
36. DH Nadungamuwa, Welimada
37. DH Nagollagama
38. DH Nakulugamuwa
39. DH Narammala (COVID Treatment Center)
40. DH Navatkadu
41. DH Nedawala, Kandy.
42. DH Padiyathalawa
43. DH Paluyamam, Batticaloa
44. DH Pattiyagama, Pallegama
45. DH Pavatkulam, Vavuniya
46. DH Pitakumbura
47. DH Pooneryn
48. DH Sooriyakanda, Buluthota
49. DH Thanamalvila
50. DH Theripaha
51. DH Thoppur
52. DH Uda Pussallawa
53. DH Veravil
54. DH Viharai
55. DH Wanela
56. DH Wattegama
57. DH Yatawatta.
58. DH Pattiyagama, Pallegama
59. DH Dawalawa
60. DH Padukka
61. DH Dharga Town
62. DH Cheddipalayam

MoH Offices

63. MOH Office Dehiattakandiya
64. MOH Office Haliela
65. MOH Office Hingurakgoda
66. MOH Office Kesbewa
67. MOH Office Padukka
68. MOH Office Puttalam
69. MOH Office Uda Pussallawa

Annex 3 – Key Informant Interviews (KIIs)

Given below is the Key Informant Interviews held with 3 main stakeholder categories (in addition to the interviews held during 40 observation visits HCFs);

Ministries / Waste Management Authorities / Local Authorities / Academia

1. Ministry of Urban Development, Coast Conservation, Waste Disposal and Community Cleanliness (Mr. Madawalagama)
2. Ministry of Environment
3. Central Environment Authority
4. Western Province Waste Management Authority (Mr. Mannapperuma)
5. Federation of Sri Lankan Local Authorities
6. Dambulla Municipality
7. Universities of Moratuwa, Peradeniya & Ruhuna

Waste Treatment Companies / Equipment Suppliers

8. Sisili Hanaro Encare (Pvt) Ltd
9. Metamizer supplier
10. Lanka Refractories
11. NERD Centre
12. UGL
13. Mediburn
14. Abans

HCFs

15. Lanka Hospitals, Dr. Karandagoda, Director
16. Ashraff Memorial Hospital, Kalmunai, Dr Ilahi, Medical Officer, Planning

Synopsis of Key Informant Interviews

1 State Ministry of Urban Development, Coast Conservation, Waste Disposal and Community Cleanliness (MoUDCCWDCC)

Interviewee – Eng. Shantha Madawalagama, Director General

Eng. Madawala was recently transferred to the above state ministry which is coming under the Urban Development Ministry (Under the Prime Minister) who was heading the National Solid Waste Management Centre (NSWMC) which was functioning under the Ministry of Provincial Councils and Local authorities. There is a plan to make him the in charge of the Waste Disposal and Community Cleanliness section of the state ministry.

1. Now MoUDCCWDCC is in the process of developing a proper coordination mechanism to bring all waste streams such as industrial and clinical without confining to solid waste management which is mainly the MSW.
2. Therefore, he feels that this project is very timely and it should be a joint effort of all relevant ministries such as MoUDCCWDCC, Ministry of Environment (MoE), Ministry of Health (MoH), Ministry of Industries (MoI), etc.
3. In case of clinical waste, MoH could be the ministry with the primary responsibility
4. He said that the database we are now creating through the online survey should be a live database in the future covering the entire HCF population with provision for annual updates. Inaccuracies of survey responses if any need to be corrected when it is converted to the database.
5. Clinical waste treatment facilities at mass scale would be advantageous and may be the only solution for better pollution control as it is not happening at many inhouse treatment facilities
6. Dambulla MC incinerator was partly funded by NSWMC
7. Some private sector treatment companies tend to overload the incinerators as they get higher revenues but this leads to dropping of chamber temperatures below the required temperatures creating harmful air pollution with toxic gases. Though the temperature sensored controlling system should be there to prevent such overloading, it does not happen so. If the treatment is centralized, automatic feeding systems can be incorporated to prevent overloading.
8. In other countries, even CO2 capturing is done using Ca(OH)2 which is an expensive operation. Such systems can be accommodated only in centralized mass scale operations.

9. Metamizer residues should be tested to ensure that it is infectious free so that Local Authorities could handle it as normal waste.
10. Ash from incineration (bottom and fly ash) should be used to make other products for paving, filler material in bitumen, etc. after carrying out tests to assess the presence of hazardous substances.
11. These ashes cannot be deposited even in normal sanatory landfills due to clogging of geo mats used to filter leachate.
12. Aruwakkalu site is to be made a national sanatory land fill rather than a sanatory land fill only for Western Province waste. One out of 5 cells therein is being converted to a cell (with bottom filter modification) which can accommodate residues of clinical waste which should be ready by end 2021.
13. Best solution would be the cluster system which can be planned out with proper data of waste generated from HCFs, availability of proper places to locate treatment plants and distance from HCFs in the catchment area to the treatment centre. Lands selected for Kawashima projects can be used for this purpose.
14. He volunteered to obtain an appointment for us to meet the Hon. Nalaka Godahewa, State Minister, Ministry of Urban Development, Coast Conservation, Waste Disposal and Community Cleanliness for us to understand his thinking and the direction in finding a lasting solution to the national problem of healthcare waste management.

2 Waste Management Authority Western Province (WMAWP)

Interviewee – Mr. Nalin Mannapperuma, Director

1. All 48 HCFs under the Western Provincial Council are brought under the Green Hospital project. Proper waste management support is given by WMAWP.
2. General waste of those 48 HCFs are collected by respective Local Authorities.
3. For the treatment of clinical waste, 6 Lanka Refractories incinerators have been installed in a cluster-based system through RDHS/PDHS
4. There are 3 dedicated vehicles for 3 districts of the Western Province for the collection of clinical waste in a routine.
5. Most HCFs have 5 to 6 acres of lands
6. Incinerator ash is kept in specially designed (by WMAWP) concrete pits as a temporary solution until a proper disposal system is developed.
7. WMAWP has a good monitoring system.
8. Only around 6 out of these 48 HCFs have EPL/SWML.
9. Biggest problem is that there are no dedicated operators. Though WMAWP train operators (onsite and offsite) from time to time they do not remain
10. There should be a proper collection system for private practitioners as they do not have sufficient quantities to justify the investing on treatment systems. Most doctors bring these wastes unofficially to their regular HCFs. Good to have a system to formalize this with a payment system
11. Small scale incinerators not having pollution control systems are getting phased out in the world and tendency is to have cluster systems with adequate capacity to justify the investment in pollution control systems.
12. Ayurveda hospitals, army hospitals, pharmacies should also be covered
13. There is no proper database yet.
14. JICA is in the process of preparing a master plan for the Western Province for waste management for a 20-year period of 2020 to 2040. This is a 3-year project and one year is gone. They will do a sample survey including the private sector results of which will be ready in 2 months.
15. There is a possibility of merging this database with what is developed by RA HCWM project

Suggestions

1. Phase out small-scale incinerators at HCFs level not having pollution control systems.
2. Instead, promote central (2 or 3 units in the country similar to the existing one) or semi central cluster systems (at provincial or district level according to the availability of waste).
3. There are 2 proposals from the private sector for similar operations like the existing one which are now in EIA stage.
4. Such systems could be fully owned by LAs, Can be on PPP basis or fully owned by the private sector. Whatever the business model adopted, these should be operated and maintained by suppliers themselves or parties having the competencies but not by LAs or by HCFs.

3 Ministry of Environment (MoE)

Interviewee – Mr. Mahinda Werahera, Director, Environmental Occupational & Health Division (EOH), MoE) and Ms. Sujjewa Fernando, Assistant Director, MoE

1. MoE feels that there are enough and more policies, guidelines, directives, circulars and even action plans but implementation is very week.
2. 2019 National Waste Management Policy adequately deals with HCWM
3. National Environment Act provide necessary regulations
4. In 1993, MoH prepared a 5-year action plan
5. Altogether, there are 1,084 HCFs. There are 25 HCFs under the central government and the balance is under the provincial councils
6. Until 2016/2017, there was a dedicated budget code for 25 HCFs under the central government for recurrent expenditure but from the requirements of HCFs, they get only about 50-25%.
7. HCFs coming under provincial councils have serious funding issues
8. EOH division of MoE has serious capacity issues not having required human resources.
9. In fact, there must be a dedicated division for waste management
10. There must be continuous training for HCF staff on HCWM as they are being transferred frequently. But MoE does not have the capacity to do so.
11. MoE has prepared guidelines and specification for waste segregation and procurement
12. Environment licensing application procedure within HCFs are very slow and staff lack knowledge in filling those applications
13. Outsourcing of waste treatment is difficult especially for provincial HCFs due to funding restrictions
14. Training is given for HCF Medical Directors and at Postgraduate level but it is not adequate.
15. Metamizer technology is superior to incineration as there is no Dioxin and Furan problem which is a critical issue
16. Liquid waste treatment in HCFs is a serious issue as they are very old and under capacity. Some of them do not function the way expected as chemicals also sent to these treatment units.
17. No required technical capacities at HCF level
18. Technically qualified team is required
19. Medical Directors are very busy with other important matters. There are no dedicated staff assigned for this task.
20. There is no proper way of handing chemicals from laboratories. There are about 3,000 different chemicals.
21. A colour coding system for hazardous chemicals is required
22. Delay tanks in many HCFs having radioactive treatments are under capacity.
23. Medical doctors should be updated on environmental issues.
24. Cluster operation for waste treatment would be a better option
25. There is a disposal system for mercury
26. Major issues requiring urgent attentions are the disposal of incinerator ash and Metamizer residues

4 Central Environmental Authority

Interviewee – Mr. Ajith Weerasundara, Director

1. According to available information, it is estimated that daily clinical waste generation is around 25 MT.
2. Sisili handles around 10-12 MT/day
3. Any generators of hazardous waste should have an EPL.
4. Any party engaged in collection, segregation, transporting, storing, etc. should have SWML.
5. But less than 1% HCFs only having above licenses mostly due to outdated waste water treatment systems.
6. Sisili is a tripartite agreement. CEA gets 1% of the turn over for its monitoring service.
7. As HCFs cannot pay directly to a private company, payment to Sisili is channeled through CEA.
8. According to the agreement, Sisili could exclusively collect clinical waste from National hospitals. However, there is an ambiguity of the word National; National hospitals or hospitals coming under the central government.
9. National Hospital Colombo pay around Rs 5 million a month to Sisili.
10. CEA also provide training on HCWM

5 Federation of Sri Lankan Local Authorities (FSLLA)

Interviewee – Ms. Hemanthi Goonasekara, CEO

FSLLA was incorporated in 2007 as a limited liability company for guarantee (not for profit) as an association of all local authorities following the model and with the support of Canadian Federation of Local Authorities. It is a membership-based organization governed by a board of directors. Present Chairman is His Worship Thushara Sanjeewa, Mayor of Kurunegala MC. Its main functions include the supporting of local authorities in policy matters and bylaws and also for capacity building. Ms. Goonasekara has been the CEO of FSLLA since inception.

1. Ms. Goonasekara feels that this is very timely discussion as FSLLA is scheduled to meet Hon Prime Minister on Monday 15 February to discuss about some issues related to MSW management.
2. She says that local authority system is quite complex and they will not be empowered without proper bylaws
3. There are 2 types of bylaws; standard bylaws and individual by laws. Bylaws have to be approved by respective Chief Ministers with the 13th amendment to the constitution. In the absence of Chief Ministers, Governors have the power to do so only for Urban Councils and Pradeshiya Sabhas but not for Municipal Councils.
4. In order to face the current pandemic situation due to the COVID 19 virus, 21 bylaws have been introduced with the support of UNDP
5. There is a general reluctance of Local Authorities to get involved in HCWM due to the fear of risk associated with final disposal of potentially infectious and injurious substances.
6. Local authorities need lots of capacity building in multiple areas. There have been lots of foreign funded project for this purpose but unfortunately such efforts have not been sustained with the closure of projects.
7. Traditionally, there had been some misunderstanding between MoH offices and local authorities over HCWM
8. There are no policy barriers for local authorities to get involved in HCWM if it is to be supported by relevant bylaws.
9. There are some progressive local authorities such as Kaduwela, Dambulla, etc. receptive to new ideas to find lasting solutions for pressing problems.

Suggestions

1. Proper interpretation of "waste generator" in CEA regulation is required. In HCW, real generator is the general public who are being treated as patients at HCFs though such HCFs as per the current interpretation are totally held responsible and accountable for HCWM which shouldn't be so.
2. Consultant team sought the assistance of Ms. Goonasekara to have an early meeting with Mayors and Commissioners of local authorities interested in getting involved with HCWM as a physical or a virtual meeting before the finalization of the RA report as their thinking also could be considered before making recommendations.

6 Lanka Hospitals

Interviewee – Dr. Karandagoda, Director,

Dr. Karandagoda assumed duties in Lanka Hospital in 2009 after serving in various government hospitals in various capacities. He was instrumental in introducing the HCW colour code to Sri Lanka which was subsequently introduced to many developing countries as well with JICA support. He has pioneered many activities at the Castle hospital in HCWM.

1. With the introduction of better HCWM in Castle hospital, there was a sharp decline of infections (by 75%)
2. Colour code was introduced also with some easy way of remembering for lower categories of people working in the HC sector;
   Yellow – Infectious waste – Saffron / Tumeric colour for disinfection
   Yellow boxes with 45 degrees red stripes – Sharps
   Blue – Recyclable papers – Clear sky colour for purity
   Green – Food waste
   Plastic - Orange

Red – Bottles – Traffic light colour for danger
Brown – Tins – Old colour
Black – Mixed and general waste

3. After these initiatives, MoE and CEA introduced the national colour code for waste.
4. However, some Local Authorities do not follow this color code
5. In Castle hospital, he introduced a welfare fund with the proceeds of sellable waste items from which concessionary loans are given to staff.
6. Medical faculties of UoP and UoJ introduced HCWM into curriculars and Dr. Karandagoda is lecturing even now at UoP.
7. Some hospitals introduced innovative methods for placenta treatments – such as above ground concrete pits where water table is high, water sealed flushing systems like in toilets instead of manholes to prevent harmful gasses coming out.
8. Lanka hospital had an incinerator but decided to obtain the services of Sisili Hanaro Encare as there are many high-rise buildings in the vicinity of the hospital.
9. He feels that Sisili is doing a good job though they charge a higher price.
10. He has observed a deterioration of HCWM practices during the past 4-5 years.
11. Some peripheral HCFs do not have the knowledge and the resources.
12. Most of the private sector HCFs (especially the smaller ones like wound treatment clinics) do not follow guidelines.
13. Some Local Authorities cooperate well while others do not

Suggestions

1. Introduce HCWM into educational curricula of courses for all categories (Medical – Doctors, Nurses, Para medical, Non-medical, Administrators, Accountants, Lower categories such as janitors, etc.)
2. District-wise mini decentralized treatment centres similar to Sisili operation with intermediary waste storage facilities to handle excess waste (In Southern Japan, these wastes is compressed to reduce the volume and kept in intermediary warehouses sometimes under refrigerated conditions)
3. There must be adequate policies and regulations to bring the private sector HCFs under a better HCWM system
4. There must be Focal Points for HCWM in all important organizations such Ministries of Health, Environment, CEA, etc.

7 Ashraff Memorial Hospital, Kalmunai

Interviewee – Dr. Ilahi, Medical Officer, Planning

Questionnaire

1. There are other units where the waste is generated such as blood banks which we have not included in the questionnaire. He has added some units under "other" as his response.
2. He asked why there are no questions on waste water treatment (grey and black, laundry water, etc.). We told him that we had to take certain questions out to make it more simple and such details will be gathered during our observation visits.
3. They have to leave out certain questions unanswered as they do not have information. Example - Cost of electricity or kWhr units consumed in autoclaves, Metamizers, etc. They only have one single bill and no sub metering. As the incinerator is run with diesel, they have the records.

Metamizer and clinical waste treatment

1. Very high energy consumption.
2. It needs around 120 kV supply.
3. As it is a very high load, there are lots of voltage fluctuations when the Metamizer is in operation.
4. To overcome this problem of fluctuations, CEB advises to have a separate transformer for Metamizer. Hospital now has a transformer of 600 kV and CEB's smallest one is 165 kV.
5. Operates around 5 days (except the week end)
6. 4 cycles per day with 1.5 hrs per cycle.
7. The Electricity cost of this is a significant portion of the total electricity bill which is around Rs 5 million per month
8. Metamizer cannot handle human parts and sharps and for which there must be an incinerator.

9. For this reason, incinerators are preferred over Metamizers.
10. In addition to the Metamizer and an incinerator, they also have an autoclave for laboratories.
11. Metamizers are operated and maintained by the supplier and they have their own personnel deployed. This contract is going to be expired in November 2020 after which either the hospital will have to extend the contract (will have a huge cost) or if not, the supplier will withdraw their personnel.
12. Disposing the left over (residues) of Metamizers is a big problem for many hospitals having Metamizers. Kalmunai hospital has its own dumpsite (not a sanitary landfill but in a state property given to them for this purpose) for this refuse. This hospital assists a lot of other HFCs in the area for their clinical waste treatment and residue dumping. Recently, they have accepted one lorry load of Metamizer residues even from Kegalle hospital for dumping at their site.
13. Local authorities have a stigma of not accepting Metamazier residue though it is hazard free.
14. This hospital is in the process of procuring another incinerator (may be a UK made one) as the Metamizer is not a good solution which is electricity gusting and very costly to operate and maintain. This may be the situation for around 20 Metamizers installed except a few.
15. They reuse very high temperature sterilizer water (around 5,000lt per day) after cooling it down to around 30-40 deg C with an underground cascade tank system. There is no heat recovery system
16. Food waste is used to make biogas which is in the kitchen
17. Coconut shells also used in a biomass fired hot water generation.

8 Sisili Hanaro Encare Private Limited (SHE)

Interviewee – Mr. Yasantha Gunarathne, Mr. Janaka Wijesekara, Mr. Nalinda Ranaraja

1. What is the contract between SHE & MoH – Cabinet approved PPP Tripartite agreement between SHE, MoH and CEA? Initial agreement for 5 years was from 2013 to 2015. Now it is extended to another 10 years from 2019 to 2029
2. When was it signed? 2013
3. What is the validity period? Until 2029
4. Any provision for extension? Yes
5. What are the obligations of SHE ? As per the agreement
6. What are the obligations of the MoH ? As per the agreement
7. What is the geographical coverage of waste collection ? Clinical waste from 3 provinces (Western, Southern and Central) and cytotoxic waste from all the provinces.
8. What is the present installed capacity of waste treatment facility ? 18 MT/day.
9. How many plants in operation ? 2 plants
10. What is the operating time ? Continues operation 365 days. As there are 2 plants, one is stopped for 4-5 days for maintenance after continuous running for 15 days
11. Any plan for capacity enhancement ? They can increase the capacity by 6 MT/day within 2 months if a need arises as space and the required inhouse competency are available.
12. What is the technology adopted? High temperature diesel fired incineration with pollution control system
13. When was it first installed and where? In Mulleriyawa as a pilot project with 4-6 MT/day capacity initially with a 5-year contract in 2013
14. Where is it now and who is the property owner? 2 acres from Kerawalapitiya on 30-year lease from the state land of 24 acres reserved for waste management
15. What was the reason for relocation? It was built in a small plot of land of 40 perch in a valley area in Mulleriyawa. There were public protests and was difficult to obtain the EPL.
16. What is the average monthly treatment quantity? 12 MT/day
17. What type of waste can be treated? Clinical waste, chemicals
18. What type waste cannot be treated? Radioactive waste and e-waste
19. Any restrictions of waste composition?
20. What is the operating temperature? First chamber 1,000 to 1,100 deg C and second chamber 1,200 deg C with 2-3 sec retention time. Temperature of the second chamber could go up to 1,300 deg C
21. What is the arrangement for pollution control ? Bag filters, activated carbon, scrubber for flue gas treatment including NOx control system. High temperature water (around 1,000 deg C is brought down to 200 deg C rapidly and neutralized.
22. What are the arrangements for ordour control?

23. How the residue is disposed? Make eco bricks for interlocked pavements. Residue not given for third parties. Bottom ash contains Stainless Steel (SS) parts from sharps which is not melted at 1,200 degC. They are planning to have a SS separator.
24. Any test carried out of residue? Yes by ITI and SGS for heavy metals every 4-5 months' time. No toxic substances as per reports.
25. Any test carried out for smoke? Yes by ITI and NBRO
26. How the waste is transported? Handled by own staff with a dedicated vehicle fleet of 9 (including 20 ft freezer trucks, small "Dimo Batta" vehicles, etc.)
27. What are the licences? EPL and SWML. Planning to obtain ISO certifications
28. What type of storage facilities (in situ, transit, HCFs)? In situ storage with the capacity for 7 days collection. However, waste received is incinerated within 24 hours. Nearly 45% of accumulated waste has been cleared. Stores are not cooled but kept under negative pressure. Excess storage is available to meet emergencies.
29. Any segregation at the treatment site? No as clinical waste and sharps received separately
30. What is the chimney height? 30 m (Decided after carrying out an emission model by NBRO)
31. What is the tipping fee (fixed amount for all kinds of waste or different rates and / or distance based)? Flat rate of LKR 103 per kg plus VAT (8% currently). This was decided by the Cabinet of ministers. There is a provision in the agreement for price revision after 4 years of operation but there is no price formula as such.
32. Waste collected from HCFs and treated from inception to date.

Other information

- There was a huge problem of HCWM in 2013. MoH invited bids to supply and install an incinerator within one month. By that time as SHE had already imported a Korean incinerator, it was possible for them to fulfil this requirement to win the bid. That is how this was started.
- So far, SHE has invested around LKR 1.5 billion
- SHE now employs around 100 people
- Most of the designs and fabrications are locally done
- SHE is planning to have 2 transfer stations (transit stores)
- SHE is getting around additional 2-3 MT/day due to COVID and therefore, there is a backlog
- SHE has its own COVID bins made out of aluminium with a cost of around LKR 50,000 per bin which can be disinfected.
- Proper segregation at HCF level is the key to success which has improved tremendously but still there is room for improvements. There is no 100% segregation though the incinerators can handle even unsegregated waste.
- SHE used to carry out HCF staff awareness and training but had to temporarily stop due to COVID
- SHE is planning to introduce their technology and expand the operation to South Asian region for which they seek UNDP assistance. They are also planning to have Dioxin and Furan testing facilities as Sri Lanka does not have such facilities yet.
- They believe that many other operators having incineration do not satisfy the requirements though some have two chambers as HHCW also consists of PVC.
- Physical visit to the site may not be possible due to the COVID situation and the safety measures they are following.

9 Lanka Refractories (LR)

Interviewee – Mr. Kalum Liyanage, GM

Incinerator (Lakmini)

1. When was the 1st LR incinerator installed and where? Durdans Hospital Colombo in 2014, Double chamber, 15 kg/hr capacity
2. When was the last LR incinerator installed and where? 4 projects simultaneously. One in Pallekelle, Aurvedic Medical Centre now converted in to a COVID treatment centre, commissioned a week before to incinerate COVID unsegregated waste. Another one in Chilaw Hospital, so far, the biggest one, 150 kg/hr. Two industrial incinerators for Prima Company in Seeduwa and Nature's Secret in Millawa.
3. How many units installed to date? 60 units in HCFs (All together 70 units including industrial incinerators)
4. How many units are now in operation? 59 units

5. How many units are now under repair ? None
6. How many units are abandoned and what were the reasons? There is one in Puttalam UC bought by the North Western Province about 5 years ago which is not in operation. According to the agreement, Puttalam UC had to provide the power supply which they did not do because of which, it is just lying there according to Lanka Refractories[8]
7. Whose responsibility is the operation of the LR incinerator? HCF staff
8. How many units are operated by LR operators only? None
9. How many units are operated by HCF operators only All
10. How many units are jointly operated by LR & HCF operators ? None
11. What is the warranty / guarantee? 1-3 years depending on what competitors offer. After 5-7 years, fire bricks need to be replaced. If there is overloading, then there could be problems of burners due to back firing, etc.
12. What is the capacity? Are there different capacities or is it the same capacity – 10-150 kg/hr
13. What is the chimney height? 12-80 feet
    Normal requirement is 20 m if the hourly input Calories exceed 0.65 MW. If it is below this threshold, there is waiver for the chimney height
14. What is the total capital cost including the LR incinerator house, accessories and bins
    Without scrubber?
    15-20 kg/hr – LKR 2.5 million
    30-40 kg/hr – LKR 5 million with 30' chimney
    50-60 kg/hr – LKR 7.5 million with 60' chimney
    100 kg/hr – LKR 8.5-9 million
    150 kg/hr – LKR 12 million
    Units over 100kg/hr are supplied with scrubbers costing around LKR 1.5 million
15. What is the average diesel consumption (lt) per month? 4-7 lt/hr per burner, 8-14 lt/hr for 2 burners
    In Iranawila and Tissamaharama LPG fired incinerators – 3-5 kg/hr per burner, 6-10 kg/hr for 2 burners
    In Welisara unit, there are 3 burners with a backup burner in the second chamber
16. What is the average electricity consumption (kWh) per month? One burner 250 Watts, 2 burners 500 Watts, 3 kWh per hour, with scrubber 8 kWh per hour
17. What is the average cost in LKR per kg of waste incinerated? Rs 25-30 / kg including depreciation for 100 kg/hr capacity unit.
    If it is LKR 10 million, compared to what is charged by Sisili Hanaro Encare, payback period would be 1 year.
18. What is the monthly cost of LR operator if applicable ? N/A
19. What is the maintenance arrangement? Service contract after 1-3 years guarantee period.
20. What is the annual cost of maintenance charged by LR ? After the guarantee period, LKR 200,000 to 350,000 per year depending on the distance as against 5-8% of the capital cost which the usual service agreement charges
21. How long it takes to respond to a breakdown repair ? 1 to 2 days. LR has a team of around 150 in their factory in Meepe including electrical, mechanical and refractory masons.
22. What are the frequently replaced components / spare parts? Photo cells, thermocouples
23. Was there any arrangement / agreement for ash disposal? No
24. Any test carried out for ash? No
25. Any restrictions of waste composition and weight for feeding? Rubber less than 5-10%
26. What are the arrangements for air pollution control? Scrubbing and long flue gas passage
27. Do you carry out segregation? No
28. Can the temperature be controlled? Yes
29. Can the COVID clinical waste be incinerated? Yes

<u>Lanka Refractories</u>
Incineration is related its core business.
They have been active for the past 10 years.
Engaged in R&D

<u>COVID waste incineration</u>

[8] **When checked with MS of Puttalam BH, it was revealed that there was an attempt by the RDHS / PDHS offices to have a cluster like operation in Puttalam UC to serve HCFs in the area. However, it did not go ahead as expected due to transport issues of bringing clinical waste from HCFs in the area and some issues about the treatment charge of Puttalam UC.**

Incinerator in Pallekelle, Ayurvedic Medical Centre commissioned a week before is used for COVID waste treatment.
It has a larger secondary chamber with a longer retention time of 3-4 Sec at 1,200 deg C against the normal requirement of minimum 2 sec.
COVID waste consists of rubber, plastics and even PVC.

Waste composition
As a thumb rule, 1,250 to 2,000 kCa/kg of waste is expected.
If the capacity is 10 kg/hr, then the total is 10x2,000=20,000 kCal whereas 1 kg of rubber has 15,000 kCal
Therefore, 7 kg of mixed waste is equivalent to just 1 kg of rubber.

Allowed percentage of rubber is around 5-10%
If this level exceeds, it makes lots of operational and maintenance issues.

Operation
Batch operation
Can operate around 10-20hr a day.
In higher capacity one like installed in Chilaw Hospital, 1 batch is for 1hr operation to prevent flue gas coming out when opening the door to feed multiple times.

Scrubber
Chilaw Hospital incinerator has a scrubber too with flue gas air to water heat exchanger. Fly gas laden water after cooling down and allowing the ash to settle at the bottom, water is recycled.

Cytotoxic waste
Can be incinerated as the incinerator is designed to operate at from 1,250 – 1,400 deg C.
It is done in the Anuradhapura Hospital.

Operators
Lack of awareness is the biggest problem as thy do not stay over a long period as there is no cadre position for it. Somehow, they get transferred after 6-12 months.
Sometimes, cleaning staff is engaged in incinerator operation.
Generally, there is a reluctance to be an incinerator operator
Lanka Refractories considers group training as a good way of overcoming this problem as they have nearly 60 incinerators operating in the healthcare sector.

Fuel
LPG is preferred over diesel as impurities of diesel creates problem in burners. LPG burners need less maintenance

Suggestions
Decentralized systems.
But LR does not want to have a system similar to Sisili.
LR can provide the equipment including pollution control systems

10. Metamizer Local Agent

Local agent – Biomed International Pvt Ltd, No 2A, Deal Place, Colombo 03
Supplier – R.R, TAYLOR Pvt Ltd, 5 Cal Close, Somersby, NSW 2259, Australia
Interviewee – Mr. Jude

Metamizer

1. What was the assistance package of the Australian project (Grant, loan or mixed)? Soft loan
2. What was the contract between Biomed & MoH? Supply, install, commission, training of operators of 20 Metamizers and 05 incinerators with 01-year warranty and 5 years' service and maintenance agreement
3. When was contract between Biomed & MoH signed? 12 December 2013 (Delay of implementation due to regime change, etc.)
4. What were the obligations of the supplier / Local agent? As stated in Q2
5. What were the obligations of the MoH? Provide space to install the unit, electricity, water supply, an assistant for the operators of Biomed

6. What is the warranty / guarantee? 01-year warranty and 5 years' service and maintenance agreement
7. What is the capacity? Are there different capacities or is it the same capacity? All are of the same capacity – Maximum 100 kg/hr or 660 lt/hr, Average 80kg/hr, Time taken is around 20-25 minutes for a batch of 30-35 kg, Recommended composition of sharps 1/3 rd maximum
8. When was the 1st Metamizer installed and where? 17 October 2016 in Thellappalai in Jaffna BH
9. When was the last Metamizer installed and where? 20 December 2018 in Anuradhapura
10. How many units installed? 20
11. How many units are now in operation? 19
12. How many units are now under repair? 05
13. How many units are abandoned and what were the reasons? 1 (Ampara – due to the problem of disposing residue)
14. Whose responsibility is the operation of the Metamizer? According to the agreement, HCF staff
15. How many units are operated by Biomed operators only? 18
16. How many units are operated by HCF operators only? 1 (Only in Batticaloa)
17. How many units are jointly operated by Biomed & HCF operators? Supposed to be a joint operation but some HCFs have not provided their staff
18. What was the total capital cost including the Metamizer house, accessories and bins? USD 757,541.11
19. What is the average electricity consumption (kWh) per month – 40 KWH for 12 hr operation
20. What is the average cost of electricity in LKR per kg of waste autoclaved?
    Per kg Rs.1.35
21. What is the monthly cost of Biomed operator ?
22. What is the maintenance arrangement? After the warranty of 1 year, 5 years' service and maintenance agreement
23. What is the annual cost of maintenance charged by Biomed? USD 495,000 per year for spare parts and LKR 12.8 million for labour for all 20 Metamizers
24. How long it takes to respond to a breakdown repair? Almost immediately as they have regional teams deployed and lead by 3 well trained people in 3 regions. However, due to delay in receiving the payments from MOH, they have a problem of stoking adequate spare parts. COVID has aggravated the situation due to delays in imports. They are now exploring the possibility of turning out some components locally.
25. What are the frequently replaced components / spare parts? Gear mechanism, Bearings Seals, Sensors, hydraulic systems -such as Hoses & Oil,
26. Was there any arrangement / agreement for residue disposal? No
27. Any restrictions of waste composition and weight for feeding? Chemicals waste are not allowed. Overloading and prolong time of operation is the major cause for frequent breakdown.
28. Any overload protection? Yes if it is above 40kg. But unsegregated matter like metal parts, big bottles, coconut shells (though the weight is within the limits) damage the shredders. Once stopped with overloading, there is a provision for manual turning. With COVID, unsegregated waste is coming and there is no way of segregating. In fact, COVID waste shouldn't be autoclaved but should be incinerated as some HCFs do.
29. What is the functionality of the Ozone unit? Odour control but the continuous exposure to Ozone also create problems
30. What are the arrangements for odour control? No proper solution due to the above problem
31. What is the average amount of waste water generated and arrangement for waste water disposal? There is no waste water as the remaining goes with the residue. What is coming out of the machine is only the condensate which is around 3-4 lt during the 1st cycle
32. Any test carried out of residue? They do it in their own laboratory to see whether the residue is infectious or not but not the substances. Occasionally, they have got the testing done by MRI and ITI
33. Any reason for frequent breakdown? As stated in Q28.
34. What is the mode of transport / Who is responsible? Did only during the cluster operation of 01 year commencing in February 2018 in Rathnapura area using their dedicated vehicles
35. Do you have storage facility / What is the capacity? Only for the above operation but not now
36. What is the mechanism for segregation? None

Other information

1. There are clear guidelines for siting plants for which they need to get CEA approval
2. Better operating units – Kuliyapitiya, Akkarapattu, KalmunaiAMH, Kalmunai, Marawila

Incinerator (Incinco)

1. What was the assistance package of the Australian project ? Same as Metamizer
2. What was the contract between Biomed & MoH? Same as Metamizer
3. When was it signed? Same as Metamizer
4. What were the obligations of the supplier / Local agent? Same as Metamizer
5. What were the obligations of the MoH? Same as Metamizer
6. What is the warranty / guarantee? Same as Metamizer
7. What is the capacity? Are there different capacities or is it the same capacity? 50 kg/hr
8. What is the chimney height – 9m
9. When was the 1st Incinco incinerator installed and where? 17 October 2016 in Thellappalai in Jaffna BH
10. When was the last Incinco incinerator installed and where? Polonnaruwa 4th April 2017
11. How many units installed? 05
12. How many units are now in operation? 05
13. How many units are now under repair? 0
14. How many units are abandoned and what were the reasons? 0
15. Whose responsibility is the operation of the Incinco incinerator? Same as Metamizer
16. How many units are operated by Biomed operators only ?
17. How many units are operated by HCF operators only?
18. How many units are jointly operated by Biomed & HCF operators ?
19. What was the total capital cost including the Incinco incinerator house, accessories and bins? USD 208,571.45
20. What is the average diesel consumption (lt) per month? 12-15lt per cycle
21. What is the average electricity consumption (kWh) per month? Very little
22. What is the average cost in LKR per kg of waste incinerated? Around Rs.65.00
23. What is the monthly cost of Biomed operator?
24. What is the maintenance arrangement? Same as Metamizer
25. What is the annual cost of maintenance charged by Biomed? USD 7,635 per year for spare parts and LKR 1.7 million for labour for all 5 Incinerators
26. How long it takes to respond to a breakdown repair? Within 24 Hrs
27. What are the frequently replaced components / spare parts? Applying Fire Cement in regular basis (after every 3 months of operation), Thermocouples, Flame sensors, Filters, Fire Bricks, burners (due to back pressure owing to excessive loading)
28. Was there any arrangement / agreement for ash disposal? No
29. Any test carried out of ash? No
30. Any restrictions of waste composition and weight for feeding? Each cycle 20Min - maximum 17kg (Plastic Waste not more than 5kg)
31. What are the arrangements for air pollution control?
32. Any reason for breakdown? It is expected that the machine is put on rest for about 4 hrs after a continuous operation of 8 hrs. Due to heavy waste loads, some machines run long hours. Overloading per cycles.
33. Any reason for firebrick liner failure? Overload
34. What is the mode of transport / Who is responsible? No transport
35. Do you have storage facility / What is the capacity? No storage
36. What is the mechanism for segregation?
37. Can the temperature be controlled? Yes. Waste should be loaded after secondary chamber temperature reaches > 800 deg C
    Primary chamber (Primary burner stops if the temperature drops to 550-650 deg C) = 750 - 950 deg C,
    Secondary chamber (Burners stops if the temperature drops to 950-1050) = 1050-1250 deg C. Not design for more than 1,500 deg C.
38. What is the purpose of having 2 burners at the second chamber?
    Maintain the temperature in Secondary Chamber Residence time - 2Sec

11. PCL Solutions (Pvt) Ltd - Local Agent of Mediburn (MB)

Interviewee – Mr. Thushantha and Mr. Rohan of PCL Solutions (Pvt) Ltd, a technology transfer company and a part of the Dilmah group.

Incinerator (Mediburn)

1. When was the 1st MB incinerator installed and where? In 2008 in Durdans, Mediburn Dual chamber, 30kg/hr, Size 6'x 4'
   Locally fabricated one in 2015 in a private company called Prabodha, 10 kg/hr
2. When was the last MB incinerator installed and where? In 2017 in Jaffna TH, Mediburn Dual chamber, 30kg/hr
   Local one in 2018 in Kinniya BH, 50 kg/hr
3. How many units installed to date? 29 units (19 Mediburn and 10 Locally fabricated)
4. How many units are now in operation? 15 Units Mediburn (No funds to repair the units in Jayawardapura, Horana, Panadura and Matara.)
5. How many units are now under repair? 02 units in Pothuwil and Samanthurai
6. How many units are abandoned and what were the reasons? Jayawardapura was damaged. 02 untis in Batticaloe TH are not in operation as they have a Metamizer and another incinerator
7. Whose responsibility is the operation of the MB incinerator? HCF staff only
8. How many units are operated by MB operators only? None
9. How many units are operated by HCF operators only? All
10. How many units are jointly operated by MB & HCF operators? None
11. What is the warranty / guarantee? 1 year
12. What is the capacity? Are there different capacities or is it the same capacity? 30-50 kg/hr
13. What is the chimney height? Mediburn 20' and local one 60'
14. What is the total capital cost including the MB incinerator house, accessories and bins? Rs 8.5 million Mediburn, Rs 6.5 million local one with 60' chimney
15. What is the average diesel consumption (lt) per month? Mediburn 10-15 lt of diesel for 30kg for both burners
16. What is the average electricity consumption (kWh) per month? 0.35 units per hour
17. What is the average cost in LKR per kg of waste incinerated? Rs 52 per kg only the operating cost
18. What is the monthly cost of MB operator if applicable? N/A
19. What is the maintenance arrangement? Yes after the guarantee period
20. What is the annual cost of maintenance charged by MB? Rs 330,000 for 4 services
21. How long it takes to respond to a breakdown repair? 24 hrs
22. What are the frequently replaced components / spare parts? Nozzles, filters, thermocouples
23. Was there any arrangement / agreement for ash disposal? no
24. Any test carried out for ash? Yes only in USA
25. Any restrictions of waste composition and weight for feeding? Not too much plastics
26. What are the arrangements for air pollution control? No
27. Any reason for breakdown? Mostly the operator incapability, negligence, segregation issues
28. What is the mode of transport / Who is responsible? N/A
29. Do you have storage facility / What is the capacity? No
30. Do you carry out segregation? No
31. Can the temperature be controlled? Yes at 1,100 degC with 2-3 sec retention time
32. Can the COVID clinical waste be incinerated? Yes in Kalmunai, Akkaraipaththu, Ashraff Memorial hospital

Other information

PCL locally fabricates incinerators with the same design of Mediburn up to the capacity of 300 kg/hr. Some of them are installed in crematoria of Borella and Madampitiya.
So far, they have installed 30 units out of which 29 are in HCFs and one in Ninja factory.

Lifetime is 8 to 10 years

They prefer only to be a supplier but not as an operator like Sisili. Abans was looking for such opportunities.

12 ULG

Interviewee – Mr. Bandara Batuwewegedara

Incinerator (ULG) – Italian make

1. When was the 1st ULG incinerator installed and where? Dambulla Municipal Council, in June 2020, 100-120 kg/hr, dual chamber with a scrubber
2. When was the last ULG incinerator installed and where? Only the 1st one. Second one will be in Kurunegala TH
3. How many units installed to date? Only 1
4. How many units are now in operation? One
5. How many units are now under repair? None
6. How many units are abandoned and what were the reasons? None
7. Whose responsibility is the operation of the ULG incinerator? initially ran by Dambulla MC operators. As they could not operate it properly, now it is operated by ULG staff
8. How many units are operated by ULG operators only? One
9. How many units are operated by HCF operators only? None
10. How many units are jointly operated by ULG & HCF operators? None
11. What is the warranty / guarantee? 3,000 working hours. To date, within the past 8 months, it has operated in 710 hours
12. What is the capacity? Are there different capacities or is it the same capacity? 100-120 kg/hr
13. What is the chimney height? 21'
14. What is the total capital cost including the ULG incinerator house, accessories and bins?– Rs 19 million
15. What is the average diesel consumption (lt) per month? 25 to 30 lt for 100kg if the moisture is below 5% and the calorific value of waste is less than 20,000 kCal.
    40-60 lt for 100kg if those parameters are above
16. What is the average electricity consumption (kWh) per month? 500 kWh per month
17. What is the average cost in LKR per kg of waste incinerated?
18. What is the monthly cost of ULG operator if applicable? Rs 55,000 per month
19. What is the maintenance arrangement? After 1 year
20. What is the annual cost of maintenance charged by ULG? 5% of the initial cost per annum
21. How long it takes to respond to a breakdown repair? N/A
22. What are the frequently replaced components / spare parts? Thermocouple
23. Was there any arrangement / agreement for ash disposal? Ash pit
24. Any test carried out for ash? No
25. Any restrictions of waste composition and weight for feeding? Less than 30% plastics
26. What are the arrangements for air pollution control? Scrubber
27. Any reason for breakdown? N/A
28. What is the mode of transport / Who is responsible? Dambulla MC
29. Do you have storage facility / What is the capacity? Dambulla MC
30. Do you carry out segregation? No
31. Can the temperature be controlled? Yes. 1st chamber 950 degC. 2nd chamber – 1,200 to 1,250 degC with 2 sec retention time. Chimney exhaust temperature – 70 degC

Other information

This unit was purchased by Dambulla MC at a price of Rs 19 million.
Rs 10 million from Dambulla MC and Rs 9 million from Ministry of Provincial Council & Local Authorities

It has a daily capacity of 600 kg
But now it is getting only 250-400 kg

It can run continuously about 16hrs a day and 6 days a week

This incinerator is used by Dambulla MC to burn unrecyclable plastics.
For clinical waste, Dambulla MC charges around Rs 80-90 per kg

Emission measurement from ITI

SO2 – ULG 7.2 mg/Nm^3 as against CEA limit of 70 mg/Nm^3
NO_x – ULG 5.9 mg/Nm^3 as against CEA limit of 300 mg/Nm^3
Particulate matter – ULG 10 mg/Nm^3 as against CEA limit of 100 mg/Nm^3
Smoke density – ULG 2% as against CEA limit of 10%
CO – ULG 18 mg/Nm^3 as against CEA limit of 50 mg/Nm^3
HCL – ULG 2.5 mg/Nm^3 as against CEA limit of 15 mg/Nm^3
Heavy metal – ULG 0.12 (CEA Mercury 0.0001 mg/Nm^3 and Lead 0.01 mg/Nm^3)

Dioxin / Furans – As per CEA, should be controlled by maintaining temperature at 1,100 ^{0}C to 1,250 ^{0}C and 2-3 second retention time in secondary Chamber

There were some corrosion issues in the scrubber tubes due to high acidity of water and hence they are trying to replace them with stainless steel

Second unit is expected be installed in Kurunegala TH in mid-March 2021.
It will be a similar unit like one in Dambulla

They are now in negotiations with other Local Authorities to have similar systems giving them 2 options to choose from; outright purchase or transfer the ownership after 7 years of operation once the cost of UGL is recovered.

If properly maintained, lifetime could be 20-25 years.

Dambulla MC Incinerator (UGL)

Wild Elephants in Garbage Disposal Site of Dambulla MC	Infectious Waste from Dambulla BH	Sharps Boxes	Incinerator
			
Incinerator Control Panel	Scrubber for Air Pollution Control	Ash from Incinerator	Discharge of Scrubber Water
			

Italian made double chamber incinerator with a water scrubber for air pollution control. Located in the garbage disposal site of Dambulla MC between Dambulla and Habarana. This was initially purchased by Dambulla MC but after sometime, with operational problems, it was handed over the supplier for operation. Plant is now running under capacity as it receives only the infectious waste and sharps from Dambulla hospital. Mayor and the incinerator supplier are trying to get infectious waste from HCFs in Matale district. Suppler is willing to have an operation similar to Sisili Hanaro with a reduced tipping fee like LKR 80 per kg. Similar incinerator is going to be procured by Kurunegala TH. With the above, there will be 2 units of this system in Sri Lanka.

13 NERD Centre

Interviewee

Eng., Ananada Namal, DG, Eng. Ajith Jayasooriya, Eng. Nandana Edirisinghe

Incinerator (NERD)

1. When was the 1st NERD incinerator installed and where?– The first HHCW incinerator was installed in Welisara Chest hospital in 1998. It was a low-grade LPG fired incinerator on trial basis without high temperature incineration facility. Prior to this, NERD had developed an industrial waste incinerator for a BOI approved garment factory with 100 kg/hr capacity. As it had design and construction failures, it had to be abandoned after 1 year of operation
2. When was the last NERD incinerator installed and where? Kurunegala TH in 2006. It was LPG fired double chamber incinerator. This was subsequently repaired and converted to LPG by a third party. Now, it needs a new chimney as the exit of the existing one is below the height of the newly constructed multi story maternity ward
3. How many units installed to date? In health sector, 05 units
4. How many units are now in operation? 02 units (3rd incinerator was installed in Ragama North TH in 2001 with 150 kg/hr capacity and it is still in operation but need some repairs). Industrial type incinerator was installed in David Peiris company in 2002 and a scrubber was introduced in 2004. This unit is also in operation now
5. How many units are now under repair? 01
6. How many units are abandoned and what were the reasons? 03 units (1st one in Welisara chest hospital in 1998 was only a trial one. 2nd one with the capacity of 30 kg/hr in Habaraduwa Health Service Centre in 1999 which was destroyed in Tsunami. 3rd one in Ragama Medical Faculty for pathological waste incineration in 2000, 30kg/hr unit operated for 3 years)
7. Whose responsibility is the operation of the NERD incinerator? HCF staff
8. How many units are operated by NERD operators only? None
9. How many units are operated by HCF operators only? All
10. How many units are jointly operated by NERD & HCF operators? None
11. What is the warranty / guarantee? 1 year
12. What is the capacity? Are there different capacities or is it the same capacity? 30-150 kg/hr
13. What is the chimney height? 20 m
14. What is the total capital cost including the NERD incinerator house, accessories and bins? Rs 7-8 million
15. What is the average diesel consumption (lt) per month? 40 kg of LPG per hour
16. What is the average electricity consumption? (kWh) per month 500-600 kWh per month
17. What is the average cost in LKR per kg of waste incinerated? 50-80 Rs/kg of waste only for fuel
18. What are the frequently replaced components / spare parts? Burner parts, safety features of LPG burners,
19. Was there any arrangement / agreement for ash disposal? No
20. Any test carried out for ash? No
21. What are the arrangements for air pollution control? Only through a tall chimney. In Kurunegala TH incinerator, there is a simple scrubber
22. Any reason for breakdown? Mainly the overloading

Other information

The intention of NERD was to develop a suitable technology through R&D and to transfer the technology to local producers under license but not to become a manufacturer or a supplier. However, no license was issued to date.

Some importers started fabricating incinerator locally.

NERD train the operators and issue a certificate.
However, operators do not follow the recommended procedures
Overloading is the major issue for operation related problems. This leads to back heating which damages the burners
For them it is just burning of waste
Sometimes, they burn clinical waste with the door open and making it an open burning system rather than incineration

Though the medical staff is well aware of the consequences of not doing proper incineration, finance and admin officers do not fully understand the implication and hence tend to give low priorities.

Non-incineration technologies are more user friendly
Needle burners are available in India which can burn sharps

Some Suppliers of Incinerators for Clinical waste

Local Manufactures

1. D.G.T. Kumarasiri
CTS Ceramic products
71/2, Dattara, Akaravita, Avissawella
Web site: ctsrefractory.com
Tel. 0777152503

2 Assistant General Manager
Lanka Refractories Ltd
Meepe, Padukka
Tel. 011 2859 098, 011 2859 173
Fax. 011 2859 282
Tel. 0777 279457

3. Mr. Sampath Kularathne (Sales Manager- Health Care Division)
PCL Solutions (Pvt.) Ltd.
111, Negombo Rd., Peliyagoda
Tel: 011 482 2117 / 077 777 0190
Fax: 011 293 3085

Importers

1 Mr. Sampath Kularathne (Sales Manager- Health Care Division)
PCL Solutions (Pvt.) Ltd.
111, Negombo Rd., Peliyagoda
Tel: 011 482 2117 / 077 777 0190
Fax: 011 293 3085

2. Shaman Madurawala
Sales Engineer.
Boston Devices Private Limited
125/2 Nawala Road,
Narahenpita, Colombo 05,
Sri Lanka.
Mobile: 94-777698820
Direct: 94-114 378777
Tel: 94-112369377
Fax: 94-112369477
Email: shaman@bostondevices.lk

Annex 4 – Observation Visits

List of Healthcare Facilities visited

	Observation Visits – Group 1
	National Hospitals (02)
1	National Hospital Colombo
2	National Hospital Kandy
	Teaching Hospitals (07)
1	Teaching Hospital Anuradhapura
2	Teaching Hospital Batticaloa
3	Teaching Hospital Kalubowila
4	Teaching Hospital Karapitiya
5	Teaching Hospital Kuliyapitiya
6	Teaching Hospital Peradeniya
7	Teaching Hospital Ratnapura
	Provincial General Hospitals (02)
1	Kurunegala
2	Badulla
	District General Hospitals (04)
1	Kegalle
2	Matale
3	Matara
4	Monaragala
	Special Units (03)
1	Castle Street Hospital for Women
2	Lady Ridgeway Hospital
3	Sri Jayewardenepura
	Base Hospitals (10)
1	Anamaduwa
2	Dambadeniya
3	Elpitiya
4	Gampola
5	Mirigama
6	Puttalam
7	Dambulla
8	Diyathalawa
9	Mulleriyawa
10	Teldeniya
Total Group 1 – 28	

	Observation Visits – Group 2
	Divisional Hospitals (05)
1	Demodara
2	Gelioya
3	Kandana
4	Padukka
5	Yatawatta
	MoH (01)
1	Padukka
Total Group 2 - 06	

	Observation Visits – Group 3
	Private Hospitals (05)
1	Asiri Hospital, Kandy
2	Lanka Hospital, Colombo
3	KMG Suwaseva, Hettipola
4	Nawinna Hospital, Kurunegala
5	Suwasevana Hospitals (Pvt) Ltd, Kandy
	Medical Laboratory (01)
1	Amaya Medical Centre, Kandy
Total Group 3 - 06	

Observation Visits Brief

1 Kurunegala Provincial / Teaching Hospital

Open store under the sun and rain	Chimney Closer to the maternity ward	Accumulated Incinerator Ash
		

Infectious Control Committee minutes were kept before COVID-19 but not presently. This information is provided to the Director but not to the Ministry of Health on regular basis, sometimes on request to Environmental and Occupational Health Directorate. There is no environmental license.

Some numerical information provided through the questionnaire was incorrect and therefore had to be corrected subsequently.

Total mixed waste generation is around 17,000 kg per month (Food waste 15,000 and other waste such as polytene, etc. 2,500 kg). Number syringes issued is around 200,000 per month.

There is no EPL now and has made an application to CEA about 4 months before.

E- waste; Kept in a store without having a proper disposal system. Recently, the stock was removed by the Municipal Council but they are not sure of what is going to happen in the future.

Still a fair amount of mercury thermometers and blood pressure meters are being used. When damaged, they are sent to "Condemning Branch" and they are unaware of what is happening thereafter. Cleaning workers do not follow instructions

Incineration
Operating cost of the incinerator is around 100,000 per month as per the diesel consumption of around 1,000lt per month. With the advice of someone, operators switch off the burners intermittently to save fuel and also to control the temperature so that they do not feel uncomfortable to reach the incinerator without knowing / understanding that the temperature below 1,200 deg C will not destroy cancer casing substances such as Dioxin and Furan. Apparently, with this initiative, diesel consumption has come down from around 2,500/2,000 to around 1,000/800lt per month.
Incinerator chimney exist is below the building height of the adjoining maternity award and hence incinerator smoke could go into this ward.

Hospital has made arrangement to procure a new incinerator (Italian made one for around LKR 24 million) through the procurement system of Ministry of Health. This unit is supposed be installed in the same location where the Metamizer is located (other side of the main road dividing the hospital complex into two blocks/locations either side of the main Kurunegala Colombo road). HHCW needs to be transported from one side of the main road to the other side now in open trolleys. Hospital is planning t deploy a close tractor for this purpose.

Metamizer
This was installed in April 2017 and its operation requires around 5,000kWhr per month. It was not functioning at the time of the visit.

Storage
Waste storage facilities is not properly organized and therefore, it is unsafe (lack of a proper storage, open storage under the sun and rain, sharps and other clinical waste in the same place, etc.).

Residue disposal
There is no disposal system for ash coming out of the incinerator. It is accumulated behind the incinerator and polluting the nearby water stream (which is running through residential areas and ending up in Deduru Oya ultimately) especially during the rainy season. There is no disposal system for Metamizer residues and now being accumulated in the site where the Metamizer is located.

Community resistance
Apparently, there is a community pressure against the air and land pollution now happening at the incineration site. There are protests from the community and also from the Water Board for the proposed site of the new incinerator.

2 Kuliyapitiya Teaching Hospital

Metamizer	Accumulated Metamizer Residue	Single Chamber Low Temperature Brick Incinerator	Chimney Closer to the ward
			

HCWM seems to be satisfactory. Clinical waste is measured and records are well kept. Staff assigned to it is fully dedicated.

With the mediation of RDHS, sharps are sent to BH Dambadeniya at a distance of around 30 km for incineration which has a newly built incinerator with excess capacity. Waste is transported to Dambadeniya using a general-purpose vehicle but not a dedicated one to transport hazardous waste.

There is no EPL now and has made an application to PEA (Provincial Environment Authority) on 12 September 2020. HCF is getting ready to apply for Scheduled Waste Management License

They vaccinate all categories except a few cleaning workers who are changed regularly. The name list with the recommendation of the Microbiologist is sent to the Ministry to obtain vaccination.

E- waste; Kept in an open space near the general waste store without having a proper disposal system.

Before COVID19, a fair amount (around 50%) of mercury thermometers and blood pressure apparatus were used. When damaged, they are sent to "RDHS" and they are unaware of what is happening thereafter. With COVID19, use of digital apparatus has been increased up to around 90%.

They still do not have a right policy to ban the plastics

There is no transit store for clinical waste as it is being directly sent to the Metamizer where there is adequate space to store any excess waste in dedicated wheeled bins.

Metamizer
This was installed in February 2018 and it is functioning properly. Rated capacity is around 40 kg. Around 2.7lt of water is used for one cycle which takes about 30 minutes. Around 1 lt of waste water per cycle is discharged to a concrete pit though the pipe leading to the pit was broken at the time of visit. Metamizer operation requires around 15,000kWhr per month. There is no separate electricity meter. Supplier has deployed one of its employees to operate the unit. Payment to the supplier for the operation of the Metamizer is directly paid by the Ministry. When its breakdowns, supplier promptly attends to repairs.

Storage
Waste storage facilities is fairly managed.

Residue disposal
There is no disposal system for Metamizer residues and now being accumulated in the site where the Metamizer is located which is very close to some private residences. Pradeshiya Sabha is willing to remove the residue provided that a safety certificate issued by the hospital authority. Hospital has made a request to the Ministry of Health and awaiting a response. There is no disposal system for the ash of the brick incinerator and it is accumulated behind the incinerator.

Community resistance
Apparently, there is a community pressure against the residue accumulation at the Metamizer site and air land pollution now happening at the incineration site.

Incinerator
Old type single chamber brick incinerator which was used prior to the installation of the Metamizer is still there for emergency operation. Now the clinical waste from COVID ward is burnt in this incinerator. Black smoke is visible. Incinerator chimney exist is below the building height of the adjoining multi story ward building and hence incinerator smoke could go into this ward. It is very unlikely that the temperature reaches 1,200 deg C to destroy cancer casing substances such as Dioxin and Furan.

3 Dambadeniya Base Hospital – Type B

Incinerator Building	Incinerator	Ash Pit
		

They vaccinate all categories except a few cleaning workers who are changed regularly. The name list with the recommendation of the Microbiologist is sent to the Ministry to obtain vaccination.

Still around 50% of thermometers and blood pressure apparatus used are mercury based. When damaged, they are sent to the condemning unit and then to "RDHS" and they are unaware of what is happening thereafter.

There is no EPL now and has made an application to PEA (Provincial Environment Authority) in July 2020. No scheduled waste license and they have not applied for it.

As the questionnaire was filled by a computer operator, most information / data provided were wrong and there were lot of missing information / data. Deputy Director / MS along with ICN officer went through the entire questionnaire in the presence of the observation visitor of the consultant team and corrected and inserted missing information after seeking the required clarifications.

Incinerator
There is a newly built (about a year ago) diesel operated dual chamber incinerator (Locally built by Lanka Refractories – Lakmini Refractories). Though it was not running at the time of visit, apparently it is being operated successfully. This has a temperature monitoring facility with the ability to maintain it at 1,200 deg C, tall chimney without any pollution control system. As there is excess capacity, with the mediation of RDHS, BH Dambadeniya assists the waste treatment of other hospitals such as TH Kuliyapitiya (for sharps) and Galgamuwa at certain times. Diesel 5,260 lt in 2019 (Rs 547,040 per year @ Rs 104/lt or around Rs 46,000 per month)

Storage
There is a dedicated waste storage facility with adequate capacity built as a part of the incinerator building and unauthorized entry is restricted.

Residue disposal
There is a temporary disposal system for ash coming out of the incinerator (a concrete pit closer to the incinerator)

Community resistance
Apparently, there is no community pressure against the air pollution as the incinerator is located in an isolated corner of the hospital premises and there are no private residences nearby and also the cemetery is just adjoining.

4 Anamaduwa Base Hospital – Type B

Open Burning of Infectious Waste	Placenta Pit	Open Burning of other waste	Composting of Garden Waste
			

This HCF got BH-Type B status in 2019 January 23.

They vaccinate only the permanent HCF staff. Earlier they used to vaccinate casual HCF staff to but not any longer. They do not vaccinate cleaning workers.

Still almost 100% of thermometers and blood pressure apparatus used are mercury based. When damaged, they are sent to the condemning unit and then to "RDHS" and they are unaware of what is happening thereafter.

There is no EPL / SWML now.

As some questions were skipped at the time of responding, ICN officers went through the questionnaire in the presence of the observation visitor of the consultant team and corrected and inserted missing information after seeking the required clarifications.

Open burning
Infections waste is burnt openly

Storage
There is a dedicated waste storage facility with adequate capacity built and unauthorized entry is restricted. However, it was observed that e-waste is mixed with glass.

Residue disposal
There is no proper disposal system for ash remaining after open burning

Community resistance
Apparently, there is no community pressure against the air pollution as the open burning is taking place in an isolated corner of the hospital premises and there are no private residences nearby

5 Puttalam Base Hospital – Type B

Infection Control Team	Segregation	Weighing	Open Burning of infectious Waste
			

Infectious Control Unit is headed by the MS and staffed with one Nursing Officers. From all wards, there is a focal point serving in the infection control committee. Entire team including the head of the institution was available for consultation

Everything (minimization, segregation, collection, weighing, internal transport, etc.) in this hospital up to the treatment is perfectly handled but then subjected to open burning as there is no inhouse treatment facility. They collect infections waste every Saturday and then burn. There is no facility for waste water treatment and the effluent is sent to drains.

They vaccinate all categories.

Still almost 100% of thermometers and blood pressure apparatus used are mercury based. When damaged, they are sent to the condemning unit and then to “RDHS” and they are unaware of what is happening thereafter.

There is no EPL / SWML now.

As the questionnaire was filled by the Secretary to MS, some information / data provided were wrong and there were some missing information / data. Entire IC team including the MS went through the entire questionnaire in the presence of the observation visitor of the consultant team and corrected and inserted missing information after seeking the required clarifications.

Open burning
Infections waste is burnt openly

Storage
There is a dedicated general waste storage facility with adequate capacity but there is no dedicated stores for infectious waste and sharps.

Residue disposal
There is no proper disposal system for ash remaining after open burning

Community resistance
Apparently, there is no community pressure against the air pollution though the opening burning is taking place very close to private residencies but it is very doubtful how long they could continue to practice this.

6 Kegalle District General Hospital

Metamizer	Accumulated Metamizer Residues near a Water Stream	Waste Store Built over a drain connected to a water stream	Stores for Infectious and General Waste
			

Response to the online survey was done by Dr. Imesh Dishara Prathapasinghe Director / MS who has been transferred to Nuwara Eliya RDHS. Present Director, Dr. Mihiri Priyanganie was not available for discussion. Only the ICNO was available for consultation.

Has requested an incinerator from Lanka Refractories with the capacity of around 150 kg per hour to serve cluster HCFs in the area due to the problematic operation of the Metamizer

Before, the installation of the Metamizer, they had both EPL and SWML but after installation, it was not possible to obtain licences due to the residue issue of the Metamizer
Vaccination is for all categories.

Still almost 30% of thermometers and blood pressure apparatus used are mercury based. When damaged, they are sent to the condemning unit and then to "RDHS" and they are unaware of what is happening thereafter.
ICNO along with another nursing officer went through the questionnaire in the presence of the observation visitor of the consultant team and corrected and inserted missing information after seeking the required clarifications.

Metamizer
Hospital has asked for an incinerator (made several requests at different times) but instead, it was given a Metamizer which was installed in February 2018 but was commissioned in September 2018 due to residue management issue. With the installation of the Metamizer, electricity bill was increased by around Rs 125,000. Subsequently, residue was transported to Ashraf Memorial Hospital but apparently there is an objection from CEA for not having SWML for transport. Since the dump site of Ashraf Memorial Hospital too does not have environmental clearance, they are in fear of accepting external waste. Earlier the Metamizer was used to serve the nearby HCFs and at times, they had to run even 24 hours. When it was continuously run, there were maintenance issues (frequent breakdown of the gear box, burning of heaters, etc.). Now they operate it for around 8 hrs. When more sharps are fed to the Metamizer, it breakdowns frequently. There are 2 operators; one from the hospital and the other one from the Metamizer supplier. Electricity consumption is around 8,000 to 10,000 kWh per month. Monthly expenditure is around Rs 300,000 excluding the payment made to Metamizer supplier directly by the Ministry of Health.

Storage
There is a nicely built waste store having two sides; one side for infectious waste and sharps and other side for general waste and also condemning store for e-waste. But this store is built on a wrong place adjacent to a water stream leading to Maha Oya.

Residue disposal
Metamizer residue is allowed to accumulate here in the water stream bank causing severe health issue for downstream water users as there are many drinking water intakes.

Sewage Treatment Plant
Apparently, it does not function properly due to some maintenance issues.

Community resistance
As there is no tall chimney, when the doors of the Metamizer is opened for feeding and discharge and also due to the leaks of doors due to poor maintenance, apparently unbearable odour comes

out and it is objected by the nearby RDHS office. Because of this problem, sometimes, they are compelled to operate it during the night time.

7 Mirigama Base Hospital – Type B

Segregation	Collection	Infectious Waste & Sharps	Food Waste
			

They have a well-functioning Infection Control Committee consisting of MS, MO Public Health, MO Planning, MO Quality, Matron and two fulltime ICNOs. In addition, Chief Clerk from the admin division and in charge NOs of every ward are also in the committee. MO Planning and Nursing Officer Health Education were available for consultation.

They do not treat healthcare waste internally and as arranged by RDHS, sent either to Wathupitiwala or Negombo hospital in Gampaha district where there are incinerators. Every Friday, there is a purpose-built vehicle coming for this purpose and collect infectious waste and sharps. However, as both incinerators do not operate now, infectious waste and sharps are stored in the chamber but separately with restricted entry.

Rest of the operation is satisfactory from minimization, segregation, collection, storing, etc.

They have a valid EPL but no SWML.

Still almost 60% of thermometers and 75% blood pressure apparatus used are mercury based. When damaged, they are sent to the Bio Medical Department in Gampaha or if they are not repairable to the condemning unit and then to "RDHS" and they are unaware of what is happening thereafter.

Food waste is given to a third party as animal food.

8 Hingurakkoda Base Hospital – Type B

Segregation	Self-made Segregation Bins	Infectious Waste Burning Unit	Waste Burning Unit
			

Very low level of understanding and awareness on HCWM
Not aware on the need for vaccination.

Still almost 100% are mercury thermometers. No mercury blood pressure meters

Incinerator
There is a waste burning Unit (Kasuga, Japan) which is an open burning system. Kerosene is used at the beginning to ignite the fire. Waste is fed from the top. There is no chimney. Visible black smoke is coming out. It is used once a week and for about 3 to 4 hours.

Storage
No dedicated stores as the waste generation is minimal

Residue disposal
Ash is dumped near the incinerator which is a very small quantity

Community resistance
Apparently, there is a community pressure against the air pollution now happening at the incineration site as there is no chimney in this system.

As the questionnaire was filled by a recently transferred ICNO from another HCF and her general understanding and the awareness on HCWM is not up to the expected standard, most information / data provided were wrong and there were lot of missing information / data. She went through the entire questionnaire in the presence of the observation visitor of the consultant team and corrected and inserted missing information after seeking the required clarifications.

9 Batticaloa Teaching Hospital

Double Chamber Incinco Incinerator	Damaged Parts of the Metamizer	Precise Record Keeping	Ash & Metamizer Residue Disposal
			
Wheeled Barrow used for Internal Transport	Weighing and Record Keeping at the Store	Accumulated General Waste	Dedicated Vehicle for Infectious Waste Transport
			

Compared to most other places, the record keeping is very good though the general cleanliness and how the premises is maintained is not satisfactory. Reason may be this is a very old HCF and lots of buildings have been added without a proper planning.

As the questionnaire was filled by the MO Public Health herself only a very few questions were incorrect and there were very few missing information / data. MO Public Health went through the entire questionnaire in the presence of the observation visitor of the consultant team and corrected and inserted missing information after seeking the required clarifications.

There is no EPL
For E- waste; there is no proper system
Thermometers 90% digital. Blood pressure apparatus – 80% digital. 20% mercury

Waste treatment
Waste treatment is done outside the HCF premises about 10 km away in a property belongs to RDHS where incinerators and Metamizer are installed and operated. There are 2 Mediburn incinerators now abandoned. Metamizer is out of operation since 8 December 2021 needing repairs. Metamizer supplier has supplied an incinerator too which is now in operation. These are now operated by the HCF staff. Though they have requested the supplier to deploy their own personnel for better operation and maintenance, this request has not been fulfilled. Chimney of the Incinco Incinerator does not have a cap and hence the rain water can get in which will damage the fire bricks linings.

At the treatment site, precise records are maintained. For incineration, following information is recorded in log book;

- Start time of one cycle
- Ending time
- Weight of the load – around 20 kg
- Temperature of the first chamber
- Temperature of the second chamber
- Colour of the smoke

Incinerator
This was installed and handed over to HCF on 21 May 2017 also under Australian assistance.
Make – Incinco
Model – FS50
Supplier – R.R, TAYLOR Pvt Ltd, 5 Cal Close, Somersby, NSW 2259, Australia
Local agent – Biomed International Pvt Ltd, No 2A, Deal Place, Colombo 03
Supplied with;
Chimney
Ash trolley 02 Numbers
Oil tank with stand
Firing tools 04 numbers

Cost of incineration
As per the records maintained, for 9 months, 22,542 lt of diesel to burn 94,215 kg of waste. Therefore, monthly expenditure is about LKR 260,000 @ LKR 104 per lt and cost of incineration only for diesel is LKR 25 per kg of waste.

Metamizer
This was installed in April 2017 under Australian assistance.
Make – MediVAc
Model - MM240SSS
Supplier – R.R, TAYLOR Pvt Ltd, 5 Cal Close, Somersby, NSW 2259, Australia
Local agent – Biomed International Pvt Ltd, No 2A, Deal Place, Colombo 03
Supplied with;
Bin lifter unit
Platform access
Water conditioning unit
240 lt yellow bins – 20 Nos
240 lt green bins – 05 Nos

Metamizer operation requires around LKR 160,000 per month. When it was new, there was no ordour but with time with poor maintenance, there is a huge ordour emanating.

Sisili Hanarao Encare Pvt Limited
Chemo waste accumulated over a period of 5 years since the commencement of Oncology unit was removed by Sisili Hanarao Encare Pvt Limited on 19 November 2020; 2,280 kg. Tipping fee – LKR 103 plus 8% VAT, Total LKR 253,627.20 including VAT. They are even willing to remove non-disposable bottles but they ask for the same tipping fee.

Storage
Proper records are maintained after weighing the waste. Waste storage facilities are not satisfactory with inadequate space. Even the general waste is being accumulated as regular buyers are reluctant to remove them due to COVID risk. Accumulated Infectious waste for a long time (around 7,000 kg) at the treatment site is awaiting disposal at a dump site approved by the Municipality and environmental authorities as this stock is too much to treat using the existing facilities

Transportation
There is a dedicated vehicle for the transportation of infectious waste to the treatment site but proper signs are not pasted. However, ordinary wheeled barrows are being used for internal transport.

Residue disposal
There is no disposal system for ash coming out of the incinerator. It is accumulated behind

Community resistance
Apparently, there is a pressure from the Primary Healthcare Unit functioning at the same property especially complaining the ordour emitted by the Metamizer.

10 Nawinna Private Hospital - Kurunegala

Nawinna Hospital	Waste Segregation Point	Infectious Waste Store
		

Number of beds – 35
Mid night occupancy rate – Around 23-29% (8-10 beds out of 35 beds)

Generation of infectious waste is around 4,500 kg per year. Infectious waste is removed by Sisili Hanaro Encare since 2014. They do the collection 4 times a month and takes about 95-120 kg at a time. Fee – LKR 108 per kg plus 8% VAT. It was handled by Finlays in 2012 and subsequently transferred to Sisili Hanaro Encare.

Year	Month	Infectious Waste (Type 1) kg	Sharps (Type 2) kg
2019	July	214	80
2019	August	381	20
2020	January	377	18

General waste removed by the Local Authority.

It was observed that segregation and storing (un covered) are unsafe.

11 KMG Suwaseva Private Hospital - Hettipola

KMG Suwaseva Hospital	Segregation	Storing	Incinerator
			

Number of beds – 09
Mid night occupancy rate – Around 2-3% (5-8 beds per month out of 9 beds)

Generation of infectious waste is around 100-120 kg per month. Generation of sharps is around 5-8 kg per month. Clinical waste is transported to incinerator site once or twice a week which is about 5 km away from the HCF in the middle of a large coconut estate by a tractor. However, it is not a proper incinerator which is locally made. Bottom ash is deposited in a covered concrete pit. They are not aware of the Sisili Hanaro Encare service. General waste removed by the Local Authority.
Segregation and storing is done very well. Sharp boxes are nicely made.

12 Peradeniya Teaching Hospital

Segregation	Store	Store
		

- Segregation happens in a satisfactory manner
- Lacks infrastructure and facilities (No specific containers for sharps collection or internal transport of clinical wastes). Makeshift cardboard boxes are used for sharps collections.
- Storage of HHCW is done in rudimentary storage facilities
- During the period when Sisili Hanaro Encare was not functioning, the hospital has been asked to store the waste in two containers. They are still there even after two years
- Capacity of septic tanks for chemical waste treatment may not be sufficient to cater the current needs
- Cleaning staff has been given the Hepatitis B vaccination on humanitarian ground. Hospital believes that this should be regularized by giving the mandatory responsibility of vaccination of the relevant workers by the service providing company.
- Cardboard boxes used for sharps collection

13 Gampola Base Hospital

COVID Boxes	Bottles	Cardboard
		

- The committee functions well, though both MO Quality management and ICNO are new to the hospital. ICNO is well experienced and take an active role in waste management. She has been in working in Kandy TH, and according to her the introduction to waste segregation in Kandy was a challenge. As a result, they introduced a system where the number of the ward or name of the unit must be in the waste collection container or the bag so that they can trace who is not doing the segregation well.
- ICNO is happy with the performance of the cleaning staff as they follow given instruction well.
- Sisili collects clinical wastes twice a week. About 1,200 kg is collected per visits. In addition, COVID related waste also collected by Sisili.
- Waste storage facilities are rudimentary. Clinical waste storage is done well
- Cardboard wastes are recycled while food wastes are sent to a piggery.
- COVID- related wastes are stored outside and capacity of bins seems to be insufficient
- Has a problem with disposal of brown colored bottles and vials
- Ann old improperly designed incinerator is available but not in operation. Heavy smoke emission, leakage from the chimney, lower stack height are the reasons for the abandoning it.

14 Karapitiya Teaching Hospital

Waste stored in the containers by Sisili-Hanaro	Food waste taken by MC
	
Waste at the stores	Waste from Corona wards needs critical attention


- Infectious control unit consists of eight nursing officers, four workers and the unit is headed by a MO.
- The duty of the infectious control unit is collection and storing the waste inside the hospital and the management part is done by the administration division. There is an income by selling the cardboards, glass bottles and plastics to the hospital. Clinical wastes and the sharps are handed over to Sisili-Hanaro Endcare Pvt Ltd by paying 103 LKR/kg (plus VAT). There is a separate budget in the hospital for this operation.
- Store room is available for storing the daily waste.
- There are a couple of 20 foot containers by the side of this hospital and part of the waste is stored in these containers since Sisili-Hanaro is not collecting the waste regularly. The containers are owned by Sisili-Hanaro Pvt Ltd.
- There are four workers dedicatedly allocated for collecting, transporting and storing the waste.
- Food and other garden waste is handed over to MC
- Kitchen waste is sent to the biogas unit and the biogas generated is utilized in the kitchen
- Sewage and other liquid waste are treated inside the hospital and the operation and management of the treatment plant is done by UDA and the hospital pay for the cost of operation.

15 Matara District Hospital

Waste collecting area	Waste Bottles	Clinical waste collection area with damaged roof
		
Plastics, saline bottles and pet bottles	Abandon incinerator	
		

- Waste management is completely handled by the PHI
- Records are kept well
- A separate budget is there for waste management
- Segregation of sharps, clinical waste, plastics, etc. are done in satisfactory level but there is no adequate and proper spaces for storage
- Sewage and other liquid waste are treated at the site and the operation & maintenance is done by the hospital staff
- All the clinical waste and sharps are given to Sisili-Hanaro Endcare Pvt Ltd at the cost of 103 LKR/kg (plus VAT).
- Sisili-Hanaro is not collecting the waste as generated and sometimes it is accumulated inside the hospital.
- The refectory layer in the second chamber of the incinerator needs repairs. As per the information given by the hospital, the repair cost would be around 1.6 MLKR. But the Ministry is not providing sufficient funds for this repair indicating that there is a MOU

between Sisili-Hanaro and the Ministry of Health. Therefore, the incinerator is not in operation now.

- A construction is carried out by UDA to develop a riverside garden "Gangabada Udyanaya" by the side of this hospital. It will badly affect the waste collection activities since this new development is taking place in the same area.

16 Ratnapura Teaching Hospital

- Infectious waste and sharps are treated in the Metamizer and chemical waste is handed over to Sisili-Hanaro Encare Pvt Ltd
- The remains after treating in Metamizer is sent to Ratnapura Municipal Council for disposal.
- But it has been observed that the plenty of treated waste is dumped along internal roadside due to accumulation of waste without being removed in time.
- Adequate space is available for storing the chemical waste until handed over to Sisil-Hanaro.
- Frequent failure of the gearwheel or the shaft of the shedder system driven by a hydraulic motor of the Metamizer.

17 Badulla Provincial Hospital

Metamizer waste disposal	Cytotoxic storage	Previous land fill is converted in to new building site
		

- Overall waste management functions in Badulla hospital is in excellent condition.
- Both Metamizer and an incinerator are in operation.
- The remains after treating in Metamizer and the incinerator are sent to land fill inside the hospital
- The cytotoxic waste is handed over to Sisili-Hanaro Endcare Pvt Ltd. These wastes is stored in a container in the hospital premises until it is collected by Sisili-Hanaro.

18 Demodara Divisional Hospital

- There is no complex operation in this hospital
- OPD and two wards are available to serve the patients.
- The kitchen and other hospital waste generation is around 3 to 5kg/day and bury them in a small pit inside the hospital premises. The sharps are collected and sent to Diyathalawa hospital for disposal.

19 Diyathalawa Base Hospital

Incinerator	Stores
	

- Midnight occupancy – 45 – 50%
- Waste generation; Infected waste - 80 - 100kg/day, Sharps 10 to 12 boxes per week. Weight of one box – 5 to 6 kg
- Duel camber incinerator with two diesel burners. Automatic control and the output temperature set at 1200 ^{0}C. But the actual reading is not displayed due to the damaged thermocouple.
- Incinerator supplier - PCL Solutions (Pvt) Limited, No. 111 Negombo Road, Peliyagoda.
- Diesel use in incinerator – 1 liter/16 kg, approximately 40 bags burn per day and weight of one bag is 4kg.
- In addition to inhouse sharps, accepts sharps from neighbouring hospitals like Demodara, Haputale, Haldumulla, Meegahakiula once a week for incineration. Approx. 100 boxes per week.
- Food waste – 120 kg/day and this waste is handed over to Diyathalawa MC
- Plastics, paper, glass bottles are sold to outsiders
- Biogas unit is abandoned due to lack of technical knowledge on operation and maintenance. This has been given to hospital through one of the projects implemented by Ministry of Energy, Uva Provincial Council.

20 & 21 Colombo South Teaching Hospital and Lanka Hospital

Name of the hospital	Colombo South TH	LANKA Hospital
Date of inspection	12/2/2021	12/2/2021
Team participated	DD/Accountant/PHI	DDMS/Matron /MO infection control/service manager
Bed strength	1,110	256
Bed occupancy rate	80%	75%
Delegation	Yes MOPH/PHI/ICNO(team) Infection control unit	MO infection control /Infection control unit
Infection control unit	4 nurses /microbiologist	MO/2 Nurses/
Infection control committee	Meets once in three months Minutes available 2020 only. Less meetings are held due to COVID	Monthly meetings Minutes available
Segregation	Good according to colour code	Excellent, according to colour code
	Segregation	Segregation
		

		
Collection	Foot operated bins, Sharps – handmade card board boxes	Separate room for collection, access is restricted. Key is with in-charge, very clean and well organized
Waste minimization	Yes for plastic bottles	Yes drinking water is available inside the ward and outside foods not allowed
Transport	Sharps – by health assistants Infectious waste by cleaning staff Separate steel carts for sharps and infectious waste	By health assistants, separate carts made with plastics, a separate lift is available for services, waste is transported only in the night
Storage – General - Sharps - Infectious waste - plastic - glass	Adequate & clean Not adequate (800 kg/month) Not adequate (9,000kg/month) Not adequate (300kg/month) Not adequate (250/month) This is mainly due to the poor turn over by company and third party Storage is poorly maintained, waste is mixed due to inadequacy of space	Adequate & good Air condition room, adequate(250kg/month) Air condition room, adequate (9,000kg/month) Adequate (500kg/month) Adequate 300kg/month) Very well managed
	Stores	Stores
		
		
Disposal – General - Sharps - infectious waste - plastic - glass	CMC Private company Private company 3rd party 3rd party	CMC Private company Private company 3rd party 3rd party
Vaccination	Only health staff	Only health staff
Management of cytotoxic drugs in Lanka hospital There is a separate room for mixing and preparation of drugs with restricted access. Can enter only with PPE/goggles. Preparation chamber and separate boxes for waste. Transport will be done only with the PPE, eye washing zinc.		

Preparation of cytotoxic drugs
  

22 - 25 Colombo South Teaching Hospital and Lanka Hospital

Name of the hospital	DH Kandana	MOH Padukka	DH Padukka	BH Elpitiya
Type	DH C	MOH office	DH B	Base H
Contact person	MO/IC	Medical Officer of Health	MO/IC/ICNO	ICNO/DO (no MS)
Bed strength	275	Not relevant	63	372
Bed occupancy rate	55%	Not relevant 14 field clinics, average attendance 1,500 per month (Antenatal immunization, family planning)	60%	57%
Delegation	Yes PHI	Yes sister in charge	No	Yes ICNO
Infection control unit	NO One ICNO	No	No One ICNO	Yes One ICNO
Record keeping	ICNO/ subject clerk	Development officer (DO)	ICNO/DO	ICNO/DO
Segregation	Not according to the colour code Normal bins, No foot operated bins, different sizes, poorly organized, Somewhat better in the dialysis unit. There are two outside places for the visitors. All bins are black color without name board probably due to the poor maintenance	Satisfied according to the colour code Waste amount is very limited	Satisfied according to the colour code Bins are different sizes and shapes	Satisfied according to the colour code normal and foot operated bins available but not adequate
Collection	No carts. yellow bags for the infectious waste and seal card board boxes for the sharps Lack of bags and the bins are very common	Sharps - puncture proof boxes Hardly any infectious waste Normal bins for other waste Lack of bags and the bins are very common	Sharps - no puncture proof boxes sealed card board boxes Infectious waste - foot operated bins and Normal bins Lack of bags and the bins are very common	Sharps - no puncture proof boxes sealed card board boxes Infectious waste - foot operated bin and Normal bins Lack of bags and the bins are very common
Waste minimization	Only for general waste separate bins are placed at the entrance	No	No	No
Transport	Cleaning staff hand carrying from the wards	No transport needed	Health staff hand carrying from the	By Health staff, with open steel

	to stores and no designated carts.	Once the boxes are field it will be kept till the third party comes	wards to stores and no designated carts.	cart to the stores once daily
Storage -	Adequate & well organized. Closed to incinerator separate stores are available Access is restricted Well maintained	Not required	Adequate but one store for both sharps and infectious waste	No proper stores, just a covered area.
Clinical waste		1-2 kg per month (only sharps) Hardly any food waste Papers – third party Glass - third party	Sharps - 10 kg per two weeks Infectious waste 10 kg per two weeks General waste not known PPE – open burn	Clinical waste - 2,400 per month (both) General waste not known PPE – open burn Clinical waste from outside (Udugama and Baggagam) 2,000kg per month
Disposal	General waste - LA Food waste by third party Plastic and saline bottles - incinerated Glass – By third party	RDHS office vehicle comes and transports to the incinerator at BH Homagama.	Send to Awissawella hospital transported by RDHS Office	General waste - LA Food waste by third party (farm) Plastic and saline bottles - sell Glass third party
Vaccination	All staff	No vaccination	No vaccination	All staff including clerical staff
Valid license	Yes, Still there are many complaints from public regarding height of the chimney. Suppler company says it cannot be extended beyond 60 ft	Not required	Not required	EPL was not issued due to ash disposal and high building close to the incinerator recommended to shift the machine
Final disposal	Own incinerator Locally made Capital cost Rs 6.5 million Maintenance agreement annual cost is Rs 300,000 Maintained by Lanka Refractories Temperature 1200 c Temperature control is possible Operated by hospital staff Fuel -diesel	Incinerator at BH Homagama no payments	Incinerator at BH Homagama or / Awissawella no payments	Own incinerator Locally made two chambers Capital 4.5 million Maintenance agreement annual cost is 22500 Rs Maintained by Lanka refractory Pvt limited Temperature 1200 c automatic temperature control present Operated by hospital staff Fuel- diesel

	Cycle is 30 minutes 10 kilos per cycle Machine runs whenever needed, normally 4-5 hours per day ,2 days per week Fuel cost in 2019 Rs 191,800 Amount of waste 2019- 3,120 kg No outside clinical waste accepted Chimney height more than 9 meters (60 ft) Ash disposal - open dumping can be seen on the land behind the machine. Hardly any breakdown, periodic maintenance done by company Regular test by ITI done for smoke and the ash reports are not available EPL was issued considering amount of ash is very little			Cycle is 30 minutes 15 kg per cycle Machine runs 10 hours continuously every other day Average fuel cost per month 177, 500 Rs Chimney height 60 ft Ash disposal open dumping Hardly any breakdown, periodically maintenance done by company Regular test by ITI done for smoke and the ash reports are not available

Images of Elpitiya Base Hospital

Incinerator	Incinerator House
	

Images of Kandana District Hospital

Kadana DH	Segregation	Waste collection
		
Stores	Incinerator	Incinerator Control Panel



26 Sri Jayewardenepura hospital

Bed strength	1,001
Bed occupancy rate	60%
Delegation	Yes PHI
Infection control unit	There are 2 trained nurses; Microbiologist is available and supervises the infection control unit activities. There is a good coordination between infection control nurses and the PHI. Infection control committee meetings were conducted according to the circular. Meeting minutes are available.
Segregation	Segregation has been done according to the colour code. Almost all wards used foot-operated garbage bins Sharps - puncture proof standard boxes
Collection	Excellent, all staff are aware of the system. Daily supervision is done by a PHI and the section matron Clean and well organized
Waste minimization	Only for general waste
Transport	All the time by the cleaning staff. Twice a day. Designated carts made by plastic are used for this purpose. Transport is supervised by PHI
Storage – General	Adequate
Clinical waste	Sharps 1,500 kg per month, infectious waste 12,000 kg per month Generally adequate, situated close to the incinerator and well built Access is restricted
Disposal	General waste By UC KOTTE Food waste by third party 27,000 kg per month Plastic and saline bottles 9,000 kg month and glass 8,000kg per month by third party certified by CEA
Vaccination	All staff
Valid license	Yes
Treatment & final disposal	Own incinerator Japanese make Capital cost Rs 20 million Maintenance agreement annual cost is 1.2 million Maintained by M S holding Temperature 1,200 DegC automatic temperature control present Operated by hospital staff Fuel - industrial kerosene Cycle is 20 minutes 4-5 kilos per cycle Machine runs from 8.30 am to 10 pm continuously Chimney height more than 9 meters Ash put in the tanks but not adequate. can be seen on the land behind the machine. Earlier a cement company used to take but due the COVID they don't come Hardly any breakdown, periodic maintenance by the supplier company Regular test by ITI done for smoke and the ash reports are available EPL was issued accordingly Smoke is hardly visible

Wheeled Waste bins	Segregation	Incinerator	Sharp Boxes
			
Stores	Stores	Incinerator	Fuel tank
			

27-30 National Hospital of Sri Lanka (NHSL), Mulleriyawa BH, Castle Hospital & Lady Ridgeway Hospital (LRH)

Name of the hospital	National Hospital of Sri Lanka (NHSL)	Mulleriyawa BH	Castle Hospital	Lady Ridgeway Hospital (LRH)
Bed strength	3,500	285	459	1,016
Bed occupancy rate	80%	80%	60%	
Delegation	Yes, areas identified for each category; ICNO, MO public health and PHI	ICNO/MO public health	MO public health/ICNO	ICNO/PHI
Infection control unit	Well established. Supervised by consultant microbiologist. Consist of sister-in-charge and 13 ICNOs. All of them have undergone training. Unit is located separately. Infrastructure facilities are not adequate (e.g. computers) Each nurse has been allocated to a zone and they visit daily the allocated zones in the morning and submit the report to CNO of the hospital. Report includes incident report, communicable cases, clinical waste, etc. There is some coordination with MO Public health and PHI but not satisfactory. MO infection control is attached to lab.	Only one trained nurse is available. No permanent microbiologist. There is a good coordination with MO Public health, PHI is not available. Infection control committee meetings were conducted but not according to the circular. Meeting minutes are available. For the last year, no meetings were conducted, but problems were discussed at COVID meetings.	There are 3 nurses; including 2 training nurses. Microbiologist is available and supervises the infection control unit activities. There is a good coordination between MO public health and infection control nurses. Infection control committee meetings were conducted but not according to the circular. Meeting minutes are available. For the last year, no meetings were conducted, but problems were discussed at COVID meetings.	There are 4 nurses; including 3 training nurses. Microbiologist is available and supervises the infection control unit activities. There is a good coordination between MO public health MO infection control infection and control nurses. Infection control committee meetings were conducted but not according to the circular. Meeting minutes are available. For the last year no meetings were conducted, but problems were discussed at COVID meetings.

	Infection control committee meetings were conducted but not according to the circular. Meeting minutes are available. For the last six months no meetings were conducted but the problems regarding clinical waste were discussed at COVID meetings.			
Segregation	Segregation has been done according to the colour code. Almost all wards used foot-operated garbage bins except in offices.	This hospital has been fully converted to a COVID hospital. Normal segregation has not taken place. Previously the colour code was used, but now it is not practiced due to the COVID situation.	Segregation has been done according to the colour code. Foot-operated garbage bins are used only in ICUs and theatres. All other wards use normal bins.	Segregation has been done according to the colour code. Normal waste bins are used.
Collection	Excellent, all staff are aware of the system. Daily supervision is done by a liaison nurse who has undergone a short training regarding clinical waste.	There is a COVID box for each ward behind the ward. All clinical waste and other normal waste of patients (sanitary pads, residual food, discarding masks) are collected into separate yellow bags and put into these boxes. Private company collects all these waste and taken for incineration.	Good, all staff are aware of the system. Daily supervision is done by a liaison nurse who has undergone a short training regarding clinical waste.	Good, all staff are aware of the system. Daily supervision is done by a liaison nurse who has undergone a short training regarding clinical waste.
Waste minimization	Only for general waste	Only for general waste	Only for general waste	Only for general waste
Transport	Majority by the cleaning staff. Transport of clinical waste of ICU and OT are done by health assistants in the unit itself. Designated carts made by stainless steel are used for this purpose. Transport is supervised by PHI, so that any issue will be corrected rapidly.	All transportation is done by health assistants. Even though there is a designated carts for clinical waste transport, it is not used at present.	All transportation is done by two health assistants trained for that particular task. There is an open designated cart made of stainless steel.	Majority by the cleaning staff. Transport of clinical waste of ICU and OT are done by health assistants in the unit itself. There is an open designated cart made of stainless steel. Transport is supervised by PHI, so that any issue will be corrected rapidly.
Storage - General	Separate storage is available for	Separate storage is available for	Excellent, separate storage facilities are	Separate storage is available for

	different waste categories. Large, adequate and well-built storage facility available for general waste. Storage available for sharps is adequate. Storage available for infectious waste is grossly inadequate. This is aggravated by slow turnover by company and the prevailing COVID situation. Access to the storage area is restricted; separate entrance and exit assigned for waste collectors.	different waste categories. All storage facilities are adequate. Access to storage facilities is not restricted.	maintained exceptionally well. All storage facilities are adequate. Access to storage facilities is restricted; separate entrance and exit assigned for waste collectors.	different waste categories. Large, adequate and well-built storage facility available for general waste. Arrangement of storage for other type of waste is very poor. Storage available for sharps and infectious waste is adequate. Access to the storage area is not restricted.
Disposal	General waste – by the CMC Sharps and clinical waste - by private companies Glass and cardboard waste – by third-party (demand for glass waste is low, therefore it remains in the hospital for long periods of time before disposal) Autoclave is available but not functioning at present. Recommended to shift the autoclave to another hospital and use the space for clinical waste stores.	General waste – local authority refused to take responsibility Therefore, open dumping in the corner of the hospital. Clinical waste – by private company PPE and masks discarded daily are open burned. Glass and cardboard waste – by third-party (demand for glass waste is low, therefore it remains in the hospital for long periods of time before disposal)	General waste – by the CMC Sharps and clinical waste - by private companies Glass and cardboard waste – by third-party (demand for glass waste is low, therefore it remains in the hospital for long periods of time before disposal) Shredder and autoclave available are not functioning at present due to public resistance. Shredder and autoclave are functional and in good condition, so can be used in another hospital.	General waste – by the CMC Sharps and clinical waste - by private companies Glass and cardboard waste – by third-party (demand for glass waste is low, therefore it remains in the hospital for long periods of time before disposal)
Vaccination	All permanent and casual staff vaccinated against Hepatitis-B. Cleaning staff vaccination was done earlier but now stopped due to lack of compliant.	All permanent and casual staff vaccinated against Hepatitis-B. Cleaning staff has not been vaccinated.	All permanent and casual staff vaccinated against Hepatitis-B. Cleaning staff has not been vaccinated.	All permanent and casual staff vaccinated against Hepatitis-B. Cleaning staff has not been vaccinated.
Valid license	Applied	Applied	Applied	Applied

Images of Mulleriyawa Hospital

Segregation	Segregation	Sharp Boxes	Wheeled Carts
			
Open burning	Stores	Separate exit	COVID Boxes
			

Images of National Hospital

Designated carts	Internal Transport	ICNO Office	Training centre
			
ICNO office	Segregation	Minimization	Segregation
			
Foot Operated Bins	Sharp Boxes	Foot Operated Bins	Internal Transport
			
General Waste	General Waste	Stores	General waste
			
General Waste	Food waste	General stores	Transport
			
Stores	COVID boxes	Stores sharp	Stores
			

Images of Castle Hospital

Wheeled Carts	Wheeled Carts	Exit	General Waste
			
Stores	Stores	Stores	Stores
			
Stores	COVID Boxes	Food Waste	Segregation
			
Stores	ICNO office	Autoclave	Shredder
			

Images of Lady Ridgeway Hospital

Stores	Stores	Wheeled Carts	Stores
			
Stores	Mixed waste	Stores	COVID Boxes
			

31 - Dambulla District General Hospital

- Met the infection Control Committee - Dr Dissanayake, Dr Fatima, Matron, ICNO, PHI
- The waste quantities reported in the questionnaire were verified and found to be accurate
- The autoclave mentioned in the questionnaire is a lab scale one
- E-waste is handed over to the municipal council

Waste collection and internal transportation

- Waste segregation happens to a satisfactory level.

Waste segregation at Dambulla hospital

- Internal transport of the waste is carried out by the cleaning service workers.
- HCF is not satisfied with the service provided by the cleaning service. Regular turnover of cleaning service workers makes it to train them.
- Vaccination of some cleaning workers has been done.

Waste storage facilities

Final disposal of the clinical wastes

- Clinical waste (about 2,500 kg/month) is handed over to Dambulla Municipal Council for incineration at a cost of 75 Rs/kg.
- Anatomical waste is buried, as the quantity is small.
- The sewerage system at present cannot cope up with the load. During the rainy season, ground water is contaminated with overflowing sewage system.
- The capacity of septic tanks for chemical waste treatment is not sufficient to treat the present load
- Incinerator is at Dambulla MC waste management site
- Has a capacity of about 100 kg/h. Italian made. The incinerator is managed by the municipal council, but operated by the company that supplied the incinerator.

Incinerator

- The incinerator is underutilized. The Mayer is planning to extend the service of the incinerator for other HCFs. If successful, this is a good model to replicate.

32 - Matale District General Hospital

Met with Dr. Dissanayake - Director, Ms. Renuka and PHI

- The infection control committee plays an active role in HCWM in the hospital.
- Appears to have an effective system in place.
- Waste quantities reported were verified against records
- Positive actions such as providing filtered drinking water to prevent PET bottle usage by patients help to reduce the waste generation.

Clean water is provided to prevent the use of PET bottles

- Waste segregation is satisfactory

Waste Segregation in Matale DGH

- Special carts are used to transport waste internally

Carts used for internal waste transportation

- Siting of the waste storage facility is good, but animals such as monkey can enter the facility

Waste storage facility at Matale DGH

- There is no proper way to dispose vials and amber colour bottles

Vials and bottles are stored until a proper disposal mechanism found

- Clinical waste disposal has been done using the onsite incinerator, but due to a fire, the unit has been damaged to an extent that it requires a major repair. At the time of visit, the clinical waste was sent to the incinerator at Teldeniya Hospital.
- The damage to the incinerator is due to catching fire to waste stored near the incinerator. This shows the importance of paying attention to safety and lack of understanding by the operators the risks associated with the operation of incinerators.

Damaged incinerator due to a fire

- Incinerator ash is disposed to an open pit. There is a high chance that some of the toxic compounds in ash be leached to the ground water.

33 - Theldeniya Base Hospital

Met: Dr. Sunil Yapa, Director -Teldeniya Hospital, Ms. Manjula, ICNO, PHI

Note: Teldeniya BH is a COVID treatment Centre and the staff is overwhelmed by the workload. Their cooperation during the visit, despite their busy schedule, is highly appreciated.

Observation:

- Waste records are well kept and the submitted data verified.
- Good waste management system is in place.
- Waste segregation happens to a satisfactory level but lacks facilities such as proper waste bins and carts.

- Onsite waste storage is only for a short period as the incinerator dispose them daily.

- The hospital owns an incinerator with a capacity of about 50 kg/h. In addition to treating its own waste, the incinerator provides the service to about 17 regional healthcare facilities in the region.
- The incinerator has been supplied by Techno Medics Pvt Ltd., and presently maintained by Lanka Refractories Pvt. Ltd., through a service agreement
- One of the issues faced by the hospital is lack of trained people dedicated to run the incinerator.
- There is a need for paying due attention to safety. The fuel tank is very close to the incinerator and an incident like Matale (a fire in the incinerator room) can destroy the entire unit.

- No proper ash disposal mechanim in place. At the moment burial is the sollution

34 - Yatawatta Divisional Hospital

Met: Dr Jayasundara - CMO, and Ms. Nadika - Nursing Officer

- Nursing officer is responsible for managing the HHCW in the facility. She has undergone some training and has made good attempt to manage waste properly. Lack of funding is a major drawback.
- Waste records are not maintained, but has measured to complete the survey
- Waste segregation happens to some extent

- Lack of human and financial resources is a hindrance to proper waste management. The hospital is understaffed and one of the first areas to affect is the waste management.
- The disposal of waste is through a barrel burning and ash is buried.

Annex 5 - Treatment and Disposal Methods for Specific HHCW Categories

Process and technology options for treatment and disposal of HHCW categories

HCW Category	Treatment/Disposal Options
Sharps	▪ Disinfection: Autoclave, Microwave technology, Chemical disinfection ▪ Mechanical shredding: On-site mechanical needle cutters or electric needle destroyers ▪ Encapsulation in cement blocks ▪ Sharps pits/Concrete vaults
Anatomical waste, pathological waste, placenta waste and contaminated animal carcasses	▪ Burning in crematoria or specially designed incinerators ▪ Alkaline digestion, especially for contaminated tissues and animal carcasses ▪ Promession ▪ Interment (burial) in cemeteries or special burial sites ▪ Placenta waste is composted or buried in placenta pits designed to facilitate natural biological decomposition.
Pharmaceutical waste	▪ Return to the original supplier (preferred option) ▪ Encapsulation ▪ Chemical decomposition in accordance with the manufacturer's recommendations if chemical expertise and materials are available; ▪ Dilution in large amounts of water and discharge into a sewer for moderate quantities of relatively mild liquid or semi-liquid pharmaceuticals, such as solutions containing vitamins, cough syrups, intravenous solutions and eye drops and harmless liquids such as intravenous fluids. ▪ Incineration in kilns equipped with pollution-control devices designed for industrial waste and that operate at high temperatures; ▪ Dilution and sewer discharge for relatively harmless liquids such as intravenous fluids (salts, amino acids, glucose). ▪ Sanitary landfill for non-hazardous pharmaceutical waste
Cytotoxic Waste	▪ Incineration at high temperatures with gas-cleaning equipment ▪ Chemical degradation in accordance with manufacturers' instructions. ▪ Alkaline hydrolysis ▪ Encapsulation or Inertization may be considered as a last resort ▪ Return to the original supplier (preferred option)
Chemical Waste	▪ Large amounts of chemical waste should not be buried, because they may leak from their containers, overwhelm the natural attenuation process provided by the surrounding waste and soils, and contaminate water sources. ▪ Encapsulation. (Large amounts of chemical disinfectants should not be encapsulated, because they are corrosive to concrete and sometimes produce flammable gases) ▪ Where allowed by local regulations, non-recyclable, general chemical waste, such as sugars, amino acids and certain salts, may be disposed of with municipal waste or discharged into sewers. ▪ An option for disposing of hazardous chemicals is to return them to the original supplier, who should be equipped to deal with them safely ▪ Sanitary landfill (for small quantities only)
Waste containing heavy metals	▪ Wastes containing mercury or cadmium should not be burned or incinerated. Cadmium and mercury volatilize at relatively low temperatures and can cause atmospheric pollution. ▪ If none of the above options are feasible, the wastes would have to go to a disposal or storage site designed for hazardous industrial waste.

	▪ Send back the waste to the suppliers of the original equipment, with a view to reprocessing or final disposal
Radioactive Waste	▪ The treatment and disposal of radioactive waste is under the jurisdiction of Atomic Energy Authority (AEA), and presently governed by Ionizing Radiation Protection Regulation of 1999 ▪ Return to supplier ▪ "Decay in storage", which is the safe storage of waste until its radiation levels are indistinguishable from background radiation; a general rule is to store the waste for at least 10 times the half-life of the longest-lived radionuclide in the waste. ▪ Long-term storage at an authorized radioactive waste disposal site. ▪ It is not appropriate to disinfect radioactive solid waste by wet thermal or microwave procedures ▪ Disposable syringes containing radioactive residues should be emptied in a location designated for the disposal of radioactive liquid waste. Syringes should then be stored in a sharps container to allow decay of any residual activity, before normal procedures for disposal of syringes and needles are followed. ▪ Higher-level radioactive waste of relatively short half-life (e.g., from iodine-131 therapy) and liquids that are immiscible with water, such as scintillation-counting residues and contaminated oil, should be stored for decay in marked containers, under lead shielding, until activities have reached authorized clearance levels. ▪ Radioactive waste resulting from cleaning-up operations after a spillage or other accident should be retained in suitable containers, unless the activity is clearly low enough to permit immediate discharge. ▪ Solid radioactive waste, such as bottles, glassware, and containers, should be destroyed before disposal to avoid reuse by the public

Annex 6 – Comparison of Treatment Technologies

Technology - Incinerators

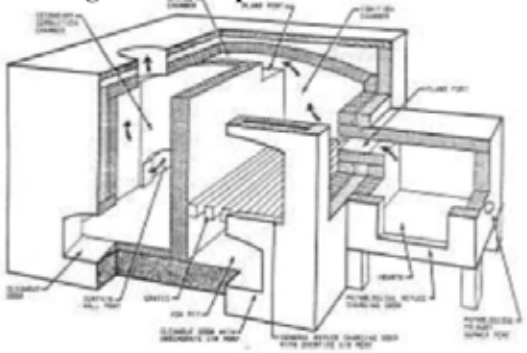
Process Description

Dual-chamber controlled-air incinerators: Incineration is a high-temperature, dry oxidation process that reduces organic and combustible waste in to inorganic, incombustible matter. This process reduces the waste volume and weight significantly. Operational temperature is in the range of 800 °C to 1,450 °C. The amount of air supplyied to the primary chamber is less than the than the ideal proportion needed for burning the carbon and hydrogen and combustion in the primary chamber is taken place at less O2 less level. The vapors produced in the primary chamber are directed into a secondary chamber and combust providing adequate excess combustion air, high turbulence, and retention time to ensure complete combution.

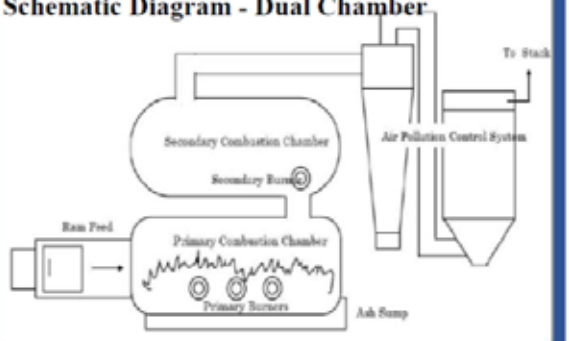
Multiple chamber incinerators: Operate in excess air mode and need more air than the duel-chamber controlled air incinerator and due to this the airbone emission level is higher in this design than the others. Two or mutiple chambers are available depending on the design. Combustion is taken place in the primary chamber and comes wth fixed or moving grtes. Secondray chamber is desinged for burn off volatile organic compounds in the flue gas and additional chambers are designed including features to settel down the ash residues while moving. Need suppliment fuel with burners both in primary and secondary chambers to propergate and maintaing the combustion at the recommended coditions.

Rotary kiln incinerator: The main characteristics of rotary kilns are: high incineration temperatures in the range 900 to 1200°C; incinerator capacities up to 10 tonnes per hour; a combination of air pollution control devices to clean the flue gas, and high energy consumption. Well trained personnel are needed to operate the equipment. Rotary kilns may operate continuously and are mainly used to treat hazardous chemical waste under controlled conditions.

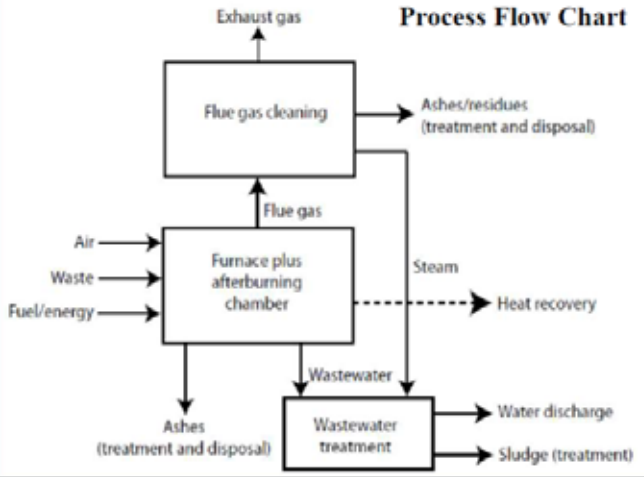
Schematic Diagram - Multiple Chamber



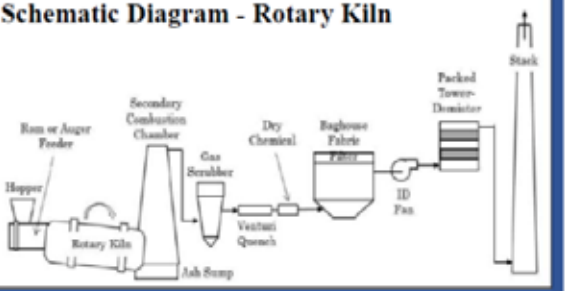
Schematic Diagram - Dual Chamber



Process Flow Chart



Schematic Diagram - Rotary Kiln



Capacity range
10 kg/hour to 100 tons/day
Energy/Power requirement
0.125 to 0.2 Fuel oil liter/kg of waste
Operating Temperature
200 ^{0}C to 1000 ^{0}C

Types of Waste Treated

Cultures and stocks, sharps, materials contaminated with blood and body fluids, isolation and surgery waste, laboratory waste, and soft waste (including gauze, bandages, drapes, gowns and bedding) from patient care. Incinerators specially designed for pathological waste are used to burn cadavers, large anatomical remains (body parts, organs, tissues and animal carcasses), laboratory chemical waste, thermally stable pharmaceutical waste, halogenated waste including plastic PVC materials, and chemotherapeutic (cytotoxic) waste.

Incineration of waste is affordable and feasible only if the calorific value of the waste is greater than 2000 kcal/kg (8370 kJ/kg). Although plastics can exceed 4000 kcal/kg (16 740 kJ/kg), some healthcare waste contain a high proportion of moisture and have much lower calorific values. Pathological waste has a low calorific value of about 400-200 kcal/kg (2000-8400 kJ/kg). Additionally, the waste should have a combustible content greater than 60% and a non-combustible portion less than 5%. Ideally, the moisture content should be less than 30%.

Minimum Height of the Incenerator

REGULATIONS made by the President on 05th June 2019 under Section 32 of the National Environmental Act, No. 47 of 1980, read with Sections 23J, 23K and 23L of that Act and Section 51.

Minimum stack height of any combustion point source shall be determined by the following equation.

$C(m) = H(m) + 0.6U\ (m)$,

where

H = The height in meters of the tallest building within 5U radius of the point source.

C = Minimum stack height in meters.

U = Uncorrected stack height in meters.

U shall be determined by following equation.

where Q = Gross heat imput in Mega Watt (MW)

Main components / sub-systems

1. Primary combustion chamber (or furnace or kiln)
2. Secondary chamber (or afterburning chamber or post-combustion chamber)
3. Air pollution control devices (or flue gas cleaning system or emission controls)
4. Wastewater treatment system if a water scrubber is used for flue gas cleaning
5. A waste feed system (or charging system) that is able to prevent temperature drops in the primary chamber during feeding of waste
6. Ash collection system such as a wet ash sump to prevent dispersion of hazardous incinerator ash
7. The grate system in the primary combustion chamber. fixed (or static) grates over an ash pit in the primary chamber in older design, while new designs
8. utilize moving (or traveling) grates, reciprocating grates, or rotating drum grates to allow more efficient combustion.

Maintenance of Incinerators

Hourly: inspect ash removal conveyor and water levels in quench pit.

Daily: check opacity, oxygen and temperature monitors; clean underfire air ports, ash pit and sump; inspect limit switches and door seals.

Weekly: clean heat recovery boiler tubes if available, blower intakes, burner flame rods and sensors, heat recovery induced draft fan if available; lubricate latches, hinges, hopper door pins, etc.

Bi-weekly: check hydraulic fluid, lubricate ash conveyor bearings; clean fuel trains, burners and control panels

Monthly: inspect surfaces and refractories, internal ram face, pilot lights; clean secondary chamber floor; lubricate blowers and fans

Semi-annual: inspect hot surfaces; clean and lubricate chains

Stockholm Convention

The Stockholm Convention is a legally binding treaty with the goal of protecting human health and the environment from persistent organic pollutants. Under the convention, the countries party to the treaty are required to use the best available techniques for new incinerators. The Stockholm Convention's guidelines for best available techniques and best environmental practices limit the levels of dioxins and furans in air emissions to 0.1 ng I-TEQ/Nm3 at 11% O2.

Note:- Single-chamber, drum and brick incinerators are not acceptable under Stockholm convention

Emissions and By-Products

A wide variety of pollutants depending on the composition of the waste. These include PM such as fly ash; heavy metals such as As, Cd, Cr, Cu, Hg, Mg, Ni and Pb; acid gases (HCl, HF, SO2, NOx), CO and organic compounds, etc. In addition, the bottom ash residues are generally contaminated with dioxins, leachable organic compounds, and heavy metals and have to be treated as hazardous waste.

Waste Charging	Infectious waste bags are placed in a metal cart or bin.
Combustion	Maintaining the primary and secondary chamber temperature above 850 °C by adjusting the combustion air level is the critical requirement.
Air Pollution Control	Need to monitor carefully the carbon monoxide levels, oxygen concentrations, hydrogen chloride concentrations, and other parameters specific to the air pollution control
Ash Removal	Depending on the type of incinerator, it is produced around 25 and 30 kg of fly ash per ton of waste. Fly ash should be considered as hazardous waste. They may either be sent to a waste-disposal facility for hazardous chemicals, or be treated on-site by drying, followed by encapsulation.
	Bottom ash are less hazardous than fly ash and can be used in civil engineering works.

Incineration	Advantages	Disadvantages
High temperature Incinerator (>1000 0C) Rotary Kiln (> 1200 0C) Dual-chamber incinerator (800 – 900 °C)	The waste is completely destroyed The waste is not recognizable Waste volume and weight are significantly reduced Large quantities of waste can be treated Toxic emissions are reduced Suitable for all types of waste	High construction cost Relatively high operating and maintenance cost Required electricity, highly skilled staff and fuel Produced ash contains leached metals, dioxin and furans. ***Dual-chamber incinerator*** Sharps are not destroyed Unsuitable for chemical and pharmaceutical waste

Method	Capacity Kg/hr	Capital Cost US$ x 1000	Operating Cost US$/kg
Autoclave	23 – 3600	30 – 1780	0.13 – 0.36
Chemical treatment	11 - 6800	20 – 890	0.15 – 2.2
Microwave	23 - 410	70 – 710	0.10 – 0.42
Incineration	250 - 4000	120 - 6000	0.15 – 0.30

Modern incinerators are designed as a package systems. Most of the pars are assembled at the factory and need to construction of a proper foundation as per the design provided by the manufacturer for fixing the incinerator.
Construction of the chimney, fuel supply systems with day feed tanks. Compressed air piping system is done at the site.
Construction of a proper enclosure with adequate ventilation, installation of waste storing facility, are need to adress separately.

Indicative capital cost with the capacity
100kg/hr = US$ 800,000. 1,000kg/hr = US$ 2,500,000.
2,000kg/hour = US$ 4,500,000.

Yuanda Boilers
Tel : +86-18236986701
E-mail : service@yuanda-boiler.com
Address: Ganxiao Road, Western Industrial District, Xihua County, Zhoukou,Henan,China

Gient Heating Industry Co., Ltd
Gaobaohu East Rd. 3 Konggang Zone, Yubei District, Chongqing 401120, China
Tel: +86 23 67383009
Email: info@gient.cn

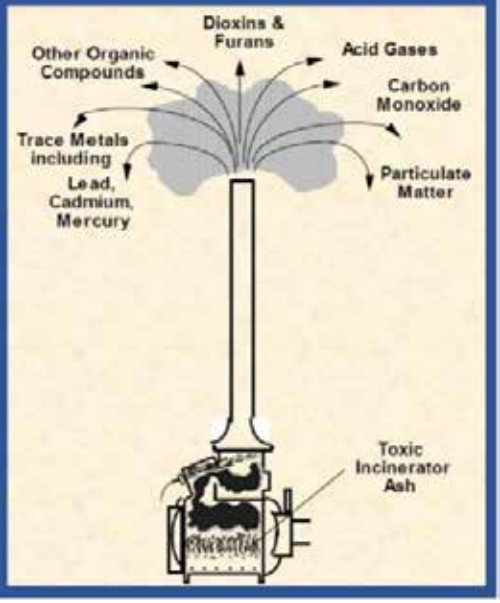
Haat Incinerators India Pvt Ltd
35 B&C, Jinani Industrial Area
Bengaluru 560 105
Tele: +91-97422-61768
slaes@haat-india.com

Inciner8 Limited: Unit 2 Canning Road, Southport, Merseyside, United Kingdom. T: +44 (0)1704 884020
https://www.inciner8.com/medical-waste/hospital-incinerators.php

PCL Solutions (Pvt) Limited.
111 Negombo Road,
Peliyagoda, Sri Lanka
0112 2933070, info@pclsolutions.lk

Lanka Refractories Limited
Meepe, Padukka, Sri Lanka
Tel: 0094 11 2859098
Email: refactlk@sltnet.lk, firebricks@sltnet.lk

National Engineering Research & Development Center.
Ekala, Ja-Ela.
nerdcentre@nerdc.lk, 011-2236284

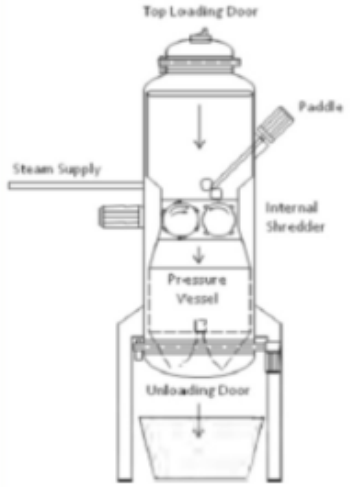


Technology: Hybrid-Autoclave

Process Description

- An hybrid autoclave consists of a metal vessel designed to withstand high pressures, and sterilizes the medical waste by heating them up to a pre-define temperature for a specific period of time.
- Introduction of mechanical shredder or mixer before, during or after steam treatment is the additional feature in this hybrid technology. Shredding increases the contact area of the waste and enhances the stream treatement process. Also, reduces the volume in final product drastically. Post-treatment grinder can be introduced as an option and further reduces waste volume down to about 20% of the original volume.

Schematic Diagram



Main Components / Sub-Systems

External Components

1. Waste feeding mechanism (Charging mechansm). Lifting mechansm or conveyor syste
2. Water uspply system including water pump
3. Wastewater discharge and treatment system
4. Solid waste disposal system

Internal Components

1. Steam generator,
2. Shredder and 3. Mixture - for mixing of waste during treatement process

Different Options Available in Hybrid Autoclaves

Different version of hybrid autoclave systems have been introduced by different techology provides considering enhancing the efficiency and the effectiveness of the treatement process. This technology options can be divided in to two main catogories.

Option 01 Shredding the waste → Undergo steam treatement process

Option 02 Soaking in hot water → Convert in to fine particles → Undergo treatement process

In addition to this, the size of the waste particles after shredding, mixing efficiency, the waste treatement temperature and pressure are different in design to design and the overll performnce of the wste tretement process is depending on the level of maintaining of these physical prmeters.

Capacity Range
38 to 2,800 liters
18 kg/hour to 3,300 kg/hr

Energy/Power Requirement
0.17 to 0.2 kWh/kg of waste
0.4 to 0.6 steam kg/kg of waste

Type of energy use
Electricity

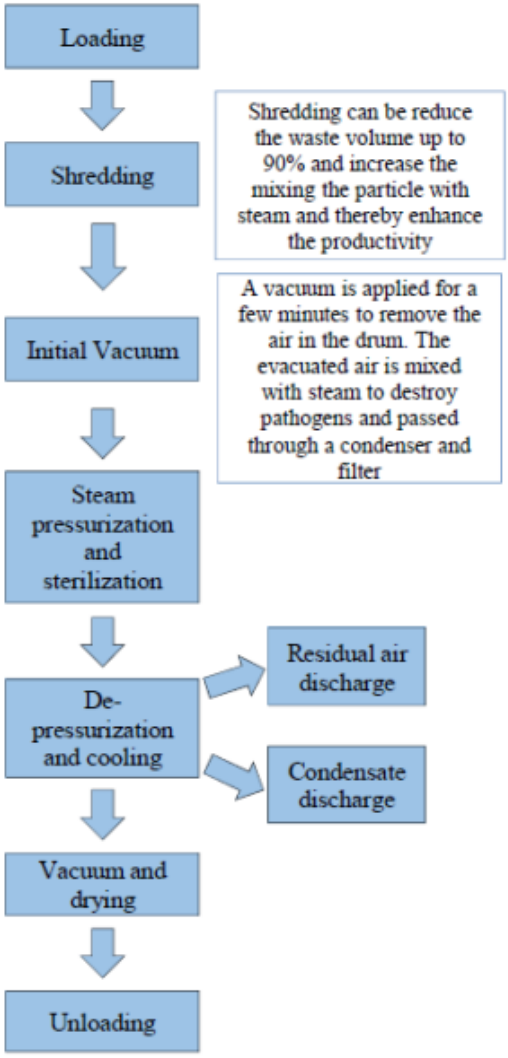
Types of Waste Treated: capable of treating cultures and stocks, sharps,materials contaminated with blood and body fluids, isolation and surgery waste, laboratory waste (excluding chemical waste) and soft waste (including gauze, bandages, drapes, gowns and bedding) from patient care.
Volatile and semi-volatile organic compounds, chemotherapeutic waste, mercury, other hazardous chemical waste, and radiological waste should not be treated in an autoclave. Large and bulky bedding material, large animal carcasses, large anatomical remains (body parts), sealed heat-resistant containers and other waste loads that impede the transfer of heat should be avoided

Pathogen Destruction: The heat trasnfer rate in to the waste materil during the tretement process is more efficienct in hybrid autoclae systems than the conventional systems and this treatement method achieve high levels of microbial inactivation.

Emissions and By-Products: Emission level of the hybrid utoclaves are alsmost similar to conventional autoclaves and less emission than the high temperture processes. Steam condensate are available at the end of the treatement process and proper waste water discharge mechanism should be in place with hybrid autoclave systems.
There may be some odors during air removing process (Creation of vacuum). HEPA filters are available in most of the modern systems to filter the odor.

Maintenance Schedule: Since lots of moving parts are available in hybrid autoclave systems, proper maintenance practices are needed to follow.
Preventive maintenance programme is essential for motors, belts, bearings and seals. Inspection and regular lubrication of sliding surfaces, checking for loose bolts or nuts around gear boxes or hydraulic cylinder mounts, inspection of safety features related to the shredder or mixing arms, and inspection and replacement when needed of worn or broken shredder cutters or mixing arms are some of the essential eliments in this preventive maintenance programme.

Operational Procedure



Installation Requirement:

1. Need a proper enclosure with adequate ventilattion and a concreate foundation which can withstand to vibration
2. Threephase electricity
3. Treated water supply and waster water discharge mechanism
4. Steam supply if not inbuilt with the hybrid autoclave.

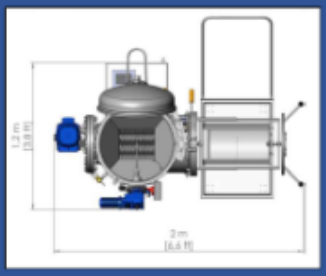
Available suppliers

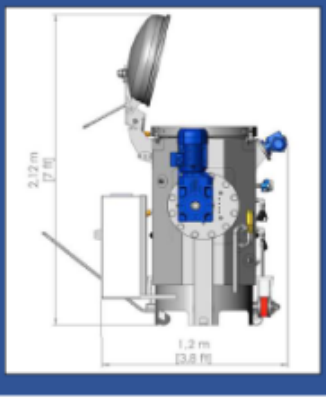
Name: RedBag Solutions Address: 3431 Benson Avenue, Suite 100, Baltimore, MD 21227, USA
Fax: +1 443 5244250
Phone: +1 443 5244245
E-mail: info@redbag.com Website: http://www.redbag.com

Name: Ecodas
Address: 28 Rue S\u00e9bastopol , 59100 Roubaix, France
Phone: +33 3 20709865
Fax: +33 3 20362805
E-mail: contact@ecodas.com
Website: http://www.ecodas.com

Name: Celitron Medical Technologies Kft.
Address: Avar Utca 5, 2600 Vac, Hungary
Phone: +36 275 12 267
Fax: +36 275 12 268
E-mail: info@celitron.com
Website: http://www.celitron.com

Name: Sterishred
Address: 7, rue du Cassé, 31240 Saint-Jean (Toulouse), France
Phone: +33 5 62 10 18 91
E-mail: info@tesalys.fr
Website: http://www.sterishred.com



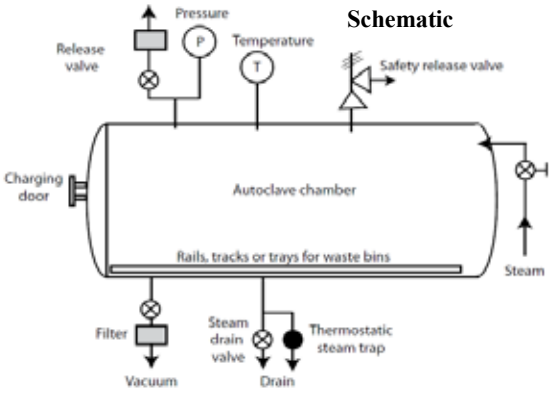


Technology: Autoclave

Process Description

An autoclave consists of a metal vessel designed to withstand high pressures, with a sealed door and an arrangement of pipes and valves through which steam is introduced into, and removed from, the vessel. Autoclave sterilizes the medical waste by heating them up to a pre-define temperature for a specific period of time. Some autoclaves are designed with a steam jacket surrounding the vessel; steam is introduced into both the outside jacket and the inside chamber. Heating the outside jacket reduces condensation on the inside chamber wall and allows the use of steam at lower temperatures.

Schematic



Main components of autoclaves

External components

1. Boiler and the steam supply - The supply steam pressure is depending on the type of design. Autoclaves with stean jackets are operate at low steam pressure (1-3 barg)
2. Waster water dischrage system
3. Solid waste desposal system
4. Waste transport and loading mechanism

Internal components

1. Treatement unit before releasing the internal air to outside. (Three clasifications are there based on the air removing mechanisms available in autoclaves
   - Gravity displacement autoclaves
   - Pre-vacuum or high vacuum autoclaves
   - Pressure pulse autoclaves.

Types of Waste Treated

capable of treating cultures and stocks, sharps,materials contaminated with blood and body fluids, isolation and surgery waste, laboratory waste (excluding chemical waste) and soft waste (including gauze, bandages, drapes, gowns and bedding) from patient care. With sufficient time and temperature, it is technically possible to treat small quantities of human tissue. Autoclaves are generally not used for large anatomical remains (body parts) since it is difficult to determine beforehand the time and temperature parameters needed.

Volatile and semi-volatile organic compounds, chemotherapeutic waste, mercury, other hazardous chemical waste, and radiological waste should not be treated in an autoclave. Large and bulky bedding material, large animal carcasses, sealed heat-resistant containers and other waste loads that impede the transfer of heat should be avoided.

Limitations of Operation

- The effectivenes of the treatement process is mainly depending on the penetration of steam in to the waste material and the treatement time. The level of heat penetration is warying with the temperature/pressure os steam, process sequence, load size, stacking configuration and packing density, types and integrity of containers used, physical properties of the materials in the waste (such as bulk density, heat capacity and thermal conductivity), the amount of residual air and the moisture content in the waste etc.
- With this senario, It is reccomended to validate the parameters required to maintain in autoclave for different types by carrying out a sample test.

Emissions and By-Products

significantly less air pollution than other thermal processes. Odors can be a problem around autoclaves if there is insufficient ventilation. If waste streams are not properly segregated to prevent hazardous chemicals from being placed in the treatment chamber, toxic contaminants will be released into the air, condensate or in the treated waste.

Capacity range

20 liters to 20,000 liters in volume. Capacities range from 1kg/hour to 2,700 kg/hour including the time needed for putting in the waste, steam exposure, and waste removal.

Operational details

Waste collection	Infectious waste bags are placed in a metal cart or bin.
Pre-heating the outside jacket of autoclave	
Loading the waste in to the autoclave	The metal cart or the bin is loaded in to the autoclave attaching a color changing indicator on top of the waste. This will help to monitor the level of treatment.
Air evacuation	Air is removed using gravity displacement, pre-vacuuming or pulse vacuuming techniques.
Steam Treatment for a pre specified period	
Steam discharge after treatment	
Unloading	Sufficient time is provided to allow the waste to cool down after unloading. The process is repeated if the colour change on the indicator strips shows that the treatment cycle was insufficient.
Documentation	Record the data in the log book
Mechanical treatment	Shredding or compacting before disposal if necessary
Land Disposal	

Duel Autoclave

Intergrated Autoclaves

Method	Capacity kg/hr	Capital Cost 000' USD	Operating Cost – USD/kg
Autoclave	23 - 3600	30 - 1780	0.13 – 0.36
Chemical treatment	11 - 6800	20 - 890	0.15 – 2.2
Microwave	23 - 410	70 - 710	0.10 – 0.42
Incineration	250 - 4000	120 - 6000	0.15 – 0.30

Maintenance Schedule

- **Daily maintenance:** check for leaks, cleanliness of the chamber, filter screen and door seal
- **Weekly maintenance:** check indicator lights, compare temperature & pressure gauges with recordings
- **Monthly maintenance:** check door gasket or O-ring, conduct microbiological tests (by lab personnel)
- **Quarterly maintenance:** checking valves, pipes, joints, strainers, drains; checking control system, interlocks and electricals; testing air removal efficiency
- **Annual maintenance:** check for corrosion and wear, check thermocouples, water level indicators, gauges, relief valves and other safety devices, and control functions.

Installation Requirement

- Enclosure with adequate ventilation & foundation
- Electrical connections
- Water supply and drains (water softening system if needed)
- Boiler and steam supply system
- Compressed air fsupply if necessary.

Advantages/Dis-advantages

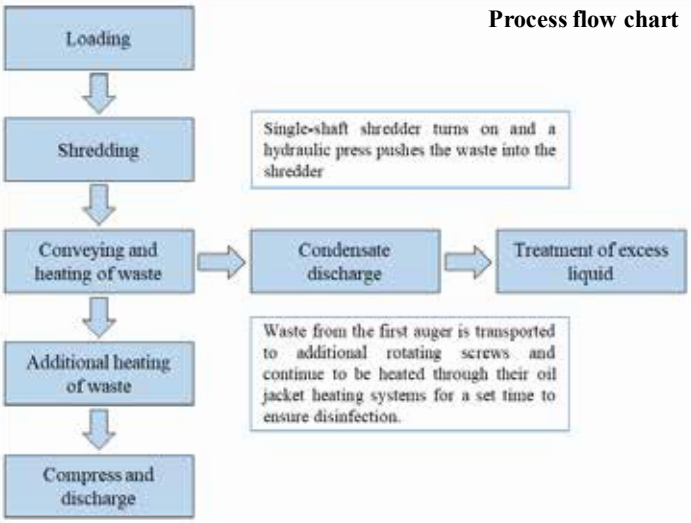
- **Advantages:** the sterilized glass, plastic and metal waste can be recovered after treatment and re-melted to produce other products, thus reducing landfill waste
- **Disadvantage of autoclaves:** waste is not physically altered after treatment, thus shredders or compactors are needed to reduce volume

Technology - Cntinuous Steam Treatement System

Process Description

Operating mechanism is simlar as hybrid autoclave system. The equipment is equipped with a hopper, shredder, steam treatement & mixing unit and drying chamber. The waste is loaded to the hopper at the front side of the treatement unit and treated waste is collected in the other end. Shredding, steam treatement aand drying is taken place at different stages in the continuous process.

Process flow chart



Available suppliers:

BioSAFE Engineering, LLC, 485 Southpoint Circle Building 200, Brownsburg, IN 46112, Tel.: +1 317-858-8099,
Fax: +1 317-858-8202, Email: info@biosafeengineering.com
www.biosafeengineering.com

ERDWICH Vertriebs GmbH Kolpingstrasse 8 - D-86916 KAUFERING Postfach 65 - D-86912 Kaufering Germany
Tel.: (+49) 08191-9652-0, Fax: (+49) 08191-9652-16, Email: infoline@erdwich.de www.erdwich.dem

Miclo Environnement, 1 Rue Pierre PFLIMLIN ZA Actipolis 3, 68390 Sausheim, France. Tel: 33 (0)3 89 31 68 50
Fax: 0033 (0)3 89 61 99 87. Email : nmiclo@wanadoo.fr http://www.miclo-environnement.fr/

Emissions and By-Products

The tests results of the treated waste residues comes out from this process are classified under non-hazardous category in the international references and recommended to disposed in a regular landfill.

Maintenance schedule

Since this is a continuous operating process, regular maintenance is essential. Systematic preventive maintenance programme is recommended with skilled labor.

Types of Waste Treated

Capable of treating the same range of healthcare wastes as autoclaves
Volatile and semi-volatile organic compounds, chemotherapeutic waste, mercury, other hazardous chemical waste, and radiological waste should not be treated.

Indicative Capital Cost:

Caacity of 500kg/hour
= US$ 650,000.
Capacity of 2,000kg/hour

Pathogen Destruction

The shredding and mixing process inbuilt with this technology enhances the heat trasnfer rate in to the waste materil during the tretement process the and achieve high levels of microbial

Capacity range

100 kg/hour to 1,000 kg/hr

Energy/Power requirement

0.125 to 0.2 Fuel oil liter/kg of waste

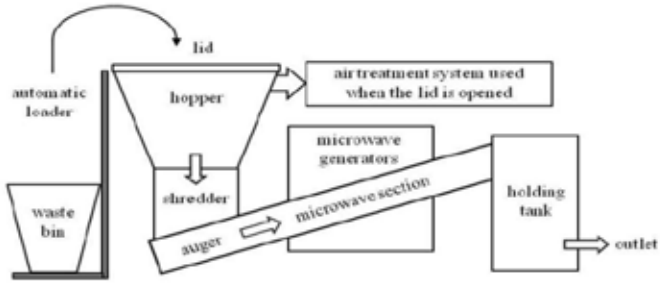
Schematic

Capacity - 500

Technology - Microwave Batch / Continuous Types

Process Description

Microwave treatement technology is almost similar to steam bsed treatment (Autoclave technology). Heat is generated throuh microwave and the water converted in to steam. The systems have multiple programmable cycles corresponding to different treatment temperatures or levels of disinfection. The treatement cycle time is approximately 30 minutes.



Capacity Range

Batch Type
30 to 210 kg/hr
Continuous process
100 - 800 kg/hr

Pathogen Destruction

Numerous studies dating back to the late 1970s showed the efficacy of microwave disinfection. The various technologes have received international certification.

Emision and by Products

Microwaving is an environmentally friendly technology. Waste water is decontaminated through the process. Air emissions from microwave units are minimal. There are no pollutant emission limits specific for microwaves. The system needs to be completely enclosed to prevent emission of aerosols during the waste shredding process.

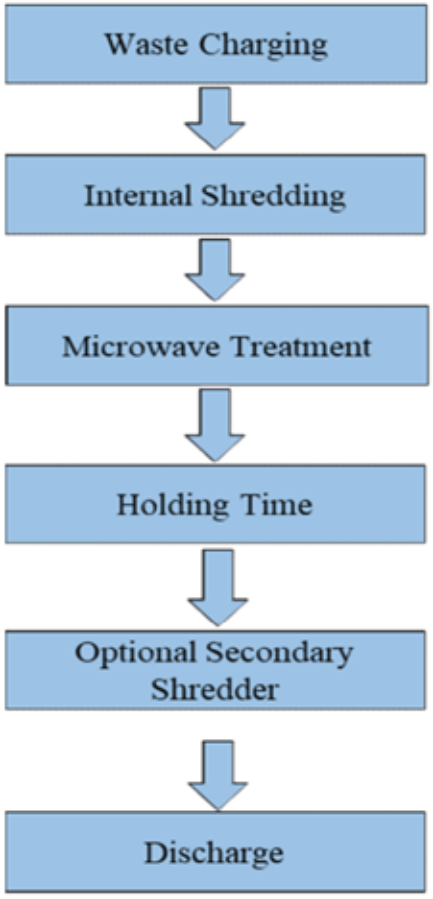
Indicative Capital Cost

A unit with a cpacity of 100kg/hour = US$ 450,000.
A unit with a cpacity of 350kg/hour = US$ 1,000,000.

Operational Procedure - Batch Type Microwave Process

Waste Charging	The waste bag is placed loosely in the machine and the lid is closed.
Start the Operation	The treatment cycle is determined by the type of waste. Select the pre programmed operating cycle prior to operation and pushes the start button which automatically locks the lid, seals the chamber and begins the treatment.
Vacuum and Steam Injection	Depending on the type of waste, the unit uses one or two vacuum cycles. Steam and/or hot water is injected in the chamber depending on the type of waste, the unit uses one or two vacuum cycles.
Microwave Treatment	The microwave generator turns on and microwave energy is used to maintain a predetermined temperature and pressure for a set time
Evacuation	Steam and condensate are drawn out of the chamber, which is flushed with air to cool the waste. Once the pressure equalizes, a signal is sounded to notify the operator of the end of the cycle
Removal of Waste	

Operational Procedure - Continuous Microwave Process



Bags are loaded into carts that attach to the feed assembly. High temperature steam is then injected into the feed hopper. While air is extracted through a HEPA filter, the top flap of the hopper is opened and the container with medical waste is lifted and tipped into the hopper.

the waste is first broken down in the hopper by a rotating feed arm and ground into smaller pieces by a shredder

The shredded particles are conveyed through a rotating conveyor screw where they are exposed to steam then heated to between 95° and 100°C by four or six microwave generators.

A holding section ensures that the waste is treated for a minimum total of 30 minutes

The treated waste may be passed through a second shredder that breaks it into even smaller pieces. This is used when sharps waste is treated in the microwave unit. The optional secondary shredder can be attached in about 20 minutes prior to operation. It is located at the end of a second conveyor screw.

Types of Waste Treated

Capable of treating the same range of healthcare wastes as autoclaves. Volatile and semi-volatile organic compounds, chemotherapeutic waste, mercury, other hazardous chemical waste, and radiological waste should not be treated. Also it is reccomended to open the tightly sealed bottle berofe loading it in to the microwave chamber. microwave technologies are not recommended for tightly sealed glass bottles that contain fluid since the pressure inside could cause the bottles to burst. The problem is avoided by leaving glass bottles partially opened. Needles and other sharp metal objects should be in puncture-safe needle containers.

Maintenance Schedule:

For the continuous microwave unit, the daily maintenance entails an inspection of 24 items including hopper area, filters, steam injection plumbing, microwave generator lamps and fans, hydraulic fluid levels, panel indicator lamps, temperature controllers and chart recorders. This inspection, outlined in a checklist, takes about 15 minutes at the start of the operating shift. Periodic maintenance includes replacement of HEPA filters, inspections of steam lines and valves, cleaning of stream injection points, and shredder maintenance.

Available suppliers

Micro-Waste Corporation 3006 SE Loop 820, Fort Worth, TX 76140, USA. Tel.: +1-817-370-2426,
Email: TABollinger@Micro-Waste.com http://www.micro-waste.com

Sanitec, 4535 W. Valerio Street Burbank, California 91505 USA. Tel.: +1(818) 565-5566. Fax: +1(818)565-0035
Email:info@sanitecind.com www.sanitecind.com/Home.html

Annex 7 – Internationally Accepted Incinerator Ash Disposal Practices

Introduction

During the combustion/incineration process, two types of as are typically produced: incinerator Bottom Ash (IBA) and incinerator fly ash (IFA). Both are internationally considered to be hazardous waste – with the risk of serious environmental pollution if not handled and disposed of correctly.

IBA, as the name suggests, accumulates at the base of the incineration unit, while IFA consists of particulate matter, either burned or partially burned, which are drawn upward by thermal air currents in the incinerator and trapped in a range of pollution control equipment.

Both IBA and IFA contain, to varying degrees, high levels of dioxins, furans, heavy metals, alkali chlorine, fluorine and carbon constituents - such as poly aromatic hydrocarbons (PAH). Typically, these contaminants are found in higher concentrations within IFA than IBA.

Consequently, incinerator ash must be pre-treated prior to final disposal or re-use. The most commonly used treatments include: solidification/stabilization; thermal treatment or leaching. They each seek to either remove contaminants, such as heavy metals, or stabilize them in an insoluble form.

Of the various treatment options, Cement Solidification Technology (CST) is the most widely applied prior to landfill disposal in most countries due to it comparative simplicity and low-cost. However, even after pre-treatment, some of the international scientific community still have some concerns about long-term leaching of contaminants into the environment.

Elsewhere, IFA incinerated at high temperatures (850–1000 ˚C) so as to destroy the PAHs before the recycling process.

Some treatment techniques combine a number of approaches. The so-called 3R-process is one of these techniques and is based on a four-step treatment, consisting of acid washing, recovery of metals by ion exchange, mixing with neutral sludge prior to combustion for mineralization.

Some of the above-mentioned pre-treatment technologies are, however, prohibitively expensive – the range typically being:

- Solidification - $ 30–60/tonne;
- Acid washing & thermal - $ 150–300/tonne;
- Vitrification - $ 150–500/tonne.

Once pre-treated, usually by solidification, incinerator ash is typically disposed of within an engineered hazardous landfill. Due to the potentially toxic nature of the hazardous waste disposed of in such facilities, they have to be designed and engineered to a higher standard than a landfill which receives only municipal waste. As well as having mechanisms for managing landfill gas and leachate, hazardous waste landfills will typically have a double base-liner (usually HDPE) to project ground-water - as compared to a single base-liner for a conventional landfill site.

Also, following pre-treatment, some incinerator ash has been used as road sub-base or in cement production, but must first pass strict leaching tests to ensure no pollutants are leaching from it. For example, within the USA, EPA leaching tests must be conducted to demonstrate that all the metals meet the established limits prior to use as a construction material or as a road sub-base.

Legislative Control

Due to the toxic nature of both IBA and IFA, it is strictly regulated throughout eh developed world. The following table summarizes the key legislative aspects of incinerator ash management within the UK and Europe.

No	Legislation	Detail
1.	The European Landfill Directive, and the UK's Enabling Act, the Waste & Emissions Trading Act	• This legislation requires the diversion of biodegradable municipal waste (BMW) from landfill. • DEFRA report on Incineration of Municipal Solid Waste (2013) states that incineration systems will divert 100% of the BMW

No	Legislation	Detail
	2003	passing through the thermal process from landfill, as the output (ash) will not be classified as biodegradable even if disposed to landfill.
2.	The Industrial Emissions Directive (IED) 2014	• The key requirements in the IED for the operation of an incineration plant are: o Specific emission limits for Sulphur Dioxide, Nitrogen Oxide, Nitrogen Dioxide, Chloride, Hydrogen Fluoride, Total Organic Carbon, Carbon Monoxide, Dust, Heavy Metal, and Dioxins and furans. o A requirement that the resulting bottom-ashes and slag produced has a total organic carbon content of less than 3%.
3.	DEFRA report on Incineration of Municipal Solid Waste 2013	• The clean-up of the flue gases will produce solid residues comprising fly-ash, which are often referred to as Air Pollution Control (APC) residues and classified as hazardous waste. • Therefore, the disposal of fly-ash must be undertaken in accordance with relevant regulations and guidance for disposing of such hazardous waste.
4.	DEFRA report on Incineration of Municipal Solid Waste 2013	• The technology supplier for the incinerator plant will define the exact emissions clean-up processes that will be employed to achieve the required standards and utilising Best Available Technique. • A common approach for control of emissions following incineration is as follows: o Ammonia injection into the hot flue gases for control of NOx emissions. o Lime or Sodium Bicarbonate injection for control of SO2 and HCL emissions. o Carbon injection for capture of heavy metals. o Filter system for removal of fly ash and other solids.
5.	DEFRA report on Incineration of Municipal Solid Waste - Outputs from incineration technologies 2013	• APC residues including fly-ash, reagents & waste-water – to be considered as hazardous waste for disposal.
6.	Treatment of Incinerator Bottom Ash (IBA) Part A Installation (capacity over 75 tonnes/day) Environment Agency, 2012	• Hydrogen gas is released from the IBA during the ageing therefore the areas of the site where flammable or explosive atmospheres may accumulate should be assessed in accordance with the Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR) • Treated and untreated IBA and the different fractions of treated IBA material shall be handled and stored separately to avoid cross-contamination.
7.	Industrial Emissions Directive (IED) of the European Parliament and of the Council under Article 175 2010	• IED sets out emission limits, flue-gases - the greatest concern of this directive. • DEFRA report on Incineration of Municipal Solid Waste (2013) states: following the combustion stage, the flue gases are normally treated to remove oxides of nitrogen, mercury, dioxins and furans, and acid gases.
8.	The Waste Incineration Directive 2000	• In the EU and UK, all waste incineration plants have to comply with The Waste Incineration Directive (2000). • This Directive sets the most stringent emissions controls for any thermal processes regulated in the EU. • Any dusty wastes (including ash) should be handled on-site such that they do not give rise to fugitive dust releases to the environment by using equipment that conforms to BAT.
9.	The Waste Incineration Directive for the Environmental Permitting (England and Wales) Regulations 2010	• The Protocol on Heavy Metals signed by the Community within the framework of the UN-ECE Convention on long-range transboundary air pollution sets legally binding limit values for the emission of: o particulate of 10 mg/m3 for hazardous and clinical waste incineration; o emission of mercury of 0,05 mg/m3 for hazardous waste incineration; and o 0,08 mg/m3 for municipal waste incineration.

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Annex 9 – Technical Working Committee

1. Dr. L T Gamlath - DDG, Environment, Health, Occupational Health & Food Safety, Ministry of Health (TWC-Chair) **
2. Dr. V T S K Siriwardana, Director, Environment, Health, Occupational Health & Food Safety, Ministry of Health (TWC Member) **
3. Dr. Inoka Suraweera, Consultant Community Physician, Environmental and Occupational Health Directorate, Ministry of Health (TWC Member)
4. Dr. Shirani Chandrasiri, Consultant-Microbiologist, Ministry of Health (TWC Member)
5. Dr. Imesh Prathapasinghe, Director, Kegalle Hospital (TWC Member)
6. Dr. Hasitha Attanayaka, Director, IDH Hospital (TWC Member)
7. Mr. J.M.U Indraratna, Deputy Director General, Central Environment Authority (TWC Member)
8. Mr. Ajith Weerasundara, Director, Waste Management Division, Central Environment Authority (TWC Member)
9. Dr. Vegini Mallawarachchi, National Professional Officer, WHO (TWC Member)
10. Mrs. Nilusha Patabandi, WASH Specialist, UNICEF (TWC Member)
11. Dr. A.G.T. Sugathapala, Senior Lecturer, University of Moratuwa (TWC Member)
12. Dr. Buddika Hapuarachchi, Policy Specialist and Team Leader, Climate and Environment Team, UNDP. (TWC Member)

** Dr. L T Gamlath was the TWC-Chair at the commencement of the assignment. Subsequently, with his retirement, Dr. V T S K Siriwardana became the TWC-Chair

Annex 10 – Core Group

1. Dr. L T Gamlath - DDG, Environment, Health, Occupational Health & Food Safety, Ministry of Health (TWC-Chair) **
2. Dr. V T S K Siriwardana, Director, Environment, Health, Occupational Health & Food Safety, Ministry of Health (TWC Member) **
3. Dr. Inoka Suraweera, Consultant Community Physician, Environmental and Occupational Health Directorate, Ministry of Health (TWC Member)
4. Dr. A.G.T. Sugathapala, Senior Lecturer, University of Moratuwa (TWC Member)
5. Mr. Ajith Weerasundara, Director, Waste Management Division, Central Environment Authority (TWC Member)
6. Dr. Vegini Mallawarachchi, National Professional Officer, WHO (TWC Member)
7. Dr. W.M.K.P Weerakkon, Registrar, Environmental and Occupational Health Directorate, Ministry of Health
8. Mrs. Nilusha Patabandi, WASH Specialist, UNICEF (TWC Member)
9. Dr. Buddika Hapuarachchi, Policy Specialist and Team Leader, Climate and Environment Team, UNDP. (TWC Member)

** Dr. L T Gamlath was the TWC-Chair at the commencement of the assignment. Subsequently, with his retirement, Dr. V T S K Siriwardana became the TWC-Chair

Annex 11 – Project Team

Consultant Team

1.	Eng. Gamini Senanayake	Team Leader
2.	Prof Parakrama Karunaratne	Environment Expert
3.	Dr Cyril De Silva	Medical Expert
4.	Eng. Ranjith Pathmasiri	Energy & Technology Expert
5.	Mr. Michael Cowing	International Consultant
6.	Ms. Chathuri Attanayake	Research Assistant
7.	Mr. Madupa Abeywardane	Project Assistant

UNDP Team

8.	Dr Tusitha Sugathapala	National Technical Advisor
9.	Mr. Sampath Ranasinghe	Project Manager
10.	Eng. Suranga Karawita	Technical Coordinator
11.	Mr. Dasitha Premartane	Project Assistant

Annex 12- PDF Version of the Online Survey Questionnaire (Group 1)

Survey on Healthcare Waste Management in Sri Lanka - Category 1 Government **HCF**

1. Details of the Healthcare Facility

This survey is carried out on behalf of the Ministry of Health, Sri Lanka under support of UNDP.

The information gathered through this survey will be used to improve the healthcare waste management in Sri Lanka and hence we request your fullest cooperation for this effort by providing accurate data related to your healthcare facility.
The survey consists of 16 sections containing 164 questions altogether. If all information are available with you, it will take about 45 minutes to complete the entire survey. However, you can exit at any point and access this form later to complete the remaining part of the survey. To exit, click 'Exit' button on top-right hand side of each page. To access the form later on, you can use the original link emailed to you.

Following abbreviations are used in this form
HCF - Healthcare Facility
HCW - Healthcare Wastes
HCWM - Healthcare Waste Management

You may reach the Consultant Team for any assistance or clarification when filling this questionnaire through following telephone numbers;

Team Leader - Eng. Gamini Senanayake, Tel. 0777804545, Email: gaminisn@gmail.com
Medical Expert - Dr Cyril De Silva Tel: 0718099986, Email: cyrildesilva2423@yahoo.com
Environment Expert - Prof. Parakrama Karunaratne Tel: 0776126110, Email: dpkaru@eng.pdn.ac.lk, Energy & Technology Expert- Eng. Ranjith Padmasiri, Tel. 0713448272, Email: ranjithpathmasiri5@gmail.com

1. Name and address of the Healthcare Facility (HCF)

2. Designation of the respondent

- ☐ Director/MS
- ☐ Deputy Director/Deputy MS
- ☐ MO Public Health
- ☐ Infection Control Nursing Officer
- ☐ PHI
- ☐ Other (please specify)

3. Name of the respondent

4. Contact Details of the respondent

Office Telephone	
Mobile	
Email	

5. Type of the HCF

- ☐ Government
- ☐ Board Managed (Semi-government)

6. Category

- ☐ National Hospital
- ☐ Special Institutions
- ☐ Teaching Hospital
- ☐ Provincial General Hospital
- ☐ District General Hospital
- ☐ Base Hospital – Type A
- ☐ Base Hospital – Type B
- ☐ Divisional Hospital – Type A
- ☐ Divisional Hospital – Type B
- ☐ Divisional Hospital – Type C
- ☐ MOH office
- ☐ Board Managed (Semi-Government)
- ☐ Primary Medical Care Unit
- ☐ Other (please specify)

7. Which services do you have in your HCF? (Please select all relevant services)

- [ ] General Medicine
- [ ] Gynaecology & Obstetrics
- [ ] Surgery
- [ ] Pediatric
- [ ] Accident and Emergencies (A&E)
- [ ] Radiology
- [ ] Radio Therapy
- [ ] Laboratory - Haematology
- [ ] Laboratory - Biochemistry
- [ ] Laboratory - Pathology
- [ ] Laboratory - Microbiology
- [ ] Minor Specialities (ENT, Eye, Dental care, etc.)
- [ ] Intensive Care Units
- [ ] Chemotherapy
- [ ] OPD
- [ ] Clinics (institutional)
- [ ] Clinics (Satellite)
- [ ] Clinics (Field)
- [ ] JMO office and Mortuary
- [ ] Cardiology
- [ ] Hemodialysis
- [ ] Peritonealdialyse
- [ ] Isolation Unit
- [ ] Other (please specify)

8. Bed strength

9. Mid-night bed occupancy rate

10. Average length of stay of a patient in days

11. Number of orthopedic patients on average per month

12. OPD attendance on average per month

13. Number of clinic sessions per week

14. Number of attendance per month on average for surgical clinics

15. Number of attendance per month on average for non-surgical clinics

16. Number of patients undergoing Radioactive Treatment per week

2. Administration

17. Has the responsibility for HCWM been delegated to a designated person?

- [ ] Yes
- [ ] No

18. if Yes, to whom the responsibility has been delegated

- [ ] Deputy Director/Deputy MS
- [ ] Microbiologist
- [ ] MO- Public Health
- [ ] Infection Control Nursing Officer
- [ ] PHI
- [ ] Other (please specify)

19. Is there a waste management committee appointed?

- [ ] Yes
- [ ] No

20. If Yes, does the committee meet regularly?

- [ ] Yes
- [ ] No

21. Do you have a separate budget line for HCWM in your institution?

- [ ] Yes
- [ ] No

22. If Yes, percentage of funds spent during last year

23. What is the total amount spent on HCWM in your institution during the last year in Rs? (please enter the numerical value only)

24. Do you have an infection control committee in your HCF?

- [ ] Yes
- [ ] No

25. If Yes, how many times the committee met during last six months?

26. Do you have meeting minutes?

- [ ] Yes
- [ ] No

27. Do you take the service of a private company for the final disposal of clinical wastes?

- [ ] Yes
- [ ] No

28. If Yes, is there a payment for waste treatment companies for their service?

- [ ] Yes
- [ ] No

29. If a payment is done, what is the all inclusive payment, including taxes, in Rs per kg?

30. What is the total amount paid per month on average in Rs?

31. Please provide the contact details of the service providing company, if applicable.

Company	
Address	
.	
Email Address	
Phone Number	

32. Do you pay for waste collectors to dispose general waste generated in your HCF?

- [ ] Yes
- [ ] No

33. If Yes, what is the total amount paid per month on average in Rs?

34. Do you have any of the following in your HCW records? (Please select all relevant)

- [ ] Types of wastes
- [ ] Quantity of wastes
- [ ] Payments made for waste collectors
- [ ] Do not keep any records
- [ ] Other (please specify)

35. If records are kept, who is responsible for record keeping

- [ ] MO Public Health
- [ ] Infection Control Nurse
- [ ] Microbiologist
- [ ] PHI
- [ ] Do not keep records
- [ ] Other (please specify)

36. Is data/reports related to waste management sent to higher authorities (eg RDHS, PDHS, etc.,) on regular basis for reviewing?

- [ ] Yes
- [ ] No

37. Do you have the following valid licenses?

- [ ] Environmental Protection Licence (EPL)
- [ ] Schedule Waste Management Licence (SWML)
- [ ] Other (please specify)

3. HCWM Staff

38. Has your institution conducted any specialized trainings on HCWM during the last two years?

- ☐ Yes
- ☐ No

39. If Yes, name the training programmes conducted

1.
2.
3.
4.
5.

40. What is the mode of training preferred by your HCF?

- ☐ Training through circulars
- ☐ On the job training
- ☐ Awareness programmes/Posters
- ☐ Other (please specify)

4. Waste Generation

Please indicate the estimated quantities of average waste generation

41. Please select the types of wastes generated in your HCF (Select all relevant types)

- [ ] Food Wastes
- [ ] General mixed wastes
- [ ] Recyclable Wastes (Plastics, Glass, Paper, Polyethylene)
- [ ] Radioactive wastes
- [ ] Infectious wastes
- [ ] Sharps
- [ ] Laboratory Chemicals (liquid and solid) wastes
- [ ] Pharmaceutical waste
- [ ] Anatomic waste
- [ ] Cyto-toxic wastes
- [ ] Other (please specify)

Quantities of Waste Generated

Please indicate the estimated quantities of monthly average waste generation

42. Food Wastes (kg/month) on average

43. General mixed wastes (kg/month) on average

44. Clean polythene and plastics (kg/month)

45. Clean glass wastes (kg/month)

46. Infectious wastes (kg/month) on average

47. Sharps (kg/month) on average

48. Liquid Chemical wastes (X-ray) (lit/month) on average

49. Pharmaceutical wastes on average per month (kg/month)

50. Pathological wastes (kg/month) on average

51. How many syringes of any type are issued from all stores per month on average?

5. HCW Minimization and Segregation

52. Do you have any waste minimisation programmes in place?

- [ ] Yes
- [ ] No

53. If yes, methods of waste minimisation (Please select all relevant methods)

- [ ] Not allowing polythene bags
- [ ] Not allowing lunch sheets
- [ ] Not allowing plastic water bottles
- [ ] Not allowing disposable styrofoam lunch boxes, cups
- [ ] Not allowing uncut king coconuts
- [ ] Other (please specify)

54. Into which categories are HCW separated ? (Please select all relevant categories)

- [ ] No Segregation
- [ ] Infectious wastes
- [ ] Sharp wastes
- [ ] General wastes
- [ ] Biodegradable wastes
- [ ] Glass
- [ ] Paper
- [ ] Plastics
- [ ] Other (please specify)

55. What is the level of segregation of wastes?

- [ ] Non-existent;
- [ ] Insufficient
- [ ] Satisfactory
- [ ] Good
- [ ] Excellent

56. Do you practice the colour code system for healthcare waste management sent by the Ministry of Health for waste segregation?

- [ ] Yes
- [ ] No

57. What type of syringes do you use? (Please select all relevant types)

- [ ] Disposable
- [ ] Reusable

6. HCW Collection and Handling (Including internal transport)

58. What kind of specific containers are used to collect infectious wastes in units/wards? (Select all relevant options)

- [ ] No Specific containers
- [ ] Normal bins
- [ ] Pedal operated bins
- [ ] Metallic containers
- [ ] Cardboard boxes
- [ ] Polythene Bags
- [ ] Other (please specify)

59. What kind of specific containers are used for sharps collections? (Select all relevant options)

- [ ] Puncture-proof disposable
- [ ] Sealed cardboard boxes
- [ ] Unsealed cardboard boxes
- [ ] Any other cardboard boxes
- [ ] Other (please specify)

60. What kind of specific containers are used for internal transportation of infectious wastes and sharps to the on-site storage facility? (Select all relevant options)

- [ ] Dedicated standard carts
- [ ] Ordinary carts
- [ ] Hand carrying
- [ ] Other (please specify)

61. Who internally transports hazardous healthcare waste from wards/units to on-site storage/treatment facility?

- [ ] Assistants (Saukya Karya Sahayaka)
- [ ] cleaning staff
- [ ] Both

7. Waste On-site Storage

62. Do you have a dedicated storage facilities for sharps?

- ☐ Yes
- ☐ No

63. If Yes, Indicate whether the storage capacity for Sharps is sufficient

- ☐ Adequate
- ☐ Inadequate

64. Do you have a dedicated storage facilities for infectious wastes?

- ☐ Yes
- ☐ No

65. If yes, indicate whether the storage capacity for infectious waste is sufficient

- ☐ Adequate
- ☐ Inadequate

66. Is the access to the waste storage restricted?

- ☐ Yes
- ☐ No

67. Does your HCF have radioactive treatment?

- ☐ Yes
- ☐ No

68. If yes, do you have delay tanks for radioactive wastes?

- ☐ Yes
- ☐ No

69. If yes, indicate whether the storage capacity of delay tanks is sufficient

- ☐ Adequate
- ☐ Inadequate

8. Occupational Safety

70. To what extent safe handling of wastes practiced by Technical (medical, nursing etc.,) staff

- [ ] Non-existent;
- [ ] Unsatisfactory
- [ ] Satisfactory
- [ ] Good
- [ ] Excellent

71. To what extent safe handling of wastes practiced by Non-Technical staff (Assistants, Cleaning staff)

- [ ] Non-existent;
- [ ] Unsatisfactory
- [ ] Satisfactory
- [ ] Good
- [ ] Excellent

72. What kind of Personal Protective Equipment (PPE) are used by those medical staff who manage healthcare wastes (*Select all relevant options*)

- [ ] Gloves
- [ ] Heavy duty boots
- [ ] Goggles
- [ ] Surgical Masks
- [ ] Face shields
- [ ] Overalls

73. Is there incident reporting system in place, including for needle prick injuries?

- [ ] Yes
- [ ] No

74. If Yes. how many injuries reported during the last year?

75. Is vaccination against hepatitis B carried out for permanent HCF staff?

- ◯ Yes
- ◯ No

76. Is vaccination against hepatitis B carried out for casual HCF staff?

- ◯ Yes
- ◯ No

77. If not, please indicate the reasons for not vaccinating the casual HCF staff *(Select all relevant options)*

- ☐ Not enough resources
- ☐ Frequent change of casual workers
- ☐ As per the government circular
- ☐ Other (please specify)

78. Is vaccination against hepatitis B carried out for cleaning workers ?

- ◯ Yes
- ◯ No

79. If not, please indicate the reasons for not vaccinating the cleaning workers *(Select all relevant options)*

- ☐ Not enough resources
- ☐ Frequent change of janitorial workers
- ☐ As per the government circular
- ☐ Other (please specify)

80. Does your HCF involve in COVID-19 related treatment?

- ◯ Yes
- ◯ No

81. Is there a specific plan to manage HCW during disasters (eg. COVID-19) ?

- ◯ Yes
- ◯ No

82. Is training part of the above specific plan?

- [ ] Yes
- [ ] No

83. Has your HCF done any improvement to HCW management due to COVID-19?

- [ ] No
- [ ] Yes

84. Have there been any training related to HCW management during COVID-19

- [ ] Yes
- [ ] No

9. External Transport and off-site treatment (incineration)

85. If the HCW is transported to an off-site treatment facility by private company, please provide details

Name of the Company	
Name of the contact person	
Address	
Telephone	

86. If the HCW is treated off-site by a private company, please provide details

Name of the Company	
Address	
Telephone	

10. Waste Treatment

87. How is food and kitchen wastes treated?

- [ ] Open dumping
- [ ] Burning within the facility premises
- [ ] Burial
- [ ] Handled by the respective Local Authority
- [ ] Inhouse biogas generation
- [ ] Hand over to third party
- [ ] Other (please specify)

88. How is the general waste (Mixed waste) treated?

- [ ] Open dumping
- [ ] Burial
- [ ] Burning within the facility premises
- [ ] Recycling
- [ ] Handled by the respective Local Authority
- [ ] Other (please specify)

89. How is the e-waste managed?

- [ ] Open dumping
- [ ] Burial
- [ ] Handled by the respective Local Authority
- [ ] Handing over to a third party
- [ ] Stored unit disposal method is found
- [ ] Other (please specify)

90. Is the treated wastes shredded before disposal?

- [ ] Yes
- [ ] No

91. How is the anatomical waste disposed?

- [ ] Burial
- [ ] Hand over to authorised third party (undertakers)
- [ ] Placental Pits
- [ ] Other (please specify)

92. How is the pharmaceutical waste managed?

- [ ] Sent for high temperature incineration
- [ ] Burial
- [ ] Open or pit burning
- [ ] Sent to RMSD/MSD
- [ ] Other (please specify)

93. How is the liquid chemicals (both lab and the radiology) waste managed? (Please select all relevant options)

- [ ] Neutralised and sent to wastewater line
- [ ] Sent to specially designed septic tanks
- [ ] On-site treatment after neutralising
- [ ] Direct disposal to drains
- [ ] Other (please specify)

94. How is the solid chemicals (eg. culture media) waste managed?

- [ ] Autoclaving
- [ ] Incineration
- [ ] Other (please specify)

95. How is the radioactive wastes managed?

- [ ] None
- [ ] Storage in specially designed safe containers/tanks

96. How is the cytotoxic wastes managed?

- [ ] None
- [ ] Handing over to a private company for off-site incineration
- [ ] Storage in specially designed safe containers/tanks

97. How is the mercury wastes managed?

- [ ] None
- [ ] Proper Storage
- [ ] Other (please specify)

98. What is the method used for infectious waste on-site treatment or disposal? (Please select all relevant methods)

- [ ] None
- [ ] Burial
- [ ] Open dumping
- [ ] Open burning
- [ ] Incinerating
- [ ] Autoclaving
- [ ] Chemical disinfection
- [ ] Metamizing (hybrid autoclave technology to shred and sterilize medical waste)
- [ ] Other (please specify)

99. What is the method used for sharps on-site treatment or disposal? (Please select all relevant methods)

- [ ] None
- [ ] Burial
- [ ] Open dumping
- [ ] Open burning
- [ ] Incinerating
- [ ] Autoclaving
- [ ] Chemical disinfection
- [ ] Metamizing (hybrid autoclave technology to shred and sterilise medical waste)
- [ ] Other (please specify)

100. Please indicate whether your HCF has a incinerator, Metamiser, or autoclave

- ○ Incinerator only
- ○ Metamiser only
- ○ Autoclave only
- ○ Incinerator and metamiser (or autoclave)
- ○ None

11. Details of on-site incinerator

101. Details of the Incinerator

Make:

Model:

Age:

102. What is the average monthly operating cost for the Incinerator in Rs? (Indicate only the numerical value)

103. Who is responsible for operating the on-site incinerator?

- [ ] HCF staff
- [ ] Supplier of the facility itself
- [ ] Other (please specify)

104. Who does the maintenance of on-site incinerator?

- [ ] HCF staff
- [ ] Supplier/Agent

105. What are the operational problems related to the onsite incinerator, if any?

- [ ] None
- [ ] Short of funding
- [ ] Poor maintenance
- [ ] Lack of spare-parts
- [ ] Power failures
- [ ] Lack of competent / skilled operators
- [ ] Public resistance
- [ ] Compliance issues
- [ ] Other (please specify)

106. What do you do when the on-site incinerator doesn't function ?

- [ ] Transfer to a nearby treatment facility
- [ ] Safe storing
- [ ] Unsafe storing
- [ ] Open dumping
- [ ] Burrial
- [ ] Open burning
- [ ] Other (please specify)

107. What is the rated capacity of the incinerator (kg/h)?

108. What is the type of fuel used?

- ( ) LPG
- ( ) Diesel
- ( ) Kerosene
- ( ) Other (please specify)

109. If liquid fuel is used , how much is the quantity consumed per month in liters

110. If LPG is used, how much is the quantity consumed per month in kg?

111. How many hours does the incinerator run per day?

112. How much time is taken to incinerate one batch (cycle time) in munites?

113. How many days does the incinerator run per week?

114. How many chambers are in the incinerator?

- [ ] Single
- [ ] Double

115. Does the Incinerator have an after burner?

- [ ] Yes
- [ ] No

116. Is a temperature monitoring facility available?

- [ ] Yes
- [ ] No

117. What is the operating temperature of the Incinerator in Centigrade?

118. Can the temperature in the incinerator be controlled?

- [ ] Yes
- [ ] No
- [ ] Other (please specify)

119. How is the HCW fed to the Incinerator?

- [ ] Manually through the door
- [ ] Through a screw feeder
- [ ] Fully automated system

120. What are the types of air pollution control (ash collection) units in the incinerator?

- [ ] None
- [ ] Cyclone Separator
- [ ] Filter
- [ ] Water spraying
- [ ] Other (please specify)

121. How is the ash from the incinerator disposed?

- [ ] Open dumping
- [ ] Bury
- [ ] Collected by the local authority
- [ ] Secure land filling
- [ ] Immobilised and Secure land filling
- [ ] Other (please specify)

122. If ash is disposed outside of your please proivde the details of the locatrion

Address

123. What is the estimated height of the Chimney?

- ◯ Below 9 m
- ◯ Above 9 m

124. Does the chimney extend above the general terrain in the immediate vicinity of the plant?

- ◯ Yes
- ◯ No

125. Does the chimney extend above the highest point of adjacent buildings (i.e. closer than 5 meters chimney height) by not less than six (6) meters for flat roofs or three (3) meters for pitched roofs?

- ◯ Yes
- ◯ No

126. How is the sharps remaining after incineration disposed?

- [ ] Open dumping
- [ ] Burial
- [ ] Controlled land filling
- [ ] Sanitary land filling
- [ ] Other (please specify)

127. In addition to the incinerators, if you have a metamiser or an autoclave, please select the appropriate equipment

- [ ] Metamiser
- [ ] Autoclave
- [ ] No additional equipment

12. Details of Metamiser

128. Who is responsible for operating the on-site metamiser?

- [ ] HCF staff
- [ ] Supplier of the facility itself
- [ ] Other (please specify)

129. What is the average monthly operating cost for the metamiser in Rs? (Indicate only the numerical value)

130. Who does the maintenance of the on-site metamiser

- [ ] HCF staff
- [ ] Supplier/Agent
- [ ] Other (please specify)

131. What are the operational problems related to of the onsite metamiser, if any?

- [ ] None
- [ ] Short of funding
- [ ] Poor maintenance
- [ ] Lack of spare-parts
- [ ] Power failures
- [ ] Lack of competent / skilled operators
- [ ] Public resistance
- [ ] Compliance issues
- [ ] Other (please specify)

132. Who is responsible for operating the on-site metamizer?

- [ ] HCF staff
- [ ] Supplier of the facility itself
- [ ] Other (please specify)

133. What do you do when the on-site metamiser does not function ?

- [ ] Transfer to a nearby treatment facility
- [ ] Safe storing
- [ ] Unsafe storing
- [ ] Open dumping
- [ ] Burrial
- [ ] Open burning
- [ ] Other (please specify)

134. Is the metamiser still in operation?

- [ ] Yes
- [ ] No

135. What is the rated capacity of the metamiser (kg/h)?

136. Operating temperature in Centigrade

137. What is the estimated electricity consumption of the metamiser per month in kWh, on average

138. Please indicate the operating pressure here if it is given in Bar

139. Please indicate the operating pressure here if it is given in psi

140. What is sterilization time in minutes?

141. How many hours does the metamiser run per day?

142. How much time is taken to treat one batch (cycle time) in minutes?

143. How many days does the Metamiser run per week?

144. How is the waste disposed off after treating in the Metamiser?

- [ ] Open dumping
- [ ] Burial
- [ ] Controlled land filling
- [ ] Sanitary land filling
- [ ] Hand over to local authority
- [ ] Other (please specify)

13. Details of Autoclave

145. Details of the Autoclave

Make:

Model:

Age:

146. What is the average monthly operating cost for the Autoclave in Rs? (Indicate only the numerical value)

147. Who is responsible for operating the on-site autoclave?

- [ ] HCF staff
- [ ] Supplier of the facility itself
- [ ] Other (please specify)

148. Who does the maintenance of the on-site autoclave

- [ ] HCF staff
- [ ] Supplier/Agent
- [ ] Other (please specify)

149. What are the operational problems related to of the onsite autoclave, if any?

- [ ] None
- [ ] Short of funding
- [ ] Poor maintenance
- [ ] Lack of spare-parts
- [ ] Power failures
- [ ] Lack of competent / skilled operators
- [ ] Public resistance
- [ ] Compliance issues
- [ ] Other (please specify)

150. Who is responsible for operating the on-site autoclave?

- ◯ HCF staff
- ◯ Supplier of the facility itself
- ◯ Other (please specify)

151. What do you do when the on-site autoclave does not function ?

- [ ] Transfer to a nearby treatment facility
- [ ] Safe storing
- [ ] Unsafe storing
- [ ] Open dumping
- [ ] Burrial
- [ ] Open burning
- [ ] Other (please specify)

152. Is the autoclave still in operation?

- ◯ Yes
- ◯ No

153. What is the rated capacity of the Autoclave (kg/h)?

154. Operating temperature in Centigrade

155. Please indicate the operating pressure here if it is given in Bar

156. Please indicate the operating pressure here if it is given in psi

157. What is sterilization time in minutes?

158. How many hours does the autoclave run per day?

159. How much time is taken to treat one batch (cycle time) in minutes?

160. How many days does the autoclave run per week?

161. How is the autoclaved waste disposed off?

- [ ] Open dumping
- [ ] Burial
- [ ] Controlled land filling
- [ ] Sanitary land filling
- [ ] Hand over to local authority
- [ ] Other (please specify)

162. How is the sharps remaining after autoclaving disposed?

- [ ] Open dumping
- [ ] Burial
- [ ] Controlled land filling
- [ ] Sanitary land filling
- [ ] Other (please specify)

14. Comments and Suggestions

163. Please provide any comments/suggestion regarding the healthcare waste management in your facility

Submit

We thank you for devoting your valuable time to complete this survey and helping the effort to improve the healthcare wastes management in Sri Lanka

Annex 13- PDF Version of the Online Survey Questionnaire (Group 2)

Healthcare Waste Management in Category 2 Government HCF

1. Details of the Healthcare Facility

1. Name and address of the Healthcare Facility (HCF)

2. Name and contact details of the contact person

Name

Mobile

Email

3. Category

- [ ] Divisional Hospital – Type A
- [ ] Divisional Hospital – Type B
- [ ] Divisional Hospital – Type C
- [ ] MOH office
- [ ] Primary Medical Care Unit
- [ ] Other (please specify)

4. Which services do you have in your HCF? (Please select all relevant services)

- [ ] Accident and Emergencies (A&E)
- [ ] Laboratory
- [ ] OPD
- [ ] Clinics (institutional)
- [ ] Clinics (Satellite)
- [ ] Clinics (Field)
- [ ] Dialysis unit
- [ ] Other (please specify)

5. Bed strength, if relevant

6. Mid-night bed occupancy rate, if relevant

7. Average length of stay of a patient in days, if relevant

8. OPD attendance on average per month, if relevant

9. Number of patients undergoing Radioactive Treatment per week

2. Administration

10. Do you have an infection control committee in your HCF?

- ○ Yes
- ○ No

11. If Yes, how many times the committee met during last six months?

12. Do you have meeting minutes?

- ○ Yes
- ○ No

13. Do you take the service of a private company for the final disposal of clinical wastes?

- ◯ Yes
- ◯ No

14. If Yes, is there a payment for waste treatment companies for their service?

- ◯ Yes
- ◯ No

15. If a payment is done, what is the all inclusive payment, including taxes, in Rs per kg?

16. What is the total amount paid per month on average in Rs?

17. Please provide the contact details of the service providing company, if applicable.

Company	
Address	
.	
Email Address	
Phone Number	

18. Do you pay for waste collectors to dispose general waste generated in your HCF?

- ◯ Yes
- ◯ No

19. If Yes, what is the total amount paid per month on average in Rs?

20. Do you have any of the following in your HCW records? (Please select all relevant)

- [ ] Types of wastes
- [ ] Quantity of wastes
- [ ] Payments made for waste collectors
- [ ] Do not keep any records
- [ ] Other (please specify)

21. Is data/reports related to waste management sent to higher authorities (eg RDHS, PDHS, etc.,) on regular basis for reviewing?

- ( ) Yes
- ( ) No

22. Do you have the following valid licenses?

- [ ] Environmental Protection Licence (EPL)
- [ ] Schedule Waste Management Licence (SWML)
- [ ] Other (please specify)

3. HCWM Staff

23. Has your institution conducted any specialized trainings on HCWM during the last two years?

- ◯ Yes
- ◯ No

24. If Yes, name the training programmes conducted

1.
2.
3.
4.
5.

25. What is the mode of training preferred by your HCF?

- ☐ Training through circulars
- ☐ On the job training
- ☐ Awareness programmes/Posters
- ☐ Other (please specify)

4. Waste Generation

Please indicate the estimated quantities of average waste generation

26. Please select the types of wastes generated in your HCF (Select all relevant types)

- [ ] Food Wastes
- [ ] General mixed wastes
- [ ] Recyclable Wastes (Plastics, Glass, Paper, Polyethylene)
- [ ] Radioactive wastes
- [ ] Infectious wastes
- [ ] Sharps
- [ ] Laboratory Chemicals (liquid and solid) wastes
- [ ] Pharmaceutical waste
- [ ] Anatomic waste
- [ ] Cyto-toxic wastes
- [ ] Other (please specify)

Quantities of Waste Generated

Please indicate the estimated quantities of monthly average waste generation

27. Food Wastes (kg/month) on average

28. General mixed wastes (kg/month) on average

29. Clean polythene and plastics (kg/month)

30. Clean glass wastes (kg/month)

31. Infectious wastes (kg/month) on average

32. Sharps (kg/month) on average

33. Liquid Chemical wastes (X-ray) (lit/month) on average

34. Liquid chemical waste (Lab)???

- Yes
- No

35. Pharmaceutical wastes on average per month (kg/month)

36. How many syringes of any type are issued from all stores per month on average?

5. HCW Minimization and Segregation

37. Do you have any waste minimisation programmes in place?

- [ ] Yes
- [ ] No

38. If yes, methods of waste minimisation (Please select all relevant methods)

- [ ] Not allowing polythene bags
- [ ] Not allowing lunch sheets
- [ ] Not allowing plastic water bottles
- [ ] Not allowing disposable styrofoam lunch boxes, cups
- [ ] Not allowing uncut king coconuts
- [ ] Other (please specify)

39. Into which categories are HCW separated ? (Please select all relevant categories)

- [ ] No Segregation
- [ ] Infectious wastes
- [ ] Sharp wastes
- [ ] General wastes
- [ ] Biodegradable wastes
- [ ] Glass
- [ ] Paper
- [ ] Plastics
- [ ] Other (please specify)

40. What is the level of segregation of wastes?

- [ ] Non-existent;
- [ ] Insufficient
- [ ] Satisfactory
- [ ] Good
- [ ] Excellent

41. Do you practice the colour code system for healthcare waste management sent by the Ministry of Health for waste segregation?

- [ ] Yes
- [ ] No

42. What type of syringes do you use? (Please select all relevant types)

- [ ] Disposable
- [ ] Reusable

6. HCW Collection and Handling (Including internal transport)

43. What kind of specific containers are used to collect infectious wastes in units/wards? (Select all relevant options)

- [ ] No Specific containers
- [ ] Normal bins
- [ ] Pedal operated bins
- [ ] Metallic containers
- [ ] Cardboard boxes
- [ ] Polythene Bags
- [ ] Other (please specify)

44. What kind of specific containers are used for sharps collections? (Select all relevant options)

- [ ] Puncture-proof disposable
- [ ] Sealed cardboard boxes
- [ ] Unsealed cardboard boxes
- [ ] Any other cardboard boxes
- [ ] Other (please specify)

45. What kind of specific containers are used for internal transportation of infectious wastes and sharps to the on-site storage facility, if relevant ? (Select all relevant options)

- [ ] Dedicated standard carts
- [ ] Ordinary carts
- [ ] Hand carrying
- [ ] Not relevant
- [ ] Other (please specify)

46. Who internally transports hazardous healthcare waste from wards/units to on-site storage/treatment facility?

- [ ] Assistants (Saukya Karya Sahayaka)
- [ ] cleaning staff
- [ ] Both
- [ ] Not relevant

7. Waste On-site Storage

47. Do you have a dedicated storage facilities for sharps?

- ☐ Yes
- ☐ No
- ☐ Not relevant

48. If Yes, Indicate whether the storage capacity for Sharps is sufficient

- ☐ Adequate
- ☐ Inadequate

49. Do you have a dedicated storage facilities for infectious wastes?

- ☐ Yes
- ☐ No
- ☐ Not relevant

50. If yes, indicate whether the storage capacity for infectious waste is sufficient

- ☐ Adequate
- ☐ Inadequate

51. Is the access to the waste storage restricted?

- ☐ Yes
- ☐ No

8. Occupational Safety

52. To what extent safe handling of wastes practiced by Technical (medical, nursing etc.,) staff

- ◯ Non-existent;
- ◯ Unsatisfactory
- ◯ Satisfactory
- ◯ Good
- ◯ Excellent

53. To what extent safe handling of wastes practiced by Non-Technical staff (Assistants, Cleaning staff)

- ◯ Non-existent;
- ◯ Unsatisfactory
- ◯ Satisfactory
- ◯ Good
- ◯ Excellent

54. What kind of Personal Protective Equipment (PPE) are used by those medical staff who manage healthcare wastes (*Select all relevant options*)

- ☐ Gloves
- ☐ Heavy duty boots
- ☐ Goggles
- ☐ Surgical Masks
- ☐ Face shields
- ☐ Overalls

55. Is there incident reporting system in place, including for needle prick injuries?

- ◯ Yes
- ◯ No

56. If Yes, how many injuries reported during the last year?

57. Is vaccination against hepatitis B carried out for permanent HCF staff?

- [ ] Yes
- [ ] No

58. Is vaccination against hepatitis B carried out for casual HCF staff?

- [ ] Yes
- [ ] No

59. If not, please indicate the reasons for not vaccinating the casual HCF staff *(Select all relevant options)*

- [ ] Not enough resources
- [ ] Frequent change of casual workers
- [ ] As per the government circular
- [ ] Other (please specify)

60. Is vaccination against hepatitis B carried out for cleaning workers ?

- [ ] Yes
- [ ] No
- [ ] Not relevant

61. If not, please indicate the reasons for not vaccinating the cleaning workers *(Select all relevant options)*

- [ ] Not enough resources
- [ ] Frequent change of janitorial workers
- [ ] As per the government circular
- [ ] Not relevant
- [ ] Other (please specify)

62. Does your HCF involve in COVID-19 related treatment?

- [ ] Yes
- [ ] No

63. Is there a specific plan to manage HCW during disasters (eg. COVID-19) ?

- [ ] Yes
- [ ] No

64. Is training part of the above specific plan?

- [ ] Yes
- [ ] No

65. Has your HCF done any improvement to HCW management due to COVID-19?

- [ ] No
- [ ] Yes

66. Have there been any training related to HCW management during COVID-19

- [ ] Yes
- [ ] No

9. External Transport and off-site treatment (incineration)

67. If the transportation is done by a private company, please provide the contact details

Name	
Company	
Address	
Address 2	
City/Town	
State/Province	
ZIP/Postal Code	
Country	
Email Address	
Phone Number	

68. Is there a inhouse treatment facility

- ◯ Yes
- ◯ No
- ◯ Not relevant

69. If the HCW is treated off-site by a private company/health institute, please provide details

Name of the Company/healthcare institute	
Address	
Telephone	

10. Waste Treatment

70. How is food and kitchen wastes treated?

- [ ] Open dumping
- [ ] Burning within the facility premises
- [ ] Burial
- [ ] Handled by the respective Local Authority
- [ ] Inhouse biogas generation
- [ ] Hand over to third party
- [ ] Other (please specify)

71. How is the general waste (Mixed waste) treated?

- [ ] Open dumping
- [ ] Burial
- [ ] Burning within the facility premises
- [ ] Recycling
- [ ] Handled by the respective Local Authority
- [ ] Other (please specify)

72. How is the e-waste managed?

- [ ] Open dumping
- [ ] Burial
- [ ] Handled by the respective Local Authority
- [ ] Handing over to a third party
- [ ] Stored unit disposal method is found
- [ ] Other (please specify)

73. How is the anatomical waste disposed?

- [ ] Burial
- [ ] Hand over to authorised third party (undertakers)
- [ ] Placental Pits
- [ ] Other (please specify)

74. How is the pharmaceutical waste managed?

- [ ] Sent for high temperature incineration
- [ ] Burial
- [ ] Open or pit burning
- [ ] Sent to RMSD/MSD
- [ ] Other (please specify)

75. How is the laboratory liquid chemicals waste managed? (Please select all relevant options)

- [ ] Neutralised and sent to wastewater line
- [ ] Sent to specially designed septic tanks
- [ ] On-site treatment after neutralising
- [ ] Direct disposal to drains
- [ ] Not relevant
- [ ] Other (please specify)

76. What is the method used for infectious waste on-site treatment or disposal? (Please select all relevant methods)

- [ ] None
- [ ] Burial
- [ ] Open dumping
- [ ] Open burning
- [ ] Incinerating
- [ ] Autoclaving
- [ ] Chemical disinfection
- [ ] Metamizing (hybrid autoclave technology to shred and sterilize medical waste)
- [ ] Other (please specify)

77. How is the mercury waste managed?

- [ ] None
- [ ] Proper storage
- [ ] Other (please specify)

78. What is the method used for sharps on-site treatment or disposal? (Please select all relevant methods)

- [ ] None
- [ ] Burial
- [ ] Open dumping
- [ ] Open burning
- [ ] Incinerating
- [ ] Autoclaving
- [ ] Chemical disinfection
- [ ] Metamizing (hybrid autoclave technology to shred and sterilise medical waste)
- [ ] Other (please specify)

79. Please indicate whether your HCF has a incinerator, Metamiser, or autoclave

- [ ] Incinerator only
- [ ] Metamiser only
- [ ] Autoclave only
- [ ] Incinerator and metamiser (or autoclave)
- [ ] None

11. Details of on-site incinerator

80. Details of the Incinerator

Make:

Model:

Age:

81. What is the average monthly operating cost for the Incinerator in Rs? (Indicate only the numerical value)

82. Who is responsible for operating the on-site incinerator?

- HCF staff
- Supplier of the facility itself
- Other (please specify)

83. Who does the maintenance of on-site incinerator?

- HCF staff
- Supplier/Agent

84. What are the operational problems related to the onsite incinerator, if any?

- None
- Short of funding
- Poor maintenance
- Lack of spare-parts
- Power failures
- Lack of competent / skilled operators
- Public resistance
- Compliance issues
- Other (please specify)

85. What do you do when the on-site incinerator doesn't function ?

- [ ] Transfer to a nearby treatment facility
- [ ] Safe storing
- [ ] Unsafe storing
- [ ] Open dumping
- [ ] Burrial
- [ ] Open burning
- [ ] Other (please specify)

86. What is the rated capacity of the incinerator (kg/h)?

87. What is the type of fuel used?

- [ ] LPG
- [ ] Diesel
- [ ] Kerosene
- [ ] Other (please specify)

88. If liquid fuel is used , how much is the quantity consumed per month in liters

89. If LPG is used, how much is the quantity consumed per month in kg?

90. How many hours does the incinerator run per day?

91. How much time is taken to incinerate one batch (cycle time) in munites?

92. How many days does the incinerator run per week?

93. How many chambers are in the incinerator?

- [ ] Single
- [ ] Double

94. Does the Incinerator have an after burner?

- [ ] Yes
- [ ] No

95. Is a temperature monitoring facility available?

- [ ] Yes
- [ ] No

96. What is the operating temperature of the Incinerator in Centigrade?

97. Can the temperature in the incinerator be controlled?

- [ ] Yes
- [ ] No
- [ ] Other (please specify)

98. How is the HCW fed to the Incinerator?

- [ ] Manually through the door
- [ ] Through a screw feeder
- [ ] Fully automated system

99. What are the types of air pollution control (ash collection) units in the incinerator?

- [ ] None
- [ ] Cyclone Separator
- [ ] Filter
- [ ] Water spraying
- [ ] Other (please specify)

100. How is the ash from the incinerator disposed?

- [ ] Open dumping
- [ ] Bury
- [ ] Collected by the local authority
- [ ] Secure land filling
- [ ] Immobilised and Secure land filling
- [ ] Other (please specify)

101. If ash is disposed outside of your please proivde the details of the locatrion

Address

102. What is the estimated height of the Chimney?

- ◯ Below 9 m
- ◯ Above 9 m

103. Does the chimney extend above the general terrain in the immediate vicinity of the plant?

- ◯ Yes
- ◯ No

104. Does the chimney extend above the highest point of adjacent buildings (i.e. closer than 5 meters chimney height) by not less than six (6) meters for flat roofs or three (3) meters for pitched roofs?

- ◯ Yes
- ◯ No

105. How is the sharps remaining after incineration disposed?

- [ ] Open dumping
- [ ] Burial
- [ ] Controlled land filling
- [ ] Sanitary land filling
- [ ] Other (please specify)

106. In addition to the incinerators, if you have a metamiser or an autoclave, please select the appropriate equipment

- [ ] Metamiser
- [ ] Autoclave
- [ ] No additional equipment

12. Details of Metamiser

107. Who is responsible for operating the on-site metamiser?

- ◯ HCF staff
- ◯ Supplier of the facility itself
- ◯ Other (please specify)

108. What is the average monthly operating cost for the metamiser in Rs? (Indicate only the numerical value)

109. Who does the maintenance of the on-site metamiser

- ◯ HCF staff
- ◯ Supplier/Agent
- ◯ Other (please specify)

110. What are the operational problems related to of the onsite metamiser, if any?

- ☐ None
- ☐ Short of funding
- ☐ Poor maintenance
- ☐ Lack of spare-parts
- ☐ Power failures
- ☐ Lack of competent / skilled operators
- ☐ Public resistance
- ☐ Compliance issues
- ☐ Other (please specify)

111. Who is responsible for operating the on-site metamizer?

- [ ] HCF staff
- [ ] Supplier of the facility itself
- [ ] Other (please specify)

112. What do you do when the on-site metamiser does not function ?

- [ ] Transfer to a nearby treatment facility
- [ ] Safe storing
- [ ] Unsafe storing
- [ ] Open dumping
- [ ] Burrial
- [ ] Open burning
- [ ] Other (please specify)

113. Is the metamiser still in operation?

- [ ] Yes
- [ ] No

114. What is the rated capacity of the metamiser (kg/h)?

115. Operating temperature in Centigrade

116. What is the estimated electricity consumption of the metamiser per month in kWh, on average

117. Please indicate the operating pressure here if it is given in Bar

118. Please indicate the operating pressure here if it is given in psi

119. What is sterilization time in minutes?

120. How many hours does the metamiser run per day?

121. How much time is taken to treat one batch (cycle time) in minutes?

122. How many days does the Metamiser run per week?

123. How is the waste disposed off after treating in the Metamiser?

- [ ] Open dumping
- [ ] Burial
- [ ] Controlled land filling
- [ ] Sanitary land filling
- [ ] Hand over to local authority
- [ ] Other (please specify)

13. Details of Autoclave

124. Details of the Autoclave

Make:

Model:

Age:

125. What is the average monthly operating cost for the Autoclave in Rs? (Indicate only the numerical value)

126. Who is responsible for operating the on-site autoclave?

- [ ] HCF staff
- [ ] Supplier of the facility itself
- [ ] Other (please specify)

127. Who does the maintenance of the on-site autoclave

- [ ] HCF staff
- [ ] Supplier/Agent
- [ ] Other (please specify)

128. What are the operational problems related to of the onsite autoclave, if any?

- [ ] None
- [ ] Short of funding
- [ ] Poor maintenance
- [ ] Lack of spare-parts
- [ ] Power failures
- [ ] Lack of competent / skilled operators
- [ ] Public resistance
- [ ] Compliance issues
- [ ] Other (please specify)

129. Who is responsible for operating the on-site autoclave?

- ◯ HCF staff
- ◯ Supplier of the facility itself
- ◯ Other (please specify)

130. What do you do when the on-site autoclave does not function ?

- [ ] Transfer to a nearby treatment facility
- [ ] Safe storing
- [ ] Unsafe storing
- [ ] Open dumping
- [ ] Burrial
- [ ] Open burning
- [ ] Other (please specify)

131. Is the autoclave still in operation?

- ◯ Yes
- ◯ No

132. What is the rated capacity of the Autoclave (kg/h)?

133. Operating temperature in Centigrade

134. Please indicate the operating pressure here if it is given in Bar

135. Please indicate the operating pressure here if it is given in psi

136. What is sterilization time in minutes?

137. How many hours does the autoclave run per day?

138. How much time is taken to treat one batch (cycle time) in minutes?

139. How many days does the autoclave run per week?

140. How is the autoclaved waste disposed off?

- [ ] Open dumping
- [ ] Burial
- [ ] Controlled land filling
- [ ] Sanitary land filling
- [ ] Hand over to local authority
- [ ] Other (please specify)

141. How is the sharps remaining after autoclaving disposed?

- [ ] Open dumping
- [ ] Burial
- [ ] Controlled land filling
- [ ] Sanitary land filling
- [ ] Other (please specify)

14. Comments and Suggestions

142. Please provide any comments/suggestion regarding the healthcare waste management in your facility

Submit

We thank you for devoting your valuable time to complete this survey and helping the effort to improve the healthcare wastes management in Sri Lanka

Annex 14- PDF Version of the Online Survey Questionnaire (Group 3)

Survey on Healthcare Waste Management in Sri Lanka - Private sector Category 1

1. Details of the Healthcare Facility

This survey is carried out on behalf of the Ministry of Health, Sri Lanka under support of UNDP.

The information gathered through this survey will be used to improve the healthcare waste management in Sri Lanka and hence we request your fullest cooperation for this effort by providing accurate data related to your healthcare facility.
The survey consists of 14 sections containing 154 questions altogether. If all information are available with you, it will take about 45 minutes to complete the entire survey. However, you can exit at any point and access this form later to complete the remaining part of the survey. To exit, click 'Exit' button on top-right hand side of each page. To access the form later on, you can use the original link emailed to you.

Following abbreviations are used in this form
HCF - Healthcare Facility
HCW - Healthcare Wastes
HCWM - Healthcare Waste Management

You may reach the Consultant Team for any assistance or clarification when filling this questionnaire through following telephone numbers;

Team Leader - Eng. Gamini Senanayake, Tel. 0777804545, Email: gaminisn@gmail.com
Medical Expert - Dr Cyril De Silva Tel: 0718099986, Email: cyrildesilva2423@yahoo.com
Environment Expert - Prof. Parakrama Karunaratne Tel: 0776126110, Email: dpkaru@eng.pdn.ac.lk, Energy & Technology Expert- Eng. Ranjith Padmasiri, Tel. 0713448272, Email: ranjithpathmasiri5@gmail.com

1. Name and address of the Healthcare Facility (HCF)

2. Designation of the respondent

- [ ] CEO
- [ ] Medical Director
- [ ] MO Public Health
- [ ] Matron
- [ ] Infection Control Nursing Officer
- [ ] Other (please specify)

3. Name of the respondent (optional)

4. Contact Details of the respondent

Office Telephone	
Mobile	
Email	

5. Which services do you have in your HCF? (Please select all relevant services)

- [ ] None
- [ ] General Medicine
- [ ] Gynaecology & Obstetrics
- [ ] Surgery
- [ ] Pediatric
- [ ] Accident and Emergencies (A&E)
- [ ] Radiology
- [ ] Radio Therapy
- [ ] Laboratory - Haematology
- [ ] Laboratory - Biochemistry
- [ ] Laboratory - Pathology
- [ ] Laboratory - Microbiology
- [ ] Minor Specialities (ENT, Eye, Dental care, etc.)
- [ ] Intensive Care Units
- [ ] Chemotherapy
- [ ] OPD
- [ ] Mortuary
- [ ] Cardiology
- [ ] Hemodialysis
- [ ] Peritonealdialyse
- [ ] Isolation Unit
- [ ] Other (please specify)

6. Bed strength

7. Mid-night bed occupancy rate

8. Average length of stay of a patient in days

9. Number of orthopedic patients on average per month, if relevant

10. OPD attendance on average per month, if relevant

11. Number of patients undergoing Radioactive Treatment per week, if relevant

2. Administration

12. Has the responsibility for HCWM been delegated to a designated person?

- [ ] Yes
- [ ] No

13. if Yes, to whom the responsibility has been delegated

- [ ] Director- Medical Service
- [ ] MO- Public Health
- [ ] Matron
- [ ] Infection Control Nursing Officer
- [ ] Other (please specify)

14. Is there a waste management committee appointed?

- [ ] Yes
- [ ] No

15. If Yes, does the committee meet regularly?

- [ ] Yes
- [ ] No

16. Do you have a separate budget line for HCWM in your institution?

- [ ] Yes
- [ ] No

17. If Yes, percentage of funds spent during last year

18. What is the total amount spent on HCWM in your institution during the last year in Rs? (please enter the numerical value only)

19. Do you take the service of a private company for the final disposal of clinical wastes?

- ◯ Yes
- ◯ No

20. If Yes, is there a payment for waste treatment companies for their service?

- ◯ Yes
- ◯ No

21. If a payment is done, what is the all inclusive payment, including taxes, in Rs per kg?

22. What is the total amount paid per month on average in Rs?

23. Please provide the contact details of the service providing company, if applicable.

Company	
Address	
.	
Email Address	
Phone Number	

24. Do you pay for waste collectors to dispose general waste generated in your HCF?

- ◯ Yes
- ◯ No

25. If Yes, what is the total amount paid per month on average in Rs?

26. Do you have any of the following in your HCW records? (Please select all relevant)

- [ ] Types of wastes
- [ ] Quantity of wastes
- [ ] Payments made for waste collectors
- [ ] Do not keep any records
- [ ] Other (please specify)

27. If records are kept, who is responsible for record keeping

- ◯ Director - Medical Services
- ◯ MO- Public health
- ◯ Matron
- ◯ Infection control Nursing officer/ Nursing officer
- ◯ Do not keep records
- ◯ Other (please specify)

28. Do you have the following valid licenses?

- [ ] Environmental Protection Licence (EPL)
- [ ] Schedule Waste Management Licence (SWML)
- [ ] Other (please specify)

3. HCWM Staff

29. Has your institution conducted any specialized trainings on HCWM during the last two years?

- ◯ Yes
- ◯ No

30. If Yes, name the training programmes conducted

1.
2.
3.
4.
5.

31. What is the mode of training preferred by your HCF?

- ☐ Training through communication materials
- ☐ On the job training
- ☐ Awareness programmes/Posters
- ☐ Staff Briefing
- ☐ Other (please specify)

4. Waste Generation

Please indicate the estimated quantities of average waste generation

32. Please select the types of wastes generated in your HCF (Select all relevant types)

- [ ] Food Wastes
- [ ] General mixed wastes
- [ ] Recyclable Wastes (Plastics, Glass, Paper, Polyethylene)
- [ ] Radioactive wastes
- [ ] Infectious wastes
- [ ] Sharps
- [ ] Laboratory Chemicals (liquid and solid) wastes
- [ ] Pharmaceutical waste
- [ ] Anatomic waste
- [ ] Cyto-toxic wastes
- [ ] Other (please specify)

Quantities of Waste Generated

Please indicate the estimated quantities of monthly average waste generation

33. Food Wastes (kg/month) on average

34. General mixed wastes (kg/month) on average

35. Clean polythene and plastics (kg/month)

36. Clean glass wastes (kg/month)

37. Infectious wastes (kg/month) on average

38. Sharps (kg/month) on average

39. Liquid Chemical wastes (lit/month) on average

40. Pharmaceutical wastes on average per month (kg/month), if relevant

41. Pathological wastes (kg/month) on average, if relevant

42. How many syringes of any type are used per month on average?

5. HCW Minimization and Segregation

43. Do you have any waste minimisation programmes in place?

- ○ Yes
- ○ No

44. If yes, methods of waste minimisation (Please select all relevant methods)

- ☐ Not allowing polythene bags
- ☐ Not allowing lunch sheets
- ☐ Not allowing plastic water bottles
- ☐ Not allowing disposable styrofoam lunch boxes, cups
- ☐ Not allowing uncut king coconuts
- ☐ Other (please specify)

45. Into which categories are HCW separated ? (Please select all relevant categories)

- ☐ No Segregation
- ☐ Infectious wastes
- ☐ Sharp wastes
- ☐ General wastes
- ☐ Biodegradable wastes
- ☐ Glass
- ☐ Paper
- ☐ Plastics
- ☐ Other (please specify)

46. What is the level of segregation of wastes?

- ○ Non-existent;
- ○ Insufficient
- ○ Satisfactory
- ○ Good
- ○ Excellent

47. Do you practice the colour code system for healthcare waste management proposed by the Ministry of Health for waste segregation?

- [ ] Yes
- [ ] No

48. What type of syringes do you use? (Please select all relevant types)

- [ ] Disposable
- [ ] Reusable

6. HCW Collection and Handling (Including internal transport)

49. What kind of specific containers are used to collect infectious wastes in units/wards? (Select all relevant options)

- [ ] No Specific containers
- [ ] Normal bins
- [ ] Pedal operated bins
- [ ] Metallic containers
- [ ] Cardboard boxes
- [ ] Polythene Bags
- [ ] Other (please specify)

50. What kind of specific containers are used for sharps collections? (Select all relevant options)

- [ ] Puncture-proof disposable
- [ ] Sealed cardboard boxes
- [ ] Unsealed cardboard boxes
- [ ] Any other cardboard boxes
- [ ] Other (please specify)

51. What kind of specific containers are used for internal transportation of infectious wastes and sharps to the on-site storage facility? (Select all relevant options)

- [ ] Dedicated standard carts
- [ ] Ordinary carts
- [ ] Hand carrying
- [ ] Other (please specify)

52. Who internally transports hazardous healthcare waste from wards/units to on-site storage/treatment facility?

- [ ] Health Assistants
- [ ] in-house cleaning staff
- [ ] Outsourced cleaning staff
- [ ] Other (please specify)

7. Waste On-site Storage

53. Do you have a dedicated storage facilities for sharps?

- ☐ Yes
- ☐ No

54. If Yes, Indicate whether the storage capacity for Sharps is sufficient

- ☐ Adequate
- ☐ Inadequate

55. Do you have a dedicated storage facilities for infectious wastes?

- ☐ Yes
- ☐ No

56. If yes, indicate whether the storage capacity for infectious waste is sufficient

- ☐ Adequate
- ☐ Inadequate

57. Is the access to the waste storage restricted?

- ☐ Yes
- ☐ No

58. Does your HCF have radioactive treatment?

- ☐ Yes
- ☐ No

59. If yes, do you have delay tanks for radioactive wastes?

- ☐ Yes
- ☐ No

60. If yes, indicate whether the storage capacity of delay tanks is sufficient

- ☐ Adequate
- ☐ Inadequate

8. Occupational Safety

61. To what extent safe handling of wastes practiced by Technical (medical, nursing etc.,) staff

- ◯ Non-existent;
- ◯ Unsatisfactory
- ◯ Satisfactory
- ◯ Good
- ◯ Excellent

62. To what extent safe handling of wastes practiced by Non-Technical staff (Assistants, Cleaning staff)

- ◯ Non-existent;
- ◯ Unsatisfactory
- ◯ Satisfactory
- ◯ Good
- ◯ Excellent

63. What kind of Personal Protective Equipment (PPE) are used by those medical staff who manage healthcare wastes (*Select all relevant options*)

- ☐ Gloves
- ☐ Heavy duty boots
- ☐ Goggles
- ☐ Surgical Masks
- ☐ Face shields
- ☐ Overalls

64. Is there incident reporting system in place, including for needle prick injuries?

- ◯ Yes
- ◯ No

65. If Yes, how many injuries reported during the last year?

66. Is vaccination against hepatitis B carried out for permanent HCF staff?

- [ ] Yes
- [ ] No

67. Is vaccination against hepatitis B carried out for casual HCF staff?

- [ ] Yes
- [ ] No

68. If not, please indicate the reasons for not vaccinating the casual HCF staff *(Select all relevant options)*

- [ ] Not enough resources
- [ ] Frequent change of casual workers
- [ ] Other (please specify)

69. Is vaccination against hepatitis B carried out for cleaning workers ?

- [ ] Yes
- [ ] No

70. If not, please indicate the reasons for not vaccinating the cleaning workers *(Select all relevant options)*

- [ ] Not enough resources
- [ ] Frequent change of janitorial workers
- [ ] Other (please specify)

71. Does your HCF involve in COVID-19 related treatment?

- [ ] Yes
- [ ] No

72. Is there a specific plan to manage HCW during disasters (eg. COVID-19) ?

- [ ] Yes
- [ ] No

73. Is training part of the above specific plan?

- [ ] Yes
- [ ] No

74. Has your HCF done any improvement to HCW management due to COVID-19?

- [ ] No
- [ ] Yes

75. Have there been any training related to HCW management during COVID-19

- [ ] Yes
- [ ] No

9. External Transport and off-site treatment (incineration)

76. If the HCW is transported to an off-site treatment facility by private company, please provide details

Name of the Company	
Name of the contact person	
Address	
Telephone	

77. If the HCW is treated off-site by a private company, please provide details

Name of the Company	
Address	
Telephone	

10. Waste Treatment

78. How is food and kitchen wastes treated?

- [ ] Open dumping
- [ ] Burning within the facility premises
- [ ] Burial
- [ ] Handled by the respective Local Authority
- [ ] Inhouse biogas generation
- [ ] Hand over to third party
- [ ] Other (please specify)

79. How is the general waste (Mixed waste) treated?

- [ ] Open dumping
- [ ] Burial
- [ ] Burning within the facility premises
- [ ] Recycling
- [ ] Handled by the respective Local Authority
- [ ] Other (please specify)

80. How is the e-waste managed?

- [ ] Open dumping
- [ ] Burial
- [ ] Handled by the respective Local Authority
- [ ] Handing over to a third party
- [ ] Stored unit disposal method is found
- [ ] Other (please specify)

81. Is the treated wastes shredded before disposal?

- [ ] Yes
- [ ] No

82. How is the anatomical waste disposed?

- [ ] Burial
- [ ] Hand over to authorised third party (undertakers)
- [ ] Placental Pits
- [ ] Other (please specify)

83. How is the pharmaceutical waste managed?

- [ ] Sent for high temperature incineration
- [ ] Burial
- [ ] Open or pit burning
- [ ] Sent to RMSD/MSD
- [ ] Other (please specify)

84. How is the liquid chemicals (both lab and the radiology) waste managed? (Please select all relevant options)

- [ ] Neutralised and sent to wastewater line
- [ ] Sent to specially designed septic tanks
- [ ] On-site treatment after neutralising
- [ ] Direct disposal to drains
- [ ] Other (please specify)

85. How is the solid chemicals (eg. culture media) waste managed?

- [ ] Autoclaving
- [ ] Incineration
- [ ] Other (please specify)

86. How is the radioactive wastes managed?

- [ ] None
- [ ] Storage in specially designed safe containers/tanks

87. How is the cytotoxic wastes managed?

- [ ] None
- [ ] Handing over to a private company for off-site incineration
- [ ] Storage in specially designed safe containers/tanks

88. How is the mercury wastes managed?

- [ ] None
- [ ] Proper Storage
- [ ] Other (please specify)

89. What is the method used for infectious waste on-site treatment or disposal? (Please select all relevant methods)

- [ ] None
- [ ] Burial
- [ ] Open dumping
- [ ] Open burning
- [ ] Incinerating
- [ ] Autoclaving
- [ ] Chemical disinfection
- [ ] Hybrid autoclaving
- [ ] Other (please specify)

90. What is the method used for sharps on-site treatment or disposal? (Please select all relevant methods)

- [ ] None
- [ ] Burial
- [ ] Open dumping
- [ ] Open burning
- [ ] Incinerating
- [ ] Autoclaving
- [ ] Chemical disinfection
- [ ] Hybrid autoclaving
- [ ] Other (please specify)

91. Please indicate whether your HCF has a incinerator, autoclave, or hybrid-autoclave

- ○ Incinerator only
- ○ Autoclave only
- ○ Hybrid Autoclave only
- ○ Incinerator and metamiser (or autoclave)
- ○ None

11. Details of on-site incinerator

92. Details of the Incinerator

Make:

Model:

Age:

93. What is the average monthly operating cost for the Incinerator in Rs? (Indicate only the numerical value)

94. Who is responsible for operating the on-site incinerator?

- HCF staff
- Supplier of the facility itself
- Other (please specify)

95. Who does the maintenance of on-site incinerator?

- HCF staff
- Supplier/Agent

96. What are the operational problems related to the onsite incinerator, if any?

- None
- Short of funding
- Poor maintenance
- Lack of spare-parts
- Power failures
- Lack of competent / skilled operators
- Public resistance
- Compliance issues
- Other (please specify)

97. What do you do when the on-site incinerator doesn't function ?

- [ ] Transfer to a nearby treatment facility
- [ ] Safe storing
- [ ] Unsafe storing
- [ ] Open dumping
- [ ] Burrial
- [ ] Open burning
- [ ] Other (please specify)

98. What is the rated capacity of the incinerator (kg/h)?

99. What is the type of fuel used?

- ( ) LPG
- ( ) Diesel
- ( ) Kerosene
- ( ) Other (please specify)

100. If liquid fuel is used , how much is the quantity consumed per month in liters

101. If LPG is used, how much is the quantity consumed per month in kg?

102. How many hours does the incinerator run per day?

103. How much time is taken to incinerate one batch (cycle time) in munites?

104. How many days does the incinerator run per week?

105. How many chambers are in the incinerator?

- [ ] Single
- [ ] Double

106. Does the Incinerator have an after burner?

- [ ] Yes
- [ ] No

107. Is a temperature monitoring facility available?

- [ ] Yes
- [ ] No

108. What is the operating temperature of the Incinerator in Centigrade?

109. Can the temperature in the incinerator be controlled?

- [ ] Yes
- [ ] No
- [ ] Other (please specify)

110. How is the HCW fed to the Incinerator?

- [ ] Manually through the door
- [ ] Through a screw feeder
- [ ] Fully automated system

111. What are the types of air pollution control (ash collection) units in the incinerator?

- [ ] None
- [ ] Cyclone Separator
- [ ] Filter
- [ ] Water spraying
- [ ] Other (please specify)

112. How is the ash (residues) from the incinerator disposed?

- [ ] Open dumping
- [ ] Bury
- [ ] Collected by the local authority
- [ ] Secure land filling
- [ ] Immobilised and Secure land filling
- [ ] Other (please specify)

113. If ash (Residues) is disposed outside of your please provide the details of the location

Address

114. What is the estimated height of the Chimney?

- ○ Below 9 m
- ○ Above 9 m

115. Does the chimney extend above the general terrain in the immediate vicinity of the plant?

- ○ Yes
- ○ No

116. Does the chimney extend above the highest point of adjacent buildings (i.e. closer than 5 meters chimney height) by not less than six (6) meters for flat roofs or three (3) meters for pitched roofs?

- ○ Yes
- ○ No

117. How is the sharps remaining after incineration disposed?

- [ ] Open dumping
- [ ] Burial
- [ ] Controlled land filling
- [ ] Sanitary land filling
- [ ] Other (please specify)

118. In addition to the incinerators, if you have an autoclave or hybrid-autoclave, please select the appropriate equipment

- [ ] Autoclave
- [ ] Hybrid-Autoclave
- [ ] No additional equipment

12. Details of Autoclave

119. Details of the Autoclave

Make:

Model:

Age:

120. What is the average monthly operating cost for the Autoclave in Rs? (Indicate only the numerical value)

121. Who is responsible for operating the on-site autoclave?

- [ ] HCF staff
- [ ] Supplier of the facility itself
- [ ] Other (please specify)

122. Who does the maintenance of the on-site autoclave

- [ ] HCF staff
- [ ] Supplier/Agent
- [ ] Other (please specify)

123. What are the operational problems related to of the onsite autoclave, if any?

- [ ] None
- [ ] Short of funding
- [ ] Poor maintenance
- [ ] Lack of spare-parts
- [ ] Power failures
- [ ] Lack of competent / skilled operators
- [ ] Public resistance
- [ ] Compliance issues
- [ ] Other (please specify)

124. Who is responsible for operating the on-site autoclave?

- ◯ HCF staff
- ◯ Supplier of the facility itself
- ◯ Other (please specify)

125. What do you do when the on-site autoclave does not function ?

- [ ] Transfer to a nearby treatment facility
- [ ] Safe storing
- [ ] Unsafe storing
- [ ] Open dumping
- [ ] Burrial
- [ ] Open burning
- [ ] Other (please specify)

126. Is the autoclave currently in operation?

- ◯ Yes
- ◯ No

127. What is the rated capacity of the Autoclave (kg/h)?

128. Operating temperature in Centigrade

129. Please indicate the operating pressure here if it is given in Bar

130. Please indicate the operating pressure here if it is given in psi

131. What is sterilization time in minutes?

132. How many hours does the autoclave run per day?

133. How much time is taken to treat one batch (cycle time) in minutes?

134. How many days does the autoclave run per week?

135. How is the autoclaved waste disposed off?

- [ ] Open dumping
- [ ] Burial
- [ ] Controlled land filling
- [ ] Sanitary land filling
- [ ] Hand over to local authority
- [ ] Other (please specify)

136. How is the sharps remaining after autoclaving disposed?

- [ ] Open dumping
- [ ] Burial
- [ ] Controlled land filling
- [ ] Sanitary land filling
- [ ] Other (please specify)

13. Details of hybrid-autoclave

137. Who is responsible for operating the on-site hybrid-autoclave?

- [ ] HCF staff
- [ ] Supplier of the facility itself
- [ ] Other (please specify)

138. What is the average monthly operating cost for the treatment facility in Rs? (Indicate only the numerical value)

139. Who does the maintenance of the on-site hybrid-autoclave

- [ ] HCF staff
- [ ] Supplier/Agent
- [ ] Other (please specify)

140. What are the operational problems related to of the onsite hybrid-autoclave, if any?

- [ ] None
- [ ] Short of funding
- [ ] Poor maintenance
- [ ] Lack of spare-parts
- [ ] Power failures
- [ ] Lack of competent / skilled operators
- [ ] Public resistance
- [ ] Compliance issues
- [ ] Other (please specify)

141. Who is responsible for operating the on-site hybrid-autoclave?

- [ ] HCF staff
- [ ] Supplier of the facility itself
- [ ] Other (please specify)

142. What do you do when the on-site hybrid-autoclave does not function ?

- [ ] Transfer to a nearby treatment facility
- [ ] Safe storing
- [ ] Unsafe storing
- [ ] Open dumping
- [ ] Burrial
- [ ] Open burning
- [ ] Other (please specify)

143. Is the hybrid-autoclave currently in operation?

- [ ] Yes
- [ ] No

144. What is the rated capacity of the hybrid-autoclave (kg/h)?

145. Operating temperature in Centigrade

146. What is the estimated electricity consumption of the metamiser per month in kWh, on average

147. Please indicate the operating pressure here if it is given in Bar

148. Please indicate the operating pressure here if it is given in psi

149. What is sterilization time in minutes?

150. How many hours does the metamiser run per day?

151. How much time is taken to treat one batch (cycle time) in minutes?

152. How many days does the Metamiser run per week?

153. How is the waste disposed off after treating in the Metamiser?

- [ ] Open dumping
- [ ] Burial
- [ ] Controlled land filling
- [ ] Sanitary land filling
- [ ] Hand over to local authority
- [ ] Other (please specify)

14. Comments and Suggestions

154. Please provide any comments/suggestion regarding the healthcare waste management in your facility

Submit

We thank you for devoting your valuable time to complete this survey and helping the effort to improve the healthcare wastes management in Sri Lanka


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