DEVELOPMENT OF PRACTICE GUIDELINES FOR SOLID HEALTH CARE WASTE MANAGEMENT IN ETHIOPIA

by

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DEVELOPMENT OF PRACTICE GUIDELINES FOR SOLID HEALTH CARE WASTE MANAGEMENT IN ETHIOPIA

I declare that the above thesis is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

I further declare that I submitted the thesis to originality-checking software and that it falls within the accepted requirements for originality.

I further declare that I have not previously submitted this work, or part of it, for examination at Unisa for another qualification or at any other higher education institution.

11 November 2022

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ABSTRACT

The purpose of this study was to investigate solid health care waste management practices in the health sector in order to develop guidelines for improving solid health care waste management practice. The setting is all health facilities found in Hossaena town. A convergent mixed-methods study design was used. For the quantitative part of this study a census method of study, which is all health care facilities found in the town was studied. All health facilities and health facility workers (540 in number) who are available in the study health facilities and having a role in HCW management practice were included in the quantitative phase of this study. Qualitative research sampling is purposive and relies on different methods. For the purpose of this study, small purposeful samples were used. The researcher of this study purposefully selected the research participants who have experienced the solid health care waste practice or key concept being explored in this study. One hospital, three government health centres, 17 medium clinics, 19 small clinics, and one surgical centre participated in this study. Both samples were drawn from the same population. The quantitative part of the study included all health facility staff who play a role in the practise of health care waste management

In the qualitative phase of the data collection open-ended interviews, focus group discussions, and analysis of visual materials were used. Questionnaires were used for the quantitative phase.

The data were analysed quantitatively by using relevant statistical tools. Descriptive statistics and Pearson correlation tests were used for the bivariate associations to assess the relationships between independent and dependent variables and analysis

of variance to compare health care waste generation rates by the type of health facilities. In most of the variables, percentages and means were used to report the findings with a 95% confidence interval. Open-ended responses and focused group findings were undertaken by quantifying and coding the data to provide a thematic narrative explanation.

These guidelines were designed and developed based on the study findings and the current knowledge available and reviewed in the literature. The purpose of these guidelines is to show the gap on SHCWMP and to provide the scientific recommendation to health facility workers, health facility managers, and regulatory bodies. The objectives of these guidelines are to improve and maintain public health safety by: Minimising solid HCW generation rate and impacts on the surrounding environment. These guidelines were developed based on the world health organization recommendation of the guide line development process and findings of this study and the extensive literature review. The final guidelines were tested and the comments from practical users were evaluated and incorporated into the guideline. In the light of the finding of this research, there are several gaps regarding proper SHCWM practice. Colour coded waste bins should be available, adequate awareness and training programmes for health facility workers, patients and visitors should be provided.

Result: Health care waste segregation practice was not implemented in 78% of the health facilities. The qualitative observation asserted that inappropriate segregation practice was observed in 98.3% of the solid health care waste containers. The main problem that was encountered in the effective management of solid health care waste management practice was a lack of awareness and commitment. Observational findings revealed that in 97.6% of the health facilities, infectious wastes are collected daily. Pre-treatment before disposal was not practised. All health facilities used incineration by using brick or barrel incinerators, and all are not meet the minimum standards solid health care waste management. The qualitative observation shows that 97.6% of the health facilities were not using the colour-coded waste bin, which leads to the mixing of infectious and non-infectious waste.

Focus group participant recommend that ‘’*providing waste management training and creating awareness are the two aspects to improve SHCW segregation practice. health facility must avail all the necessary supplies that used for SHCWMP,*

punishment for those violating the rule of SHCWMP, *Mask, disposable gloves and changing gowns are a critical shortage at all health facilities''*

Conclusions: Lack of knowledge, absence of training and orientation, lack of protective vaccinations, and inappropriately constructed incinerators are the leading causes of inappropriate solid health care waste management practice.

Keywords: Development; disposal; guideline; solid health care waste; waste management.

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DEDICATION

This work is dedicated to the Almighty God for his faithfulness.

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LIST OF ABBREVIATIONS

ART	Anti-retroviral therapy
BC	Black carbon
CICU	Central intensive care unit
DALY	Disability-adjusted life years
EPA	Environmental Protection Authority
FGD	Focus group discussion
FMHACA	Food, Medicine, and Health Care Administration and Control Authority
FMOH	Federal Ministry of Health
GDP	Gross domestic product
GHG	Greenhouse gas
HCF	Health care facilities
HCWMS	Health care waste management system
IPC	Infection Prevention and Control
PPE	Personal protective equipment
PHA	Polycyclic aromatic hydrocarbons
PVC	Polyvinyl chlorides
SEM	Social ecological model
SHCWMP	Solid health care waste management practice
SHCWGR	Solid health care waste generation rate
SPSS	Statistical Packages for Social Sciences
UNISA	University of South Africa
UNICEF	United Nation International Children's Emergency Fund
WMT	Waste management theory
WUNEMMCSH	Wachemo University Nigist Eleni Mohamed Memorial Comprehensive Special Hospital

CHAPTER 1

ORIENTATION TO THE STUDY

1.1 INTRODUCTION

Waste is generated by human activities; everyone creates it, but some people and organisations want to think about the consequences (Martin, Ebenezer & Samueal 2017: 349). Solid waste can be classified into various types. On the basis of composition, solid waste can be divided into inorganic waste and organic waste; in terms of the form, it can be classified as solid waste, semi-solid waste. In consideration of the pollution characteristics, it can be divided into general and hazardous waste. On the basis of the classification of waste sources, solid waste can be divided into four categories, municipal solid waste, industrial solid waste, agricultural solid waste, and hazardous waste (Kumar, Zhang, Kumar, & Ronghua, 2019: 2).

1.2 BACKGROUND INFORMATION ABOUT THE RESEARCH PROBLEM

In the ancient history of human development, the disposal of SW was peaceful due to proper waste management. The main components of waste were left over food, vegetables, fruits, and wood. At that time wastes were household wastes that were easily decomposable. There were no health care facilities, and industries that generate infectious and chemical wastes. With the growth of the human population and the advancement of technologies, the amount of wastes generated and its compositions increased over time (Bello, Ismail, & Kabbashi 2016: 2).

1.2.1 The global situation of Health care waste management

Solid health care waste (SHCW) is all unwanted and discarded solid wastes generated during health-related activities involving in disease prevention, health promotion, rehabilitation, diagnosis treatment, research, and other health-related activities (Jemil, Anant & Mukesh 2014: 377; WHO 2014: 8; Daniel & Mebin 2019: 41). Infectious and non-infectious solid wastes, such as sharps, blood, body parts,

chemicals, pharmaceuticals, medical devices, radioactive materials, paper, and food wastes are generated in health care facilities during the provision of health care services (WHO 2015:1). It is also defined as non-gaseous or non-liquid products generated by human activities that are no longer needed (Debere, Gelaye, Alamdo & Trifa 2014: 1, 2).

Within 15 to 20 years, because of rapid growth rate of human population and migration of the people from rural to urban, and as their economies develop the apparently inevitable rise in waste per person per day, solid waste generation rate has been doubled in cities at developing countries of Africa and Asia. Similarly, as a result of globalisation and a shift in production, in developed and developing countries and thus industrial and hazardous waste generation rate are increased. In recent decades some developing countries have made significant progress, but the poorest countries waste collection coverage and controlled disposal rates are remained in a low level (Wilson & Velis 2015: 1049).

Healthcare waste (HCW) is any kind of wastes that is generated during the provision of any health-related services. HCW includes secretion and excretion from humans, culture, and wastes that contain stock of infectious agents, discarded plastic materials contaminated with blood or other body fluid, pathological wastes (human tissues and body parts, fluids, organs), discarded medical equipment, sharps and other wastes generated during any health care service provision that is considered potentially hazardous to health (Wafik, Mariam, Mahdi & Habib 2014: 21).

In developing world, particularly countries including Ethiopia, health care waste management (HCWM) system is an important area of public of health. Many health care providing facilities in this country do not meet the minimum standards of clinical waste management required for proper handling and disposal, this is because of very little attention given for HCWM. Problems are exacerbated by an unexpected increasing number of health care providing facilities like clinics, hospitals, and diagnostic laboratories. Proportions of SHCW generation rate in the health facilities are not proportional to the WHO recommendation (Biniyam 2019: 591; Deress, Jemal, Girma & Adane 2019: 1, 2).

Waste that is generated at health care facilities, if it is not managed properly can cause a high risk to health facility staff, the patients, the community, the economy, public health, and the environment (Gilbert & Noble 2016: 144; Sudhir, Vishal, Ashok, Rita, Harshada 2015: 1).

Adequate and standard arrangements should be made for transporting HCW from any point of generation to the final disposal site without disturbing and contaminating the surface and in an environmentally friendly manner. This can be effectively practiced if we are scientific and conscientious in dealing with HCW (Kumar et al. 2015: 383).

The African continent is facing a growing waste management crisis. The waste generation rate per capita and the amount of waste generated are relatively low compared to the developed worlds. Rapid urbanization, consumers purchasing habit, and the increased population in Africa, has led to increased waste production related major socioeconomic transformation causing human health and the environment to be affected by the mismanagement of waste (Linda et al., 2019: 1).

1.2.2 Health care waste situation in Ethiopia

In Ethiopia, there is no updated separate HCWM regulation to enforce the proper segregation, collection, transportation, and treatment of health care waste, although the rate of non-compliance for proper waste management is high. There are two HCWM guidelines independently produced by the Food, Medicine and Health Care Administration and Control Authority (FMHACA), and the Federal Ministry of Health (FMoH) (Elliott, Marianne 2015: 99; Teshiwal, Mekonnen & Kasaw 2019: 1). Health facilities are primarily located in urban and semi-urban areas. Peoples living near to health care waste incineration and improper disposal facilities are continuously exposed to before and after the disposal of improper waste disposal owing to incessant burning smoke clouds, and the ash remaining after incineration, which contains various chemicals and minerals in high concentration (Elliott et al. 2015: 104).

Wastes containing disease causing organisms from health care service provision areas are remained a neglected public health problem in developing countries, resulted in polluting the environment and affecting the general masses. Waste management compliance with the standard HCWM practice still has not moved from paper to implementation practice (Biniyam 2019: 591).

1.3 DESCRIPTION OF THE RESEARCH PROBLEM

According to Teshiwal et al. (2019: 3) there are no specific HCW regulations in Ethiopia, to enforce the proper segregation, collection, transportation, and treatment of HCW and non-compliance with the relevant World Health Organisation (WHO) waste management standards is wide spread. Studies have shown lack of awareness, lack of training, lack of adequate resources, staff resistance to change, lack of commitment by health facility managers negligence, and a negative attitude of the health care staff towards HCW management.

The World Health Organization estimated that unsterilized syringes caused between 8 to 16 million cases of hepatitis B, 2.3 to 4.7 million cases of hepatitis C, and 80,000 to 160,000 cases of HIV infections every year. In developing countries showed that the proportion of health-care facility (HCF) that do not use proper waste disposal methods range from 18% to 64% (Debalkie & Kumie 2017: 47).

A survey conducted by WHO on HCWs management in 22 developing countries revealed that the proportion of health care facilities with improper waste treatment practices was between 18 and 64 % (Rafiee et, al. 2016: 7). It is expected that in less than a decade, solid waste production in Africa grew 160%. These figures are quite high compared with other countries (Adu, Gyasi, Essumang, Otabil, 2019: 2). A number of needle-stick injuries have been reported among hospital workers and scavenger families while handling infected waste mixed with other types of waste. In Sub-Saharan Africa, the reuse of contaminated syringes and needles in medical care has accounted for 5% of HIV infections. The substantial human suffering and financial burden of these infections due to improper management of Health Care Waste (HCW) is staggering (Asrat et, al. 2019: 126).

Waste generated from health care activities poses a higher risk for nosocomial infections and injuries. Health care waste poses one of the greatest hazards to human and the environment because they can significantly increase exposure to infectious contaminants. Health care waste generated at health care facilities in the cities of Hossaena are inappropriately managed and treated as household. HCWMPs in the study area have not being investigated and the problems are not being effectively addressed. Few studies have been conducted in the country whivh makes it difficult for decision makers and experts to include proper waste management in the priority list of the health sector to develop a plan and policy for environmental waste management.

1.4 PURPOSE OF THE STUDY, RESEARCH OBJECTIVES AND QUESTIONS

1.4.1 Purpose of the study

The purpose of this study was to investigate SHCWM practices towards developing guidelines to improve SHCWM practices.

1.4.2 Research objectives

1. To assess the types of solid HCW generated at the health facilities found in Hossaena, Ethiopia.
2. To assess the health facility workers' knowledge on the management of different types of solid HCW.
3. To determine implementation gaps in the existing Ethiopian national SHCWM policies.
4. To explore and describe the experiences of SHCWM at a different level in Hossaena Town.
5. To develop guidelines to improve management practices of SHCWM in Ethiopia.

1.4.3 Research questions

1. What are the different types of solid HCWs generated in health care facilities?
2. What is the level of knowledge of the health care institution staff on SHCWM?
3. What are the gaps in the existing Ethiopian national HCW management policies?
4. What are your experiences of SHCWM practices at different levels in Hosanna Town?
5. What guidelines can be proposed to improve management practice of SHCWM in Ethiopia?

1.5 SIGNIFICANCE OF THE STUDY

Few studies have been conducted on solid medical waste in Ethiopia. In particular, private health facilities were not considered in most of the studies. Solid HCW management guidelines developments are not prepared and studied in the country.
This research has been useful for policy makers and program planners to develop and design strategies to improve HCW management throughout the country and provide a simple cost effective easily accessible and practical document or guidelines for planners, decision-makers, and stakeholders.

The results of this study present data that can be used to determine and predict the type of solid HCW generated in the facilities, the generation rate of SHCW at different health facilities, and level of the health facilities workers knowledge on SHCWMP. The study identified the gaps from the current practises of HCW management practices and proposed appropriate guidelines for SHCWM.

The main purpose of this guideline is to serve as a tool to promote healthy and safe working environment in the health facilities. The proposed guidelines are applicable to all health facilities and health facility workers in Hossaena town. The implementation of these guidelines therefore, is essential for the achievement of

sound management of healthcare waste. These guidelines recommend safe, efficient, sustainable, affordable and culturally acceptable methods for the treatment and disposal of health-care waste, both within and outside health-care establishments. Implementation of these guidelines will protect public health and provide a safer working environment, minimize waste generation and environmental impacts of waste treatment and disposal, enhance the safe handling of healthcare waste and set standardized healthcare waste management practices. These guidelines also specify roles and responsibilities of all those engaged in or affecting the generation, storage, transportation, treatment, and disposal of healthcare waste.

1.6 DEFINITION OF KEY TERMS

1.6.1 Development

The process of developing or the act of developing an event that presents a new state in a changing situation. In this study, development refers to the preparation of guidelines for solid health care waste management practice.

1.6.2 Disposal

Intentional burial, deposit, discharge, dumping, placing or release of any waste material into or on any air, land or water. In the context of radioactive waste management, disposal means the placement of waste in an approved, specified facility or the approved direct discharge of effluents into the environment. Disposal is undertaken without the intention of retrieval (WHO 2014:306).The definition is adopted for this study.

1.6.3 Guidelines

Written directions aimed at assistance towards effective policy implementation (WHO 2014: 3). In this study, guidelines refer to the document prepared to provide knowledge and guidance for solid health care waste management practice in Ethiopia.

1.6.4 Solid Health Care Waste

Tangible end product resulting from health care activities (WHO 2014: 325). The definition is adopted for this study.

1.6.5 Waste management

All the activities (collection, handling, segregation, transportation, treatment, and disposal) of the process of managing unwanted materials that have no purpose and not useful (WHO 2014:26). The definition is adopted for this study.

1.7 THEORETICAL FOUNDATION OF THE STUDY

1.7.1 Research paradigm

Paradigm is a worldview or framework through which knowledge is filtered (Leavy 2017: 31). In order to answer the research questions and to achieve the research objectives, the researcher believes that a pragmatist worldview and its alignment to the mixed-methods research are most appropriate for this study. Pragmatism is a philosophical position and a practical approach to problems and maters that recognises the value of knowledge solely in terms of its usefulness (Dennis 2016: 534). Pragmatism focuses on the ends that we value. Pragmatic knowledge helps to plan and conduct the research design that to answer the research questions (Burke & Larry 2014: 81).

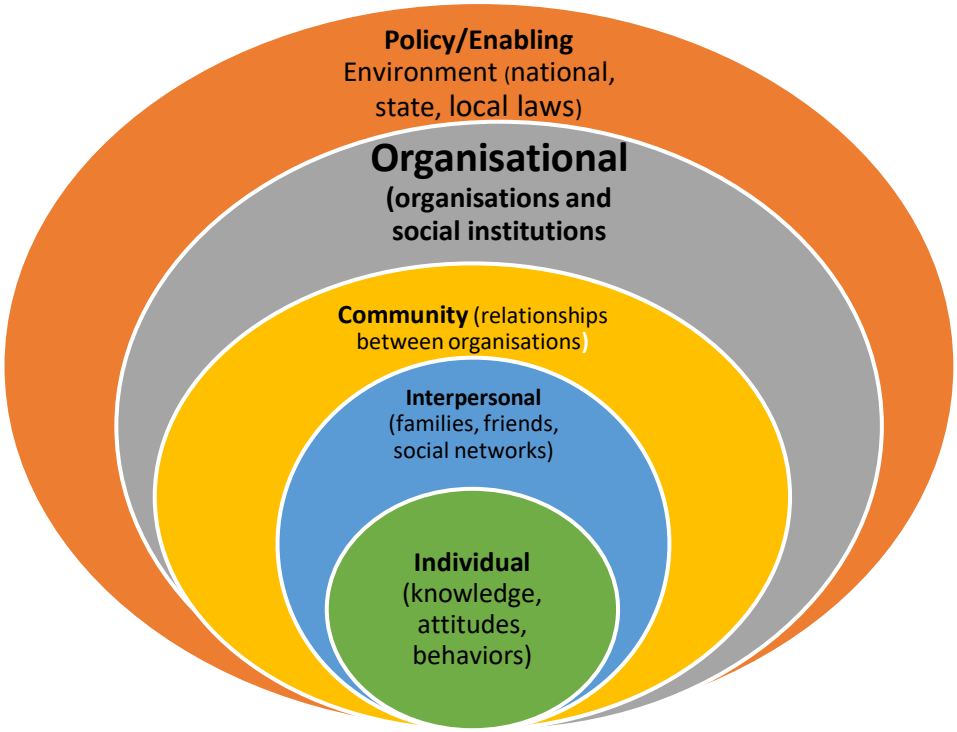

Figure 1.1: The social ecological model adopted from Urie Bronfenbrenner

1.8 RESEARCH METHODOLOGY AND RESEARCH DESIGN

1.8.1 Study setting, study population, sampling, and sample size

1.8.1.1 Study setting

A study setting is an area in which the research takes place (Leavy 2017: 235). The setting for this study was Hossaena Town health facilities, located 232 kilometres from the capital city of Ethiopia, Addis Ababa, and 165 kilometres from the regional town of Hawasa. The health facilities found in the town has been, one university hospital, a private surgical centre, three government health centre, 17 medium clinics, and 19 small clinics were available in the town and, health facility workers who have direct contact on generating and disposal of HCW, and those who are responsible as a manager of health facilities found in Hossaena Town are the study settings.

1.8.1.2 Study population

As Neuman (2014) points out, research populations are individuals or objects with a well-known collection that are known to have similar characteristics. It is defined by the sampling criteria and formulated by the researcher from which a researcher draws a sample, and the results of the study has been generalised (Neuman 2014: 247). The target population is the larger population, from which the results of the study are to be generalised and from which participants are selected (Burke & Larry 2014: 346; Cassell, Cunliffe & Grandy 2018: 482; Polit & Beck 2017: 365).

1.8.1.3 The target population

1.8.1.3.1 Target population for the quantitative study

The target population for the quantitative phase of this study was 556 health workers who have direct contact with SHCW from generation to disposal, and health facility managers were included in the data collection (26 medical doctors, 67 health officers, 194 nurses, 57 laboratory workers, 97 cleaners, 115 other facility workers) employed in the 41 health institutions (one hospital, one surgery centre, three government health centre, 17 medium clinics, and 19 small clinics found in Hossaena Town.

1.8.1.3.2 Target population for qualitative study

The target population for the qualitative phase of this study was purposively selected employees of health facilities in Hossaena town.

1.8.1.4 Sampling method and technique

Relatively small purposeful samples were drawn for the qualitative part of this study, while a relatively large sample was used, for the quantitative phase was used for the quantitative phase to improve generalisation of the quantitative result. Both of the samples were taken from the one population, but the number of individuals in the qualitative data collection phase is much smaller than the individuals in the quantitative data collection phase and include different individuals in order to get appropriate result.

1.8.1.4.1 Sampling for quantitative phase

Based on the theory of probability, the quantitative part of this study typically relies on the technique of probability sampling, where the health facilities under study were selected from all the health facilities present in Hossaena Town based on this theory. All health facilities have a chance of being selected for this study (Leavy 2017: 78,109; Polit & Beck 2018: 373). A simple random sampling technique was used, based on the theory of probability (Cassell et al 2018: 485; Johnsen & Christensen 2014: 345). The quantitative phase of data collection included all health facility staff who are available in the health facilities and who play a role in the health care waste management practises.

The generation rate of HCW and the type of the waste assessed, the practice of segregation, collection, transportation, and disposal system was observed quantitatively by using structured questionnaires. To ensure the representativeness of the samples, various types of health facilities were considered from the town. Questionnaires were used to collect data from the health facility staff on generation, segregation, collection; transportation, and disposal method of HCW.

1.8.1.4.2 Sampling for qualitative phase

Sampling in the qualitative phase followed the purposive sampling method. In the purposive sampling method, the researcher purposively selects research participants who are familiar and knowledgeable about the topic of the study (Creswell & Plano 2018: 246; Polit & Beck 2018: 372). The aim of purpose full sampling is to find the information-rich individuals (Burke et al. 2014: 370). For the focus group discussions to get appropriate data, health facility managers, nurses, laboratory professionals, cleaners, and pharmacy professionals were targeted to obtain appropriate data.

1.8.1.5 Data collection method(s) and procedures

The purpose of data collection in any study is to collect the necessary information to answer the research questions that has been asked in the study. In mixed method studies qualitative and quantitative data must be collected. In this study, the data

collection involves collecting both quantitative and qualitative data simultaneously, analysing the two data's separately, and then merging or comparing the results from the two data sources (Creswell & Plano 2018: 242; Leavy 2017: 175).

1.8.1.5.1 Data collection for the quantitative phase

The quantitative phase of this study assessed three components. Health care waste segregation practice, the availability of waste segregation equipment for HCW segregation, temporary storage facilities, transportation for final disposal, and disposal facilities data were collected by using a structured questionnaire, observation of HCW generation. Re cycling or re using practice, waste treatment, the availability of HCWM committee, and training data were collected.

Ten environmental health technicians with at least a diploma and were recruited for quantitative data collection including assessment of the type of waste generated separately from each health facilities in the sample. To increase the trustworthiness of the data collected, non-participant observation of HCW management practice was conducted by the researcher of this study.

The researcher conducted a pre-test of the quantitative data collection instrument on 5% of the sample size, which means in two health facilities, one government and one private health facility found outside of the study area. The result of the pre-test revealed that the data collection instruments were easy to understand by the research participants and there were no any difficulties to understand and to answer the research questions by the respondents. The data collectors are easily familiar with the data collection tools.

1.8.1.5.2 Data collection for the qualitative phase

The qualitative phase of the data collection for this study was employed by using focus group discussions, and semi structured interviews about SHCWMP. Two focus group discussions (FGD) from each health facility were conducted in the government health facilities, one administrative level and one technical worker level and one

FGDs were conducted for all private health facilities because of the number of available health facility workers. Each focus group has 4 individuals.

For this study, FGDs and semi-structured interviews were used for data collection. Both the focus group discussions and the semi structured interviews were conducted in the respective health facilities of the participants (Burke et al. 2014: 313).

Data collection begun with individual interviews using an interview guide, followed by the focus group discussions. Interviewing is an opportunity for the researcher of this study to gain the full picture into how people interpret their environment. Issues that were not adequately addressed in the individual interviews were clarified and discussed in-depth in the focus group discussions. During interviews, the researcher used a tape recorder and took notes to record the relevant responses of the interviewees on HCW management practices.

To enhance the credibility of the data collected both the focus group interviews and observation was conducted by the principal investigator. The focus group interview guide was pretested, Worabe town was selected for the pre as it is closet to the study area which is found 60 kilometres far from the study area and the town contains health facilities like hospitals, health centres and clinics.

1.8.1.6 Preparation of the data collection instrument

In order to improve the quality of the data, data collection instruments were translated from English into Amharic, considering the ease of understanding of respondents, and translated again into English by a language expert to check the consistency of the meanings.

1.8.1.7 Method of data analysis

For both qualitative and quantitative data analysis, the arrangement and preparation of data for analysis, examination of the data, analysis of the data, interpretation of

the analysis, and validation of the data and interpretations of the results should be conducted in mixed methods studies (Creswell & Plano 2018: 289).

1.8.1.7.1 The quantitative data analysis phase

Quantitative data were entered into Epi data version 3.1 to minimise the data entry errors and exported to the statistical package for social science SPSS window version 27.0 for analysis. A numerical value was assigned to each response in a database; the data were cleaned, recoded, establishing a codebook and the trends were visually checked to see if the data were normally distributed. The data were analysed quantitatively by using relevant statistical tools. Descriptive statistics and Pearson correlation test were used for the bivariate associations and analysis of variance (ANOVA) to compare the HCW generation rate by the type of health facilities. Bivariate (correlation) analysis was used to assess the relationships between independent and dependent variables. Then, multiple linear regression analysis was used to establish the simple correlation matrices between different variables for investigating the strength relationships of the study variables in the analysis.

1.8.1.7.2 The qualitative data analysis phase

Qualitative data from observational and focus group interview was transcribed into word processing and verbatim transcription was used and entered ATLAS. ti 8 software. Different steps were followed. These included organising and preparing the data for analysis by involving the transcribing interviews, optically scanning materials, typing up field notes, analysing all observed material and sorting and arranging the data into different types depending on the sources of information, then reading and looking at all data, this step provides a general picture of the information and an opportunity to reflect on its overall meaning. The process also included coding and organising the data, reading all data, organising, and preparing data for analysis. The analysis as performed separately for each health facility (Creswell 2014, 247).

1.9 RIGOUR

1.9.1 Rigour for the qualitative phase of this study

1.9.1.1 Credibility

To ensure the quality of this study prolonged engagement and persistent observation were practiced to achieve the accurate and truthful practice of the participants lived experience to learn the actual practice of solid health care waste management practice in which it is embedded and to minimise distortions that might creep into the data (Forero, Nahidi, De Costa, Mohsin, Fitzgerald, Gibson, McCarthy & Aboagye-Sarfo 2018: 3).

To ensure the quality of the data, the data collection tools was translated from English to Amharic, considering the ease of understanding for respondents, and will be again translated back to English by a language expert to check the consistency of the meanings.

Interviewer spent more time per site to engage with participants. The open ended interviews were tested in two facilities to ensure the tools are easily understandable by the research participants and data colector.

To ensure the credibility of this study the researcher developed trust with the study participants. By using the FGDs guide the researcher conducted open and deep FGDs. All FGDs and in-depth interviews were conducted by using Amharic language which is the federal government language and transcribed verbatim.

1.9.1.2 Transferability

Transferability is considered a key component in achieving a rigour in qualitative study (Cassell et al 2018: 525). Patricia (2017: 155) cited Lincoln and Guba 1985 transferability is the ability to transfer research findings from the study site to another. To assure transferability of this study the qualitative samples are selected critically that samples are having enough information about the study topics. The

transferability of this study depends on the similarity or fittingness of the context of the study area.

For this study, the researcher was ensured by an appropriate sampling for qualitative study.

1.9.1.3 Dependability

Dependability is the quality of being trustworthy and reliable; it seeks to ensure the findings of this study are repeatable if the inquiry occurred within the same study participants, and within the same context. Cypress 2019 (255) cited Lincoln and Guba (1985) indicating that dependability in qualitative research closely corresponds to the notion of reliability in quantitative research. In this study, dependability was ensured by validity checks, the use of standard interview guides and audio recording of all the interviews.

1.9.1.4 Confirmability

Cypress (2019:255) asserts that confirmability is the ability that the result will be confirmed with the same result if it is done by other researchers. It is also the degree of similarity about the meaning, relevance, and accuracy of the data between two or more researchers. Notes and audio recording were taken during FGDs, and it is compared with transcribed data. Validity checks also helped to ensure confirmability.

1.10 VALIDITY AND RELIABILITY FOR THE QUANTITATIVE PHASE OF THIS STUDY

Quantitative research was evaluated by the two main criterias that are reliability and validity (Leavy, 2017: 113).

1.10.1 Reliability

Reliability may be defined as how the consistency of measurement instrument scores by using the same methods under the same circumstances. To ensure the

reliability of the data and the finding in this research the researcher used a measuring tool that had previously been used by different studies. The data collection tools were the same for all subjects at all times including its constructs (content validity and construct validity) (Kumar et al 2015: 383; WHO 2014: 212; WHO 2017: 315).

Internal consistency of the instrument was ensured by checking the transcripts to ensure that the similarity of the meanings is similar during transcription, making sure that there is no a difference between definition of codes. These were performed by constantly comparing the data with the codes and by writing memos about the codes and their definitions. Cross-checking of codes were performed by the inter coder agreement (Creswell 2014: 252; Creswell & Creswell 2018:202).

1.10.2 Consistency

The researcher conducted the investigation in an ethical manner and ensured that the instruments are administered the same way always they are used under the same conditions with all the subjects. Both the adapted and self-designed questionnaires were pre-tested in a pilot study in other hospitals, health centres and clinics outside the study area, which is not part of this study. The outcomes of the pilot study led to the revision of the instrument in line with the items that was identified for improvement. Training was provided to all data collectors so that they properly understand the research questions, on how to approach the respondent and how to collect the appropriate data.

1.10.3 Validity

Validity is the quality of being based on truth, about the degree to which an instrument or test measures what it is expected to measure (Sampson 2017: 39). External validity and internal validity are the two major components of research design. To ensure internal validity in this research, the data collection tools were prepared to answer the research objectives. External validity was maintained by involving all health facilities and health facility workers who have direct contact on handling and management of HCW found in the town.

For this study, all observational checklists and questionnaires are logically related to the variables to be measured. In addition, standardisation of the measuring tools was assisting to improve the validity of the study. This study used an instrument that were pretested in the other health facilities and the weight scale that are used to measure the weight of the generated wastes are checked twice a day by using the well-known weight was helped to improve the validity of the study.

1.11 ETHICAL CONSIDERATIONS

1.11.1 Ethical considerations related to data collection

1.11.1.1 The institution

The researcher obtained ethical approval and permission to conduct this study from three organisations including the department of health studies' scientific review and the department of health studies: Research Ethics Committee, University of South Africa (UNISA), Hadiya zone health department and health facilities. The researcher assured all the health facilities managers that the confidentiality of the participants and the health facilities information would always be respected and secured all the time.

1.11.1.2 The participants/respondents

All study participants were informed about the data collection procedures and the beneficence of the study. The interview was conducted after obtaining their verbal consent. Participation in this study was voluntary, and they were informed not to participate in this study if they wished to do so (Creswell & Plano 2018: 488). Prior to collecting the actual data, a briefing was given to the participants about the aim and purpose of this study, and those who volunteered to participate in this study were asked to give oral consent. In addition to this:

1. Study participants were informed of ensuring no names of individuals and health care facilities were mentioned in the study to ensure anonymity.

2. Participants were informed that all the data collected are in an anonymous manner and accessed only by the researcher and the supervisors.
3. The researcher was assured all the health facility workers and managers that the confidentiality of the study participants and health facilities would always be respected throughout the study.

1.12 SCOPE OF THE STUDY

The scope of this study was to develop guidelines for SHCWM practice in Ethiopia.

1.13 STRUCTURE OF THE THESIS

The thesis consists of six chapters.

Chapter 1 provides orientation of the study, and defines the research problem, purpose of the study, objectives, and methodologies.

Chapter 2 presents a literature review on HCW management practice and guidelines development and provides a theoretical framework suitable for this study which has been adopted as the theoretical and conceptual foundation of the study.

Chapter 3 outlines the theoretical framework and the research design and method used in this study.

Chapter 4 focused on the findings of this study, data analysis and discussions of the findings.

Chapter 5 presents SHCWM guidelines development process and guideline evaluation results

Chapter 6 Presents the summary, conclusion, and recommendation of this study.

1.14 SUMMARY

Globally HCWM system is a major public health issues specially in developing counties including Ethiopia because of the little attention given for HCWMP and health facilities do not meet the minimum standards of waste management required for the proper handling of HCWs. This chapter presented the orientation of the study, and the next chapter presented the literature review.

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

To understand the current SHCWM practice and the availability of relevant policies and its application regarding SHCWM, a literature search was conducted based on the objectives of this study.

2.2 THE GLOBAL CONTEXT OF SHCWM

Waste is generated by human activity; everyone creates it, but some peoples and organisations want to think about the consequence (Martin, et al. 2017: 349). Globally, waste management is one of the leading priority concerns for the environment and human beings. Since the beginning of civilisation, the environment has been used as a sink for all wastes produced by human being. The impact of environmental pollutions caused by solid waste is one of the greatest concerns for the globe (Kumar 2016: 1).

As the number of human population and technological advancements increased over time, the waste generation and composition are correspondingly increased in the level and a need for more viable solutions (Bello, Ismail, & Kabbashi 2016: 2).

2.3 WASTE GENERATED FROM HEALTH CARE FACILITIES

Wastes from health care facilities were subdivided greatly into infectious and non-infectious waste. Sharp, pathological, pharmaceutical waste, radioactive, hazardous chemical, and general waste. Infectious solid waste is a waste contaminated with blood or other body fluids, wastes from isolation wards and waste residue from cultures. Hazardous chemical waste includes disinfectants toxic metals such as mercury, halogenated and non-halogenated solvents, and other organic and inorganic chemicals (Eyup 2018: 168, 176; WHO, 2014: 21).

Globally, infectious waste is produced mainly by health institutions. This poses enormous environmental and public health challenges (Caniato, Tudor & Vaccari 2015:99-101; Hua, Hu-Chen, Ping & Xue-Guo 2017:509,512). It is also complex to manage properly because of its composition, variety and potentially infectious to health, safety and toxicity and hazards of its components, if it is not properly managed (Adekunle, Romona & Andrew 2018: 137,141; Anoushiravan, Monireh, Mohammad, et al. 2019: 277,279).

HCW is one of the most of great significant environmental and public health problems around the world (Wafik, Mariam, Mahid & Habib 2014: 21). Its management is not only in terms of safeguarding human health, but also from an environmental, social, and economic point of view (Binaya, Gopal, Dhiraj & Nirmal 2015: 62; Caniato, Tudor & Vaccari 2015: 98,100; Dolores, Ana, Lopez, Miguel & Amaya 2018: 52).

Countries around the world have different HCW management practices, because of various factors like socio-economic, culture, rules and regulations, educational background of the people, the availability of treatment technologies, monitoring, and evaluation of the activity (Caniato et al. 2015: 93).

2.4 INFECTIOUS AND NON-INFECTIOUS SHCWM PRACTICE AROUND THE WORLD

Infectious HCW has the second most dangerous waste world-wide, and it should be managed properly by well-trained persons or institutions. Designing continuous education and training programmes will increase the level of understanding, and practice for health facility staff; this will help in making less severe the chance of inappropriate disposal of infectious waste (Khan, Cheng, Khan & Ahmed 2019: 868).

Exposure to hazardous cytotoxic drug wastes are mutagens, carcinogens and teratogens to nurses, pharmacists, and waste handlers. A study conducted in Germany reveals spontaneous abortion and mutagenicity observed in hospital-based studies of oncology nurses (Tabash, Rim, Mahmoud, Elborgy & Abu-Hamad 2018: 429).

Safe management of HCW has become a global concern. The WHO estimates that 10-25% of SHCWs are hazardous. However, this proportion varies from country to country, and it ranges from 16% to 75% (Yazie, Tebeje & Chufa 2019: 1).

2.5 GLOBAL CHALLENGES ASSOCIATED WITH SOLID HCW

Zaman and Ahsan (2020) cited Hoornweg (2012), indicating that the global waste generation rate has increased, and it is expected to continue to increase in the future. The world cities according to the World Bank studies generate 1.3 billion tons of SW each year and the volume is expected to increase to 2.2 billion tonnes by 2025. The study also found that developing countries only collect around 41% of the waste generated, and the rest, 59%, remains uncollected at the points of generation (Zaman & Ahsan 2020: 1).

In the past few years, on a global basis, the public and organisation concern about HCW management has increased considerably. But inadequate management practices were implemented because of ambiguous understandings of the risks and consequences (Fawaz, Ganesh, Sabin & Anna 2016: 31).

The local communities around the world are affected by substandard, illegal, and outdated SHCWM and disposal systems, from industrialised countries (Fazzo, Minichilli, Santoro, et al. 2017: 2).

More than thirty tons of medical waste are generated each day in metropolitan cities around the world. It is deadly dangerous that most of the health facilities, especially government-owned facilities, are not properly managing the generated waste. HCW handling and management rules are not properly followed. Both domestic and infectious wastes are disposed of together. Most of the health facilities used open disposal of all kinds of waste without complying with the rules and regulations (Manzoor & Sharma 2019: 311).

2.6 ADVERSE CONDITIONS ASSOCIATED WITH IMPROPER SHCWM

Nosocomial or health-care-associated (HCAI) infections are a subset of infectious diseases acquired in a health-care facility. HCAIs are infections that are not present in the patient at the time of admission to a healthcare facility but developed during the course of the patient's stay and are the fastest-growing problems at every level of the health care system in the universe.

According to the WHO estimation, hundreds of millions of populations in the world are affected by nosocomial infections and it is a major global issue for patient and public health safety (Yallew, Kumie & Yehuala 2017: 2; WHO 2014: 195).

Inappropriate handling of HCWs is a health hazard of global importance (Farooq, Omar, Shahid, et al. 2017: 1). It affects patients and health care workers but also have affected the general population, foetuses in the wombs of mothers, scavengers, and sanitary personnel handling wastes (Banstola et al. 2017: 47; Angus, Callistus, David, et al. 2016: 84; Sudhir et al. 2015: 2-13).

Epidemiological studies of different literature show that communities residing near HCW disposal sites in the United Kingdom were found to be at increased risk of adverse health effects such as certain forms of cancer, low birth weight, birth defects, fever, headache, irritation in the eyes, itching, skin infection, accidental injury from sharp materials, the difficulty of breathing owing to smoke from waste disposal sites, bad smell and children's exposure with contaminated needles (Karki & Niraula 2020: 2; Yazie et al. 2019: 1).

2.7 EFFECTS OF IMPROPER DISPOSAL OF SOLID HCW ON THE WORK ENVIRONMENT

Environmental pollution related health problems are not only a problem in industrialised and developed countries such as the United States of America (USA). The burning of HCW generated at every health institution produces greenhouse gasses that contribute to photochemical ozone depletion and global warming, smog formation and eutrophication (Ghersin, Flahery, Yager & Cummings 2020: 99;

Manzoor & Sharma 2019: 326). Carbon dioxide (CO_2) is the most abundant greenhouse gases produced during the incomplete burning of HCWs. Such practice can pollute the ambient air and has a significant effect and increase the rate of heart attack and pulmonary disease linked to pollution (Ghersin et al. 2020: 99).

Globally, over 16 million injections were administered, and as a result of this, fully loaded harmful microorganisms are generated together with sharp waste (Kumar, Somrongthong, Ahmed 2016: 706; Manzoor & Sharma 2019: 314). Inadequate care of these waste exposes health facility workers and the community to occupational injuries and transmission of disease. In the USA over 385,000 health workers are injured by sharp objects contaminated with blood and other body fluid (Marsum, Anies, Bagoes, Widjanarko & Wahyuningsih 2020: 663).

2.8 INFECTIOUS AND NON-INFECTIOUS SOLID WASTE GENERATION RATE AND HEALTH EFFECTS

The WHO repeatedly states in different reports that the majority (75-90%) of the SW generated at health institution is similar to household wastes we call non-infectious waste or general waste. The rest (10-25%) are representing a higher risk to health. This includes infectious waste among which are body part wastes, sharps waste, chemical or pharmaceutical waste, broken thermometers, and radioactive and cytotoxic waste (WHO 2014: 3).

This small part of HCW can pose public health and environmental risks if it is not managed or disposed of in a proper way (Meleko, Tesfaye & Henok 2018: 126; Mohammad & Habibur 2018: 9; Onoh 2018: 56). Improperly managed solid HCW is acting as a favourable media for potentially dangerous medically important vectors like flies, mosquitoes and posing life-threatening health effects, socio-development health effects, and local ecology adversely (Naresh, Narsi, Subhash & Ashok 2018: 35).

Infectious solid HCW can be a source for cross contamination of infectious diseases like hepatitis B, HIV/AIDS, hepatitis C, diarrhoea, tetanus, cholera, tuberculosis, infertility, genital deformities, mutagenicity, hormonally triggered cancers, low birth weight at birth, birth defects, asthma, dermatitis, typhoid, neurological disorders in children, and other viral infections through sharps contaminated with blood (Hussein & Mona 2018: 1278; Manzoor & Sharma 2019: 326; WHO 2015: 10).

The largest parts of hazardous HCW generated at health institutions are potentially infectious (WHO 2014: 107). Selecting the appropriate treatment technology for infectious HCW is a very tough decision-making process for health managers and policy-makers because of conflicting environmental, socio-economic and political decisions (Hua et al. 2017: 508).

Owing to this many people and most organisations did not arrange treatment facilities for infectious wastes to cope with environmental protection and preservation measures (Hussein & Mona 2018: 1278). This is because of poor segregation practice, inappropriate transportation mechanisms, shortage of trained human power, lack of appropriate PPE, insufficient funds available, and poorly available training are the bottleneck for the improper management of SHCWM practice (Manzoor & Sharma 2019: 315).

The rapid growth of institutions that provide medical services world-wide together with the increment of utilising single use medical supplies has contributed to large amounts of HCWs generation. Inappropriate and poor management of medical waste causes pollution of the surrounding environment, unpleasant smell, a chance for multiplication and growth of rodents and medically important insects, and worms may load a burden on the community and lead to transmission of diseases like intestinal disorders, bloodborne pathogens and injury from sharp contaminated with blood and other body fluids. Self-reported health symptoms among residents living near medical waste disposal sites include more sleepiness, fatigue, and headaches (Manzoor & Sharma 2019: 312,317).

2.9 ADVERSE HEALTH EFFECTS OF IMPROPER SHCWM

WHO in 2014 states, that health care waste containing mercury can cause impaired vision and hearing, emotional instability, paralysis, sleeping disorder, developmental delays and developmental deficits during foetal development, and attention deficit are some of the adverse health effects of mercury exposure. It is one of the dangerous chemicals released into the atmosphere from health care facilities. According to the USA, Environmental Protection Agency's estimation, solid health facility waste contributes 10% of mercury release to the atmosphere in a different form (WHO 2014: 28).

Polyvinyl chlorides (PVC) are the main chemicals used to fabricate medical products, reducing the amount of this chemical is a challenging task. As a result, manufacturers should be responsible to substitute PVCs with other less or non-hazardous materials (Elliott & Marianne 2015: 105).

2.10 CURRENT SHCWM METHODS AND TECHNOLOGIES

The majorities of solid HCWs end up either in landfills or incinerated. In the USA, 75-100% of solid medical wastes are incinerated (Vanberkel & Moayed 2017: 132). Open burning and poorly constructed incinerators are the major sources of black carbon emission or smoke released into the atmosphere. Black carbon emissions (BC), dust, ammonia, sulphate, and nitrate are the biggest cause of climate change and a threat to life on earth. SHCW is a major source of black carbon emissions or darker smoke released into the atmosphere due to the incomplete combustion. This may increase cardiovascular and respiratory mortality and morbidity, immune, neurological disorders, lung, and kidney disease (WHO 2014: 31). The use of and the burning of plastics containing chemicals in health care industry on a global scale must be stopped immediately with better policies in place (Manzoor & Sharma 2019: 324; Raila & Anderson 2017: 424).

Most of the HCW treatment technologies commonly discussed in the literature are superheated steam, plasma pyrolysis, thermal, ozone, irradiative, and mechanical (WHO 2014: 194). Integrated thermal plants, combustion, anaerobic mechanical-biological treatments; aerobic mechanical-biological treatments, gasification, used for the treatment (Rada 2016: 4) are available on the market. Choosing the above technologies depends on the type of waste generated, the capacity of the health care facility, the rule, and regulations, and the enforcement ability of the locality. Most of the solid health care waste management technologies have no recorded demonstrable evidence and new HCWM technologies should be evaluated critically before selecting to use (WHO 2014: 194).

2.11 SOLID HCW INCINERATION PRACTICE

In the 19th and 20th centuries incineration of waste by using an incinerator are the most common method of waste disposal. In the 20thcentury, landfill becomes another option. Land air and water pollution are the serious problems of incineration and landfilling of solid waste management techniques around the urban waste management plants (Rada 2016: 1).

Treating infectious HCWs is much more costly than non-infectious HCWs. An appropriate segregation practice at the source of generation can reduce the number of wastes classified as infectious/hazardous and as well as minimise the cost of treatment (Nguyen 2016: 36). Ata, Kamyar, Mohammad, & et al. (2016) in their study of assessment and selection of the best treatment alternative for infectious waste by modified sustainability assessment of technologies methodology, concluded that different countries select different kinds of HCW treatment technologies. Most of the existing HCW treatment technologies limitations are only mathematical models without focusing the sustainability concept.

HCW incinerators found in most of the health facilities are not the final disposal mechanism of waste management. The incinerator does not eliminate all toxic substances; the burning of wastes minimises the volume but does not eliminate the health hazards which are toxic chemicals that are out after incineration. Lead, mercury and cadmium are some of the basic elements of the heavy metals that are

concentrated and do not disappear from ash after the incineration practice. Out of the waste that is incinerated into the incinerator, 30% of them remains as ash at the end of the incineration process (Alili, Krstev, Krstev, Stamenov & Stoilov 2018: 281). Mercury amalgam, silver, tin, copper, and zinc batteries, metals, and the residue of materials had been used in dental clinics since 200 years ago. The most important service areas that used and discharge mercury wastes to the environment are dental clinics. The effects of many of these materials on public health are still not known well (Momeni, Farad & Arefinejad 2018: 52).

2.13 SANITARY LANDFILL PRACTICE OF SHCW

Sanitary landfill for HCW management technique is the cheapest disposal method (Hussein & Mona 2018: 1288). But disposal of HCW into burial in a landfill site may pose infection and other health problems to workers and the public. The risk may be difficult to quantify, and the most problems are direct contact with waste items, disease-causing pathogens, and leachate may be released to groundwater sources, and surface water streams (WHO 2014: 194).

The negative impact of leachate from waste disposal sites is polluting the groundwater with different pollutants and a study shows the heavy metals leaching into the groundwater were exceeding the drinking water standards (Manzoor & Sharma 2019: 319). The carefully planned sanitary landfill can still offer serious problems for the environmental qualities of the surroundings. The composition of the gases and leachates generated during biodegradation varies primarily according to the availability of oxygen which can change abruptly according to many factors difficult to control (Fuller & Warrick 2018: 5).

A study conducted by Adama, Esena, Fosu-Mensah, & Yirenya-Tawiah 2016: 1,4) shows the bottom ash after incineration of medical waste at dumpsite was studied and a high concentration of mg/kg for, Pb (143.80), Zn (16417.69), Cd (7.54) and Cr (99.30), and organic pollutants such as furans and polychlorinated dioxins. Dioxins and furans are toxic at a very small concentration (WHO 2014: 20).

This concentration was above the allowable limits for disposal in any disposal facility because of the incomplete burning of metallic components of the waste.

These metals can leach and percolate into groundwater or be carried through run-offs, inhaled in dust from both the incinerator site and final disposal plants and bioaccumulate in plants and animals that live near the dumpsite (WHO 2014: 297). Irritating, oxidising, corrosive and flammability are other properties of HCW (Yordanova, Angelova, Kyoseva & Dombalov 2014: 185). Both smoke and ashes should be controlled by using air pollution control devices (Dehghania, Ahramia, Nabizadeha, Heidarinejadd & Zarei 2019: 732).

Laboratory analysis of HCW ash after incineration shows chloride and hardness content in leachate were increased above the permissible level of WHO and Environmental Protection Agency guidelines. The chemistry and biology of the soil ecosystem also changed. Polyvinyl chloride containing medical supplies was the main source of these heavy metals in the incinerated ash (Manzoor & Sharma 2019: 320,321,325).

Combustion, pyrolysis, and gasification are some of the thermal methods of solid waste management technologies that are commonly used for simultaneous waste management and recovery. Even though with the presence of some environmental concerns raised combustion, pyrolysis, and gasification were successfully used as a pilot scale. Pyrolysis has a few short comings compared to the other waste management technologies that need to consider for efficient/sustainable energy recovery using this technology. Liquid and gaseous products are complex, and it may use wastes which are recyclable. Likewise, the process may utilise the organic part of the waste which otherwise could be used for other highly sustainable processes such as composting. Furthermore, the requirement for high temperature could be another disadvantage of the pyrolysis process. For example, a plasma pyrolysis process may require a temperature between 5000-14,000°C. Equally, the gasification of waste for energy recovery has also some issues regarding its sustainability. Firstly, the process may not have very high carbon sequestration efficiency as carbon dioxide may be released. Similarly, during the process, toxic

substances such as heavy metals and halogens could be released into the environment (Albanese & Ruiz 2016: 4).

The waste volume generated, and the type of waste generated are to be studied before deciding to use any solid waste treatment technologies because different types of HCW should have to be managed and handled differently (Ghasemi& Yusuff 2016: 18). Improper management of HCW affects the environment in terms of water pollution, air pollution, and land pollution. This may be the chance of causing infectious disease (Fawaz et al. 2016: 33; Sudhir et al. 2015: 13; Tulu 2014: 134).

2.14 HEALTH AND ENVIRONMENTAL EFFECTS OF IMPROPER SHCWM

As Manzoor and Sharma (2019: 313) assert, the current waste management practice is not only damaging the economy of the country but also it is responsible for exposing health facility workers, patients, attendants, and people's those living near to health facilities, and HCW disposal sites. In addition to disease causing microorganisms, heavy metals found in the waste are causing huge health defects. Most of the heavy metals and polycyclic aromatic hydrocarbons (PAHs) end up in soil and are leach to the groundwater and surface water.

The nonbiodegradable nature of heavy metals accumulates in the environment and aquatic animals are causing difficulties to avail cost-effective and environmentally sound waste management technologies (Manzoor & Sharma 2019: 313).

Manzoor and Sharma (2019) cited (Eckelman & Sherman) (2016) who aver that health sectors' waste disposal emission is responsible for greenhouse gas, air pollutants, acid rain, smog formation, stratospheric ozone depletion, and carcinogenic and non-carcinogenic air pollutants released all over the world (Manzoor & Sharma 2019: 313,324). Fires used for burning the waste may be out of control and may harm the nearby properties (WHO 2014: 31). Chemical particulates are found in concentration during the summer than the moon soon period. The health effects of these pollutants are 47,000 disability-adjusted life years (DALYs). In

America, health care contributes 8% of the total greenhouse gas emissions, and this should not be neglected (Manzoor & Sharma 2019: 313,324).

However, if incineration is the only choice for disposal of HCWs, improperly constructed and low-temperature incinerators and open burning methods should be banned by environmental authorities and standard incinerators should be managed properly and continuously monitoring and maintenance should be done periodically (WHO 2014: 120).

2.15 SHCWM TRAINING

According to Manzoor and Sharma (2019) cited by Frank et al. (2009: 259), occupational safety training is an important parameter for appropriate HCW management, but staff do not receive HCW management and occupational safety training and how to properly utilise personal protective equipment. Studies further argue that the absence of continuous capacity-building training for health facility workers and the absence of vaccination is an obstacle to manage emergency spillages and needle stick injuries (Manzoor & Sharma 2019: 334).

Nurses and housekeepers are the most exposed and at the high-risk group of workers in any health care facilities for solid waste injuries. Bloodborne pathogens were acquired from sharps, blades and recapping of needles (Mattoo, Hameed & Buttu 2019: 188). The annual injury rates for nurses and housekeepers in the USA were 10-20 per 1000 workers. Among all workers, the highest range of injury rates reported was 180 per 1000 population (WHO 2014: 33).

Risks of waste can generally be classified as occupational, environmental, legal, political, social, and economic. Sometimes there are multiple, related risks, such as the burning of regulated chemical waste in a municipal incinerator, which is not only illegal but may result in an explosion and the production of toxic ash or off-gases (Reinhardt & Gordon 2018: 7).

Solid HCW contains disease-causing pathogens like bacteria, viruses, parasites, fungi, and actinomycetes. Some of them can infect humans directly from the air and

others can infect foods and humans after landing on crops. Contaminated water resulting from leachate can enter into drinking water and food poses the most significant health risk to humans. The potential environmental hazard and public health risks, minimising the generation rate, substituting with fewer amounts of waste, proper segregation, collection, transfer, disposal site selection, disposal plant construction, and selecting the appropriate treatment technology for the management of waste is a complex issue (Epstin 2015: 6; Wafik et al 2014: 21; Hua et al 2017: 508).

Bulk generation and disposal of waste have become a worldwide environmental and public health problem. Advanced mechanical recycling or thermal treatments to recycle plastic solid waste helps to avoid the landfilling process (Albanese & Ruize 2016: 1).

Globally, the HCW management issue never received much attention as much as other development agendas because of the more financial sustainability, legal acceptability, technical feasibility, and environmentally friendly technology (Hussein et al. 2018: 1278). Knowledge attitude and practice about the seriousness of harm from HCW has now become more responsible to governments, medical practitioners, and civil societies (WHO 2014: 1).

2.16 KNOWLEDGE AND PRACTICE OF HEALTH FACILITY WORKERS ON SHCWM

Theoretical knowledge is essential for solid waste management practice. A study conducted by Matto et al. (2019: 188) reveals that doctors have more theoretical knowledge than practice and nurses have more practical knowledge than doctors. Therefore, regular on the job training is essential for health workers to have appropriate solid waste management practices. Research shows that knowledge has a positive correlation with attitude and practice. Training plays an important role in enhancing the knowledge and practice of HCW management practice (Reddy & Shammari 2017: 640).

The knowledge of HCW management was not given much attention by the health care institution administrators and the staff involved in waste management (Banstola et al 2017:47; Samuel & Mathew 2019: 43). Owing to these reasons, HCW generated at health institutions is inappropriately managed and treated as household waste (Hangulu & Akintola 2017: 1). Training of the healthcare workers (Khan et al. 2016: 41) employees; lack of knowledge and commitment in relation to HCW segregation practice has a clear impact on better management of the HCW (Hangulu & Akintola 2017: 5; Krishnaveni 2018: 68; Lourdes et al 2018: 567). Regular refreshment and on-job training, availing HCW management guidelines, availing audio-visual materials and the availability of three bin systems are mandatory for effective management of waste (Deress, Hassen, Adane, & Tsegaye 2018: 8).

Health facilities that have no comprehensive waste management system end up spreading infections into the staff, patient and the nearby community. To avert this, they require a committed and sound administration, waste management personnel's, good legislation, sound planning, adequate finances, and complete participation of trained staff (Rida, Sadiq, Hussain & Rehman 2019: 72).

2.17 NON-INFECTIOUS WASTE PRODUCTION AND MANAGEMENT

WHO (2017: 21) forwarded that all HCW management practice should be properly planned, practiced and the activity should be monitored at the health facility level, zonal, regional, and national levels. The existing HCWM practice should be evaluated properly before developing a functional plan and before beginning any SWM activity.

Safe HCW management is fundamental for the provision of effective, quality, people-centred care, protecting patient and staff safety, and protecting the environment (WHO 2017: 21).

If it is properly managed, most studies report that general waste from health care facilities has no risk to the environment as well as to the waste handlers, but a study conducted by Rishav, Nilanjana, Risheen and Sumanta (2018: 14) on the topic of waste management among health care personnel in a rural tertiary care hospital of

Darjeeling District, West Bengal, India states that general wastes can also cause health problems like scavenging by animals and rag pickers, air pollution, water pollution.

Leftover foods and other food wastes are currently growing in the HCW management field.

Food waste production in the health facilities impacts negatively on environmental and socio-economic levels. From an environmental point of view, left over foods contributes to greenhouse gas emissions during final disposal on landfill and during activities associated with food production, processing, manufacturing, transportation, storage, and distribution. Food waste generated at hospitals is classified as general or non-hazardous waste, but its production has impacts on environmental, social, and economic levels. (Rada 2015: 4,9; Rada 2016: 5).

2.18 SOLID HCW SEGREGATION PRACTICE

Solid waste generated at any health care facility has a higher chance of infection and injury than other types of waste (Pullishery, Panchmal, Siddique & Abraham 2016: 30, 33; Ravishekar, Shailaja, Sumeena, et al., 2016: 64). Nosocomial infections owing to accidental exposure to blood and anybody fluid present a series of public health problems, especially for health care workers and it is a risk of acquiring blood-borne diseases. Most of the nosocomial infections are preventable through appropriate waste management practice, strong compliance with utilisation of personal protective equipment, immunisation, and post-exposure prophylaxis (Ngwa, Ngoh & Samuel 2018: 1). More importantly, using personal protective equipment (PPEs) such as masks, gloves, shoes, and clinical coats, helps to minimise exposure to infections and injuries (Wafula, Musiime & Oporia 2019: 8).

The WHO /UNICEF released a new global data in 2019 and there is no or very limited safe management practice of HCW in a large proportion of health facilities. The data shows over 40% of countries do not segregate wastes properly in the least developed countries. The situation is far worse with 27% of the countries having basic services (WHO 2019: 1).

Segregation of wastes by using colour-coded bins like black for non-infectious or general waste, and yellow for infectious waste are internationally accepted all over the world (WHO 2014: 78; Anita et al. 2016: 2; WHO 2017: 6) but the difference observed in some countries like Vietnam, ‘‘solid health care waste is put into special yellow plastic bags marked with the biohazard symbol. Chemical and radioactive waste is stored in special black plastic bags with labels indicating the source. Green bags are used for general waste’’ (Nguyen 2016: 354). Despite the inadequate supply of colour-coded containers and low commitment of health care workers are prominent everywhere in Ethiopia (Berihun & Solomon 2017: 6).

Health care workers and other individuals who are in close proximity to HCW disposal sites are at risk of acquiring infection and occupational injury and disability (Ganesh, Masita & Saraswathy 2018: 246). The impact of this problem may be temporal or lifelong to death (Kontogianni & Moussiopoulos 2017: 193). Another adverse impact also that attracts human scavengers, rodents and vector insects which provide food and shelter, bad odour, and are aesthetically unsightly.

2.19 VARIOUS COUNTRY’S WASTE MANAGEMENT PRACTICE

The increasing amounts of solid waste generated in developing countries are a major issue affecting the health care system. The rapid growth of industrialisation, urbanisation, population rise, and elevated standards of living are directly related to HCW generation in developing countries (Meylan, Lai, Hensley, Stauffacher & Krutli 2018: 35792).

According to WHO (2014: 194) explanations, SHCW disposal options in developing countries are limited. Therefore, small-scale incinerators and open burials have been used as a disposal options. The WHO assessment in 2002 shows 18% to 64% of health care facilities dispose of medical wastes improperly (WHO 2014: 194).

Today the world is suffering from the soil, air, and water pollution and these are the largest environmental causes of disease. Developing countries are th e most disproportionately affected region and the effects of the pollution on the health status

of human beings are mostly seen (Zelda, Michael, Phoebe & Brian 2020: 99). Improper and careless management is still rampant and created environmental problems. Studies have reported that, in developing countries, medical wastes are mixed with municipal waste posing a risk of a serious and significant threat to both the health of the handler and the environment (Khan, Cheng, Khan & Ahmed 2019: 863; Yazie, Tebeje & Chufa 2019: 1).

More than 75 % of the hazardous wastes generated at health facilities have been left untreated. Lack of regulation, clear definition, limited data availability, and poor coordination were the challenges (Caniato et al. 2016: 386). In most of the health care facilities, waste generation data were not properly recorded, and a well-planned HCW management system is highly dependent on the generation of the data (Khan et al. 2019: 867).

In developing countries, solid HCW disposal methods are open burning in the open air mixed and combined with municipal solid wastes. Illegal recycling and resold are a long year experience performed daily (Khan et al. 2019: 864). Waste recyclers are the most exposed group of people than the general population owing to the increased risk of direct exposure to disease-causing pathogens, chemicals and radiation (Kistan, Ntlebi, Made, et al. 2020: 2).

The WHO states that in the developing countries, the data on health impacts of improper solid waste disposal were very few, and half of the developing countries are at risk from environmental, occupational, and public health exposure to public health (WHO 2014: 35).

Health facility acquired infections are the leading causes of death among hospitalised patients in developing countries. Around 15% of patients will develop the infection. An unsafe environment and poor HCW management methods are attributed to 60-80 % of healthcare-acquired infections (Anderson, Cronk, Best, et al. 2020: 1).

Studies among healthcare workers in Malaysia showed that healthcare workers were at risk of sharp injuries while giving care to patients, giving an injection, blood

collection, and intravenous cannula insertion (Ganesh et al. 2018: 248). Little emphasis is given to the risk of injuries to health facilities workers during the performance of their daily duties owing to negligence, not adhering to safety policies, nor complying with the standard during segregation of medical waste, especially sharps (Reama, Tipplea, Salgadoa & Souza 2016: 273).

In most developing countries, open burning of medical waste in a pit is still common (Emillia, Julius & Gabriel 2015: 253). Open burning of solid health care waste generated at health care facilities creates different health and environmental problems such as emitting toxic chemicals into the air and toxic ash residues which are major sources of dangerous chemicals (Singhal, Tuli & Gautam 2017: 197). The negative effect of these chemicals has become a threat to the community and staff of the health care organisation that government should enforce on policy reform and application (Agbiji & Landman 2014: 10).

Small clinics are generated more hazardous waste than big hospitals by 20%. This difference was observed because of the extended average length of stay at the hospital which generate more general waste than infectious. Small clinics did not completely meet the standard criteria of waste management rules. The absence of appropriate segregation, collection, storage, transportation, and disposal was common problem in developing countries (Khan et al. 2019: 868). Little knowledge of clinic staff was mainly the cause for violating the waste management rules (Lourdes et al. 2018: 560).

2.20 SOLID HCW MANAGEMENT PRACTICE IN AFRICA

HCW management is an environmental and public health issues around the world particularly in developing countries. Infectious waste disposal affects all individuals' particularly health care providers (Yazie et al. 2019: 4). In most of African countries, HCW final disposal and treatment facilities are inadequate or substandard. This is owing to lack of enough capacity not only limited to adequate finance but also in technological and infrastructural advancement (Ibrahim, Muhamad & Nassereldeen 2016:3). It is, therefore, mandatory to enforce special legislative and regulatory

measures to help manage the often-dangerous nature of HCW (Kidane Fiseha, Mohammed & Linda 2018: 73).

Improper disposal of HCW left out is scattered by wind, children, animals, and waste pickers. Most of this waste actually ends up in the environment (Helelo, Senbeta, Anshebo 2019: 1081; Popoola, Ayangbile, Adeleye. 2016: 676). Air pollution, bad odour and flies breeding are considerable nuisance if the collection time delays. Flies carry pathogens from the waste and put them on food item; finally transmitting disease to human being. Flooding also results from clogging of the drainage line. Timely collection of waste should be done especially in hot climate to control fly breeding (Popoola, Ayangbile, Adeleye 2016: 676).

Infectious waste mismanagement affects all individuals. This is probably owing to lack of awareness, lack of appropriate waste segregation containers, lack of enforcing laws and regulations. In Africa, 47% of the studies indicates there are problems of waste segregation. This could be owing to the fact that a small portion of infectious waste may be added to non-infectious waste container, then all the infectious waste may be unnecessarily contaminated (Yazie, Tebeje & Chufa 2019: 4,5).

The presence of infectious agent, a cytotoxic and genotoxic chemicals composition, the presence of biologically aggressive pharmaceuticals, toxic and hazardous chemicals, and the presence of radioactive and sharp materials are the hazardous nature of HCW affecting the developing countries. All health facility workers coming into close proximity of hazardous waste are exposed to the consequence of waste (WHO 2015: 14).

According to the WHO estimation, in Africa, one-third of the burden of disease is attributable to environmental pollution. Africa is one of the trades and final illegal disposal region for trans boundary hazardous and industrialised waste disposal. Less than 20% of the hazardous waste end up in sanitary land fill and the rest are disposed everywhere improperly (Fazzo et al. 2017: 2). The leachates from sanitary landfills are responsible for contamination of ground and surface water. In a developing country, about 80% of the disease-causing deaths such as cholera,

bacillary dysentery, typhoid fever, infectious hepatitis, leptospirosis, amoebic dysentery, gastroenteritis, cryptosporidiosis and bacillary dysentery are contracted through consumption of polluted water by contaminated waste (Eze, Nwagwe, Ogbuene & Eze 2017: 98).

The fastest growing population, rapid urbanisation leads to the increasing number of health facilities (Hussein etal. 2018: 1287). The use of out-dated and inappropriate techniques in developing countries the decision makers are faced a new challenge in solid waste management (Vikas & Ramesh 2015: 82). Solid waste management practices are the major problems facing the sub-Sahara Africa (SSA) countries. Most cities and towns in this region spent quarter to half of their environmental budget for solid waste management including SHCWM practices (Orhorhoro & Oghghorie 2019: 1729).

In developing countries HCWM is the main challenges of health care facilities and other concerned bodies, because of weak HCWM legislation, and law enforcements, lack of awareness and limited resources. These include financial resources resulting in inefficient waste management in many African countries, with the potential to directly impact human health and the environment. To establish successful HCW management practice in Africa, it will rely heavily on environmental governance including policy, private public participation, attitudinal change of the community and health facility workers, and behaviour of the people (Kidane et al. 2018: 3).

According to a study conducted by Jean Gerard Tatou in Cameron, the author concluded that HCW management issue never mentioned during the health care training programme at college and university. He believes that the best way to achieve best HCW management is to include the issue in health training curriculum. Health worker's awareness about HCW management knowledge will be better raised and the practice also increased (Jean 2014: 2).

Open burning and incineration with barrel and brick incinerator is the most preferred method of infectious and hazardous waste disposal methods in Africa, but the major challenge is incinerators are made locally and incomplete combustion releases toxic

gases to the environment (Adesina, Sonibare, Diagboya, Adeniran, Yusuf 2018: 275).

Incineration and autoclaving treatment methods of SHCWMP have drawbacks, atmospheric air pollution due to the emission of incomplete burning causes adverse effect for health and the environment created by the incinerator and autoclave treatment are not suited for all kinds of SW (Elliott & Marianne 2015: 106). Therefore, selecting the appropriate incineration sites is an important element for the hazardous materials owing to environmental, economic and social effects.

Emissions of pollutants to the atmosphere impose risks to people both continuously and randomly (Berihun et al. 2017). In developing countries, people living near to the solid waste management sites are exposed to many dioxins and furans (Elliott et al. 2015: 104).

2.21 CHALLENGES ASSOCIATED WITH SHCWM PRACTICE IN ETHIOPIA

HCW management practice in Ethiopia is not much different from other African counties. A study conducted in Sidama zone SNNPRS shows that 35% of the studied institutions collect sharp wastes in a manner that exposes the workers and people to needle stick injury and blood borne pathogens. According to Meleko et al. (2018) cited WHO (2007), the problem of sharp waste management is global problem and the WHO estimates around 23 million infections occurred owing to improper HCW management (Meleko, Tesfaye & Henok 2018: 126).

Segregation of waste according to the WHO recommendation is essential for appropriate waste management practice. HCWMP Effectiveness and efficiency is a major problem worldwide and has been identified as a particular problem for developing countries. Studies revealed that HCW segregation practice at source in Ethiopia is poor and inadequate. Little interest was observed from the health facility administration to improve HCW management practice (Olaifaac, Govenderb, & Rossc 2018: 137).

The best way to control the impact of HCW is to generate less (Elliott & Marianne 2015: 106). Minimisation or substitution with less waste and generation, segregation, transportation, storage, treatment, and disposal are important parts of a waste management operation (Maryam & Rosnah 2016: 23). According to a study conducted in Addis Ababa, hospitals waste management steps were not properly practised by all the hospitals surveyed (Tadesse & Kumie 2014: 12).

Infectious waste generation rate in the Ethiopian health facilities is 21-70% this is unacceptably high, and its management are poor. Lack of accessible guideline, financial constraint, poor managerial support, lack of adequate training, inappropriate use of personal protective devices was identified as the main challenges for effective HCW management practice (Yazie et al. 2019: 1).

There are recommendations to improve SHCW management. These includes providing in service training for health facility workers on SHCWM measures at work and accurate registration and reporting of occupational exposure with strict follow up monitoring and training of both the technical staff and the nontechnical staff (Caniato et al. 2015: 98; Gihan, Shimaa & Rania 2018: 56; Pooja, Bikash, Vipin, Vikrant, Yogesh & Anil 2016: 170; Ravishekar et al., 2016: 17; Solomon, Julian & Frederick 2019: 6). Therefore, continuous supervision (Solomon et al. 2019: 9) are critical for the proper and appropriate management of biomedical waste to clarify definitions and waste segregation, although attention is usually focused on HCWM staff, like doctors, nurses, cleaners and waste collectors, it is evident that all the health care facility personnel should be involved (Caniato et al. 2015: 98).

Risk associated with inappropriate HCW management has gained attention on several international and local summits. SHCW generated in Ethiopia health facilities has not get significant attention from the affected individuals, community and concerned authorities (Meleko et al. 2018: 126).

2.22 SOLID HCW MANAGEMENT REGULATIONS IN ETHIOPIA

Concerning the HCWM regulation in Ethiopia, there are no separate and specific regulations for the HCW management to enforce them for the proper management of solid waste. Currently, there is no compliance with the implementation of the HCW management rules and regulation that is prepared by the Ethiopian federal environmental protection authority (FEPA), Ethiopian Federal Ministry of Health (EFMoH), and Ethiopian food, medicine, and healthcare administration and control authority (EFMHACA) independently.

Lack of training, poor commitment of the health facility administrators, staff resistance, shortage of adequate resources, unfavourable attitude of health care staff, in addition, studies indicated staff resistance because of awareness, lack of training, poor commitment of the administrative staff, negligence, lack of adequate resources, and unfavourable attitude, lack of administrative supervision of the healthcare staff were the main identified challenges (Yazie et al. 2019: 4, 5).

Even though there is a problem of reliable records of the quantity and nature of HCW (Meleko et al 2018: 126), the type of waste generated at health care facility is an important space. Generation rate and type vary from country-to-country and even from health facility to health facility in the same country. The per capita solid waste generation rate will vary significantly. Factors contributing to such discrepancies include lifestyle and economic structure (Rada 2016: 3), health care facility level, proportion of disposable materials used, the type of service provided (Eyup 2018: 169; WHO 2014: 14) the number of medical and other staffs, presence, or absence of waste management policy, living habits and standards may reflect differences (Banstola et al. 2017: 47).

2.23 HCW INCINERATION PRACTICE IN ETHIOPIA

In most of the developing countries, incineration of waste in open pit and locally fabricated incinerators are common methods of solid waste disposal. In Ethiopia like other developing countries, incineration is common method of waste disposal method.

Most of the incinerators are operated under suboptimal condition and the incineration was done by untrained personnel. As a result, many noxious organic and inorganic pollutants are released in the flue gas (Yazie et al. 2019: 5).

Significant problems were seen regarding health facilities incinerator design, construction, sitting, operation, maintenance, and management of incinerator (Berihun & Solomon, 2017: 6). As stated by Ephrem and Mekonnen (2017: 89), in Addis Ababa, hospitals and health care centres use substandard incinerators which functions under low temperatures and generate higher amounts of dioxin and furan gasses. Improper and incomplete combustion by incinerators can produce air, soil and water pollutant gases which are not environmentally friendly and also for public health.

According to the World Bank report in 2017 Solid waste management is stated as part of the Ethiopian government policy. The waste management policy aims to enforces for waste generation quantity reduction, sorting the generated solid waste properly at source, establish facilities and incentives for appropriate waste management, reuse, recovery, and recycling. In 2007 the government of Ethiopia adopted a solid waste management proclamation it mandates safe health care waste management practice for people and the environment.

2.24 NATIONAL AND INTERNATIONAL WASTE MANAGEMENT REGULATIONS IN ETHIOPIA

Ethiopia has ratified two important international conventions the Basel and the Rotterdam. The Basel convention enforces its parties on the transboundary movement of hazardous and other wastes by its regulation to ensure the scientific and sound transportation and management in an environmentally sound manner. The Basel convention is the first agreement globally signed by countries to establish a global standard for the trade and disposal of hazardous and toxic waste between nations. The aim of the convention is to protect the life of the people and the environment from the adverse effects resulting from waste generation transportation, disposal, and transboundary movement of any infectious and hazardous waste between the countries (WHO 2017: 2).

Environmental pollution control proclamations No.300/2002 are one of the major environmental safety proclamations in Ethiopia. This proclamation was stated in “Negarit Gazeta’’ which is the main source of information that announces the law regulation and proclamations in Ethiopia. Article number 3 sub article number 4 states that ‘‘It is a kind of the polluter pay principle that states any person or any organization who disposed any kind of waste that pollute the surrounding environment should be enforced to clean up or pay the required amount of the clean-up cost of the polluted environment determined by the authority or by the relevant regional environmental agency’’.

Article number 4 states about management of hazardous waste, chemical and radioactive substance, article number 6 sub article number 1 states about waste management standards specifying the levels allowed and the methods to be used in the generation, handling, storage, treatment, transport and disposal of the various types of waste (Federal negarit gazeta 2002: 1959).

2.25 CONCLUSION

This chapter provided information on the current SHCWM practice in developed and developing countries. The discussion in this chapter shows that countries around the world have different HCW management practice and in the past few years in a global basis concern about solid waste management practice has increased. Studies revealed that appropriate SWMP are realised in developed countries by using and enforcing SWM codes of practices and guidelines, provision of regular training for staff, full participation of all staff and the availabilities of technologies, allocation of adequate finance, the waste handlers equipped with the latest information, the presence of the responsible waste management team, and the availability of compressive plan. However, the rapid growth of urbanisation and the increment of the number of health facilities, SHCWM practice in developing countries is not scientifically sound. The discussion in this chapter shows lack of reliable data on the amount of solid HCW and ineffective SHCWM practices are demonstrated in most of the African countries, because of poor segregation and collection of waste, absence of modern treatment and disposal facilities, lack of political commitment, poor

allocation of budget, negligence of the facility leaders, absence of continuous capacity building for health facility workers.

Polychlorinated biphenyl (PCBs), Polycyclic aromatic hydrocarbon (PAHs), furans and dioxins are heavy metals and organics that are identified types of pollutants released from the onsite substandard incineration of clinical waste that identified in numerous studies. Health related problems resulted from substandard incinerators and open burnings of clinical waste in the occupational environment were reported in the literature. Skin diseases, respiratory and intestinal infections are the main health related problems suffered the vulnerable populations specially children in the vicinity of substandard health care waste disposal sites.
Studies in most of Africa countries depicts that the current SHCWM cannot assured the safety of healthcare establishment's staff, patients, and the nearby population. The current mismanagement constitutes a threat to public health and the environment.

Health care waste management handling and the safety of the handler in Ethiopia like other African countries is very low. The management of HCW is of great concern. The assumptions are generally that there is a lack of proper HCW management practices at healthcare facilities. Therefore, there is an urgent need for the development of HCW management guidelines that should be implemented consistently. In the area of this study, HCW generation rate and composition are not studied, which makes it difficult to plan and develop an appropriate intervention strategy in order to provide better HCW management.

CHAPTER 3

THEORETICAL FRAMEWORK, RESEARCH DESIGN AND METHODS

3.1 INTRODUCTION

This chapter describes the research design, research method, study area and study settings, population, sampling, data collection, rigor of the study, analysis, interpretation, limitations and ethical considerations.

3.2 STUDY AREA AND SETTING

This study was conducted at Hossaena Town which is the capital city of Hadiya zone. The town issituated232 kilometres far from the capital city of Ethiopia, Addis Ababa and 165 kilometres far from the regional city of Hawasa. Geographically, the town is found at $7^{0}3'19"$ - $7^{0}56'1"$ North latitude and $37^{0}23'14"$ - $38^{0}52'13$ East longitude. About 10% (201,145) of the zonal population lives in the town. Annual rain fall of the town is 1000-1700mm (Tiruneh & Addise 2017: 22). Forty-one health facilities are found in the town.

Healthcare system organisation in Ethiopia, classified in three-tier system (1) referral hospitals has expected to serve 3.5 million to 5 million population (2) general hospitals were expected to serve for 1 million population and district health service (one district hospital with five health centres and 25 health posts). According to the information obtained from Hadiya zone health department and Hossaena City administration health office, there is one comprehensive specialised hospital with 350 beds, one private surgery centre with 25 beds, three government health centres, 17 medium clinics and 19 first line or small clinics in the study area. According to the zonal health office report a total of 192,514 patients and clients get service in the government health facilities in 2021. About 91,421 patients and clients get the service in private health facilities (Hadiya Zone Annual Report 2021).

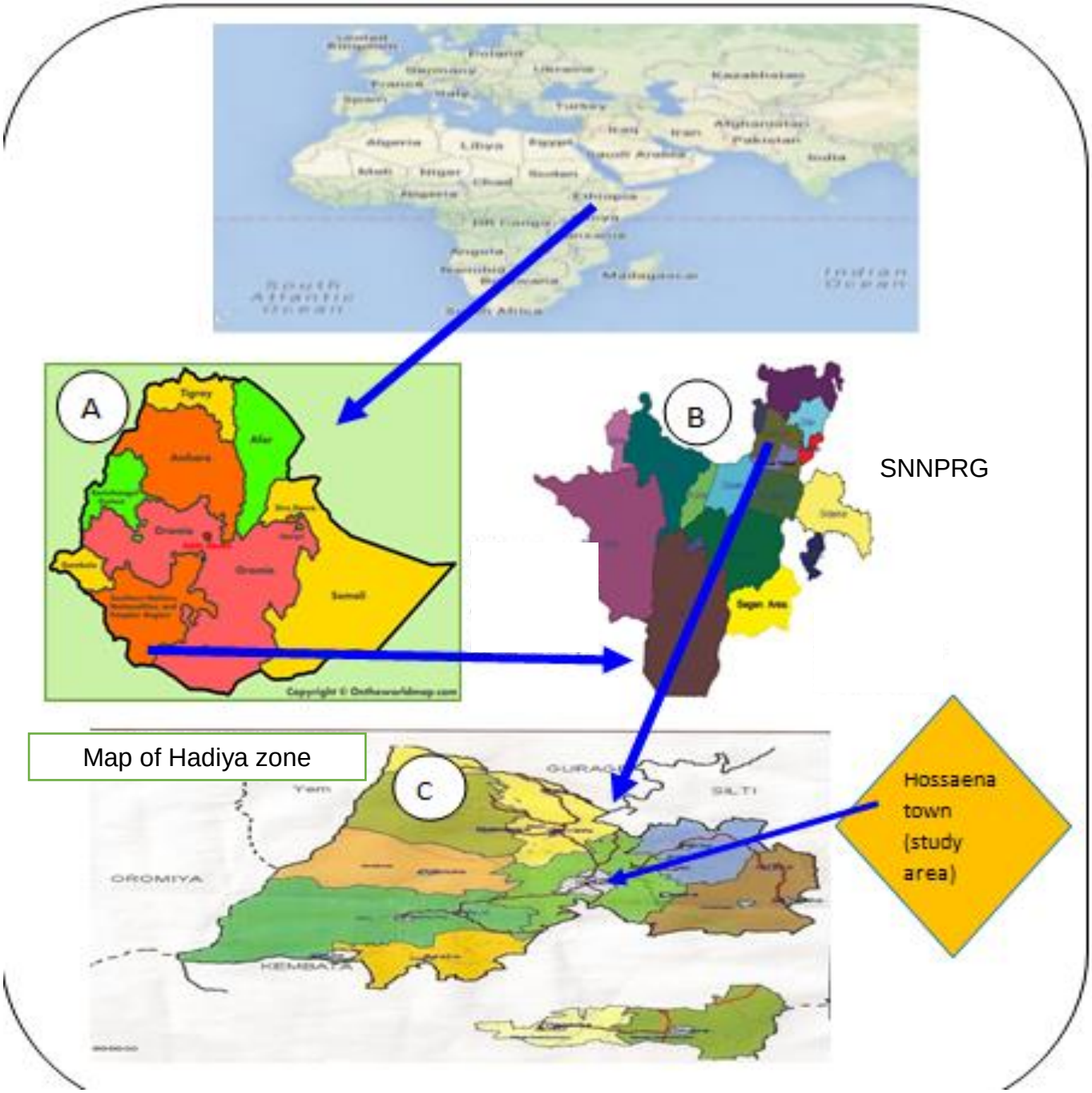

Figure 3.1: (A) Map of Ethiopia shows all regional states, (B) Map of southern nation Nationalities and Peoples Regional State shows all zonal governments(C) Hadiya zone and Hossaena Town administration).

3.3 THEORETICAL FRAMEWORK CHOSEN

Urie Bronfenbrenner in the1970s introduced a conceptual model of socio-ecological model (SEM) for understanding human development. The initial theory of SEM was provided by a nesting circle. The SEM levels included in this study seek to be comprehensive with the individual, community, institution, and policy. According to Urie Bronfenbrenner, solid waste management is affected by the interaction between individuals, communities and environment -these include social, physical and political components (Jill 2017: 295).

The social-ecological model (SEM) is constructed to increase benefits and decrease the costs of human actions in their interactions with the environment (Ulysses, Patricia Washington, Taline, Rafael, & Thiago 2019: 77). SEM helps to develop successful and effective programs and to understand factors affecting behavior in the social environment. Social-ecological models emphasise multiple levels of influence (such as individual, interpersonal, organisational, community and public policy) and the idea that behaviours both shape and are shaped by the social environment. The principles of social-ecological models are consistent with social cognitive theory concepts which posit that creating an environment conducive to change is important to make it easier to adopt healthy behaviours.

The socio ecological system theory emanates from the understanding of the interaction between society, in terms of social-economic system and natural system. SEM theory also acknowledges that it takes a combination of both environmental/policy-level interventions and individual-level to achieve considerable importance or changes in health behaviours, including proper waste disposal behaviour.

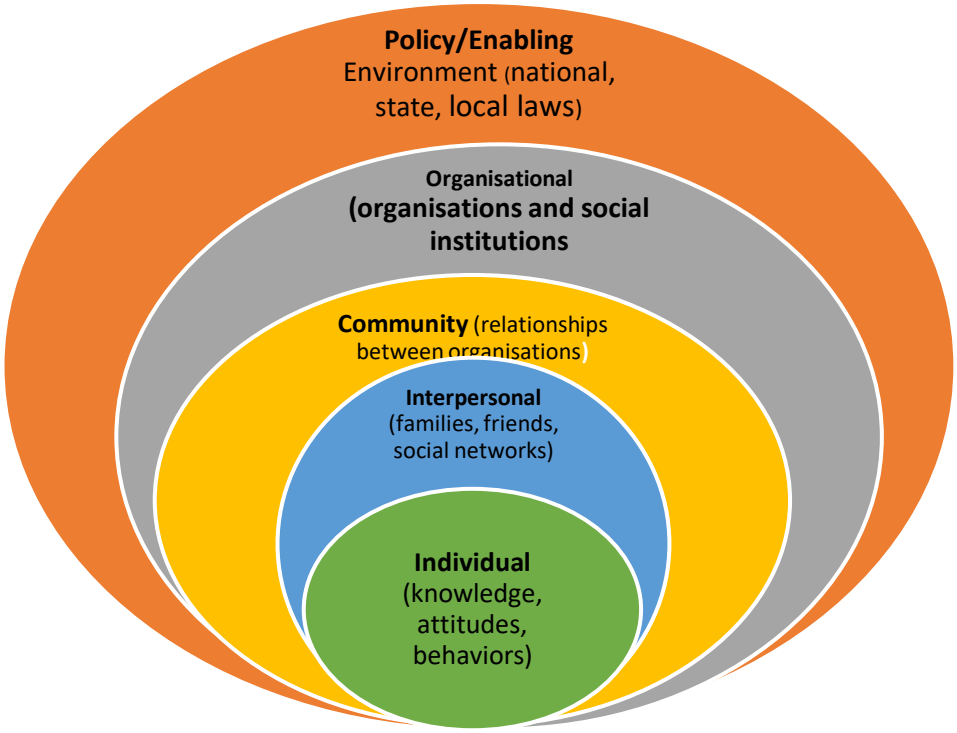

Figure 3.2: The social ecological model adopted from Urie Bronfenbrenner

3.4 APPLICATION OF THE SOCIAL ECOLOGICAL MODEL TO THE STUDY

The five nested level of interaction in the SEM is a theory based public health research approach that show as the level of interaction of individual and their behaviour to understand in the context of the five nested: individual, interpersonal, community, organisational, and the policy enabling-environment. These types of models also assist in identifying the power of influence points for solid waste management.

This study applied the three levels social ecological model. The macro level: it includes international and national policies. The Meso level: it includes the organisational level, policy makers and stakeholders' level. The micro level: at individual level, knowledge, attitude, and behaviour of the workers at health facility level. For the quantitative phase of this study, this model will guide this research by providing a proposed explanation for the relationship among the study variables being tested by the investigator. For the qualitative phase of this study, they may often serve as a lens for the inquiry (Burke & Larry 2014:559).

The Social Ecological Model of solid health care waste management practice shows that there are a close connections and interactions between different levels of the model. Creating healthy people and environment is not only the responsibility and the result of the individual, but it is the responsibility of the staff, the patient attendant and his or her environment. In the SEM, some of these connections and interactions have been clarified, which may enable opportunities to design interventions to improve farmworker well-being.

Existing HCW management practices in developing countries are highly influenced by the commitment of political bodies, the availabilities of scientific policy and the compliance rate of the health facilities. Types of waste generated, and the volume of waste generated will depend on the volume of patients served by the health facilities, the type of service provided in the health care facilities and the commitment and knowledge of the health facility workers and administrative workers.

The availability and allocation of budget to adequately manage the HCW will be one of the remedies to manage HCW generated at any health facility. In addition to the above-mentioned conditions, the availability of materials and health facility setting arrangements will be the cause of good or bad HCW management practices. For this study, the researcher utilised the SEM. Urie Bronfenbrenner developed a conceptual model for the SEM to understand human development in terms of the individual and society as reflected below.

3.4.1 The role of individual knowledge, attitude, and practice in SHCWMP

It is important to understand the role of all concerned bodies in the management of SHCW. All of the human beings are produce waste so we all have to take the responsibilities of the appropriate management, it is not just the responsibilities somebody who moves it around for us or who manages or disposes of it for us. Waste management policies developed in the countries clearly places responsibilities for the health care waste producer. So, it is important to be clear under what circumstances your institution is doing as a waste producer. An individual plays the main role in the solid waste management. He/she is the base of the solid waste management programmes.

The individual can do the following to reduce wastes.

1. Reduce solid waste: reduce solid waste at source, means using less paper and less use of plastic carry bags.

2. Re use solid waste: reuse of the selected wastes that do not contain pathogens will be motivated.

3. Re cycle means separating plastic, metal, rubber, and glass and sending it to be recycled for manufacture of other products.

3.4.2 The role of families, friends and, social networks in SHCWMP

Today, solid health care waste management is the major area of concern worldwide. It is a losing battle against the hazardous consequences of improper waste disposal and attaining a safe, clean, and healthy environment. Waste generation, waste collection and transportation, treatment and disposal are physical components of waste management system that are vital in attaining a clean healthy environment. Patients' health workers and attendants are important stakeholders in the solid waste management process because of their direct involvement in generating waste.

3.4.3 The role of community (relationships between organisations) in SHCWMP

SWM Practice in developing countries exceeds the capacity of the local government. Lack of community participation, government officials and health facility managers, individuals working in the health facilities patients and visitors are responsible for SHCWMP. SHCWM and organization practice are the challenges for all municipalities of developing countries. The lack of establishing a cooperative relationship with communities and health facilities to improve their commitment to SHCWMP is one of the reasons for the inability of local municipalities. This cooperation and practice increase the involvement of the concerned bodies in the collection and transportation of solid waste from the source of generation to the disposal sites.

The participation of communities in SWM is essential because SWM as a continuous maintenance system views community participation in SWM as a cost-effective way of addressing SWM challenges. SHCWM project requires the effective participation of different stakeholders like municipalities, decision makers' entrepreneurs' technical professionals. In developing countries community participation used as a positive driver rather than scarcity of resources, public health and climate change. SWM is the top priority problems of the local municipality and the most important issues facing local municipal authorities in developing countries.

Local communities should be considered as an important stakeholder for decision making process. Local municipal authorities are the responsible organisation to control and manage the final disposal of SHCW. The complexity of the waste, financial constraints and multidimensionality of the system and the inefficient organisation are the main challenges faced by local municipal authorities in SWM. Furthermore, local municipal authorities and local health care administration offices are expected to advocate for a reduction in solid waste generation rate appropriate segregation practice and reusing of some solid wastes rather than relying on local municipal waste services to achieve recycling goals (Serge, 2020:224).

3.4.4 The role of organisations and institutions in SHCWMP

Organisations and institutions have role in SHCWM practice. SWM requires good governance, transparent system, effective and efficient institution. The quality of SWM service clearly linked to the governance environment in the country. SWM is often cited as one of the most visible indicators of the state of urban governance. In countries and urban areas that have a strong governance environment, SWM institutions tend be more effective. Out sourcing of solid waste management to external organisations or private sectors are currently recommended practice for the management of sold health care waste to pull the necessary skills and expertise to improve health service delivery. Private sector participation provides an opportunity to strengthen effective waste management practice (Allison 2015: 1).

3.4.5 The role of policy or enabling environment in SHCWMP

SHCWM needs an effective policy, guideline, and regulatory framework that vividly defines the role and responsibilities of concerned bodies must be in place.

All concerned organisations and individuals like service providers, the public the international, national and local government agencies public and associated powers and procedures are required to implement laws governing the management of solid waste. In addition to the availability of clear legislation; it must be enforceable, which requires adequate institutional capacity, financing, and legitimacy, to be effective. The SEM helped the researcher to understand factors affecting behaviour and provide guidance for developing guidelines for SHCWM.

Social ecological models emphasise multiple levels of influence (such as individual, interpersonal, organisational, community and public policy) and the idea that behaviours both shape and are shaped by the social environment. The principles of social ecological models are consistent with social cognitive theory concepts which postulate that creating an environment conducive to change is important to making it easier to adopt healthy behaviours in our case waste management.

3.5 RESEARCH DESIGN

A research design is something which acts as a plan or a master plan of the research work (Prabhat 2015: 18; Bougie & Sekaran 2016: 95). These include items such as the focus of the research, the research purpose, the kind of research to be undertaken, operationalizing and investigating the research problem or issue foundations of approaching, setting out the approach, theory and methodology to be employed; the types of data required, how they will be collected, and from whom the data will be collected; how the data were analysed, interpreted and reported (Cohen, Manion & Morrison 2018: 176; Johnson & Christensen 2014:183; Majid 2018: 1). For this research, mixed method research design was used as glue that holds the research project together, that is used to structure the research work together to try to address the central research question.

The research design presents a sound reasoning for why the study is conducted, it can be used to identify the specific objectives, and provides a logical plan for how those objectives will be met. Design decisions of this research were to demonstrate the value and rigor of the proposed research.

It will also clearly show the relationship between this research problem; the conceptual or theoretical framework that will guide this research design, data collection methods, and the data sources, and analysis procedures (Tolley, Ulin, Mack, Robinson, & Succop 2016: 45).All the stages of the research design provide a serious of explanation and guidance about the idea of the research, the type of the information to be collected, what type of information gathered, how it should be measured.

3.6 RESEARCH PARADIGM

Research paradigm is an approach or a model, a worldview or perspective about research held by a community of scholars to conduct research that is based on a set of concepts, shared assumptions, practices, and values. It acts as a function of how a researcher thinks about the development of knowledge and how results should be interpreted (Greener & Martelli 2015: 42; Leavy 2017: 31).

The chosen paradigm for this study is pragmatism as the researcher believes that a pragmatic world view and its alignment to the mixed-methods research will be most appropriate for this study because of pragmatism places the research question at the centre of the inquiry and supports using both qualitative and quantitative methods, links all methodological decision to the research question (Leavy 2017: 168; Burke & Larry 2014: 82). The pragmatic paradigm enabled the researcher to utilise both qualitative and quantitative assumptions in studying the practice of HCW management. Applying different worldviews, qualitative and quantitative forms of data collection and analysis, multiple methods, to provide the best understanding of a research problem (Creswell 2014: 40-42).

Prabhat (2015:18) explains in his book a good research design increases the reliability of the data collected, analysed, and decreases bias. Carefully selected research design depends on the research questions, specific objectives, and constraints of the project such as time, money and or access to data (Sekaran & Bougie 2016:96).

3.6.1 Mixed methods design

Mixed methods research design refers to an emergent methodology of research around the late 1980s and early 1990s (Patricia 2017: 89). Different scholars defined mixed method research in the literature, and for the purpose of this study a definition by Creswell (2014) will be adopted. Mixed method study involves qualitative and quantitative data collection and analysis of the collected data in a single study. In a mixed method study the data are collected concurrently or sequentially and the integration is conducted side by side in the process of the research (Patricia 2017: 164).

The integration and mixing of quantitative and qualitative data in a single study advances the mixed method studies. Mixed method was selected because of the strength of each method generally and the weakness of both approaches. Practically mixed method provides a sophisticated, complex approach to research that appeal to those on the forefront of new research procedures. At a procedural level, it is a useful strategy to have a more complete understanding of research problems/questions (Creswell 2014: 267).

According to Elizabeth (2018: 5) cited Creswell and Plano (2007: 147), mixed method is one of the research designs with philosophical assumption as well as methods of inquiry. As a method, it focuses on collecting, analysing, and mixing both quantitative and qualitative data in a single study. As a methodology, it involves philosophical assumptions that guide the direction of the collection and analysis and the mixing of qualitative and quantitative approaches in many phases of the research project. The central premise is that using qualitative and quantitative approaches together provides a better understanding of the research problems than either approach alone.

Mixed method research involves collecting qualitative and quantitative data of the single research and integrating both to get more comprehensive understanding of SHCWM practice. This is a problem centred approach to research in which methods and theories are used instrumentally, based on their applicability to this study. The core assumption of this form of inquiry is that the combination of qualitative and quantitative approaches provides a more complete understanding of a research problem than each approach alone to understand the research problem more fully than either approach alone (Creswell 2014: 215; Patricia 2017: 191).

There are four types of mixed method research design, convergent or concurrent, explanatory sequential, exploratory sequential and nested method design. Generally, both methods are used to overcome a weakness in using one method with the strengths of another (Leavy 2017: 263; Johnson & Christensen 2014: 660). For this study convergent mixed methods research design was selected.

3.6.2 Convergent or concurrent mixed methods

In the convergent or concurrent mixed methods approach the data collection, quantitative and qualitative data has been conducted simultaneously followed by the combination and comparisons of the multiple methods. Different but complementary data on health care waste management practice involved in this approach. Therefore, the convergent interpretations of the two data bases are used. It is often referred to as the concurrent triangulation design because the data of HCW management practice is collected and analysed individually but at the same time (Edmonds & Kennedy 2017: 181).

The key assumption of concurrent mixed methods approach in this study is that both quantitative and qualitative data provides different types of information often detailed views of participants' solid waste management practice qualitatively and scores on instruments quantitatively and together they yield results that should be the same. In this approach, the researcher collected both quantitative and qualitative data, almost at the same time and analysed them separately, to cross-validated or compared the findings are if similar or different between the qualitative and quantitative information.

Concurrent approaches of data collections process are less time consuming than other types of the mixed methods studies because both of the data collection processes are conducted at the same time and at the same visit to the field (Creswell 2014: 267,269).

In this study the qualitative and the quantitative data are provided different information and it is suitable for this study to compare and contrast the finding of the two results to obtain the best understanding of this research problems.

Triangulating of data and checking for complementarities, that is, to gain a more complex and complete picture of the subject matter. According to Plano and Nataliya (2017: 79,104), using either qualitative or quantitative method of data collection alone to answer the research questions of this study is insufficient and both approaches combined can lead to a better understanding of the research phenomenon. Therefore, concurrent mixed method was utilised to overcome the weakness of individual method and will be used to obtain more valid conclusion that are more meaningful and complete picture.

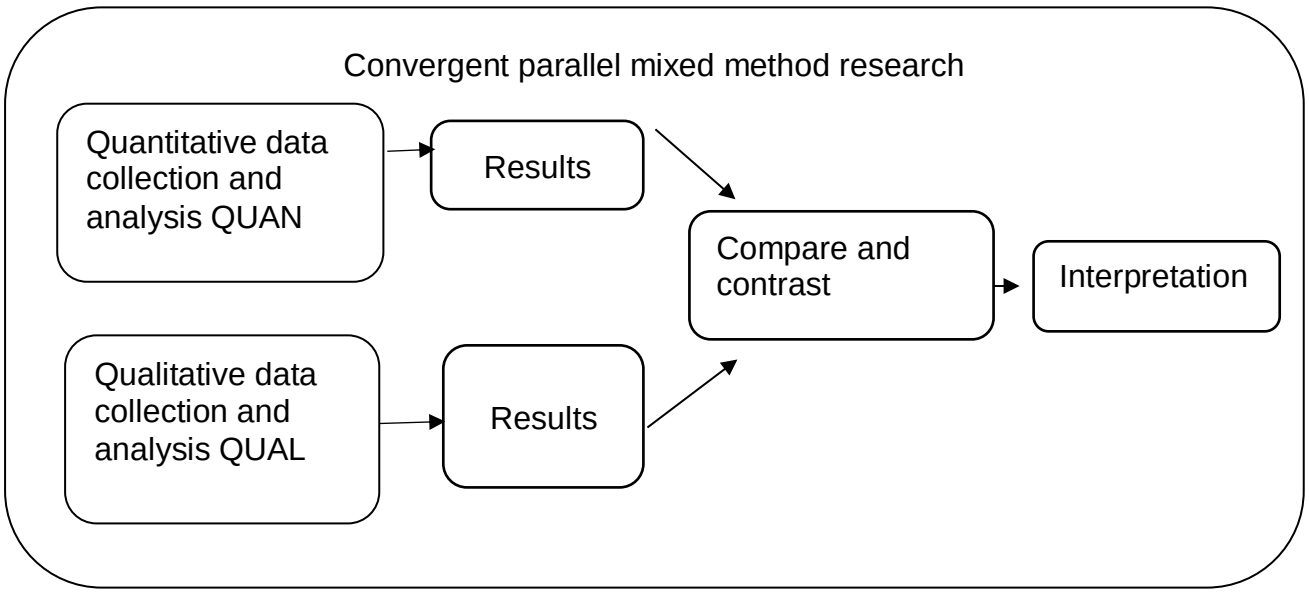

Figure 3.3: Convergent parallel mixed method research design adopted from Creswell.

3.7 FURTHER CLASSIFICATION OF THE MIXED METHODS

According to Catherine et al. (2018:108) cited Creswell and Plano (2007), mixed method design further classified into triangulation, design. Triangulation is better fitted and selected by the researcher for this research. Both qualitative and quantitative data are collected simultaneously to use the result to understand the research problems well. For the best understanding of the research problems, the triangulation design usually helped and it is a one phase design. In the triangulation design, the researcher of this study implements the qualitative and quantitative methods of data collection approximately with the same time period and equal weight of qualitative and quantitative. It generally involves the concurrent, but separate, collection and analysis of quantitative and qualitative data so that the researcher of this study best understands the research problem well.

As a general consensus, mixed methods have been better to overcome the weakness of a single method. Triangulation means comparing and contrasting the results obtained by qualitative and quantitative method and complementary means to get complementary results with one another method used to obtain more valid conclusion that are more meaningful and complete picture.

3.8 PHASES OF THE CONVERGENT MIXED METHODS STUDY

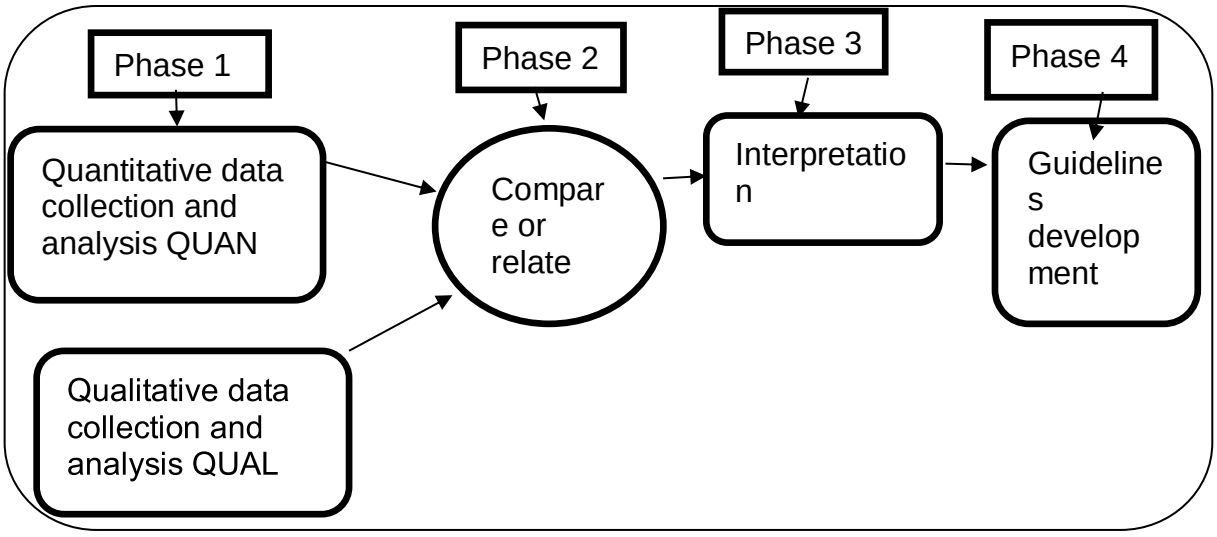

Figure 3.4: Convergent mixed methods phases adapted from Creswell (Creswell, 2014:270).

3.8.1 Phase one

In phase one, a researcher collected quantitative and qualitative data by using the pretested data collection tools. The main assumption of this approach is that both quantitative and qualitative data provide different types of information on SHCWM practices in the study area.

3.8.1.1 Qualitative data collection and analysis phase

The qualitative data collection process was employed by using individual interviews and focus group discussions. Based on the availability of staff numbers who are available in the government health facilities (Comprehensive specialized hospital and three government health centres) two focus group discussions from each health facility that is one technical worker level and another one FGD from health facility administrators were conducted, and one FGDs were conducted for all private health facilities because of the number of available health facility workers. Each focus group had four individuals. To increase the trustworthiness of the data collected, non-participant observation of HCW management practice was conducted by the principal investigator. Focus group discussion and semi-structured interviews are the data collection tool for this study. Both focus groups and interviews were conducted in the facilities' compound of each participant (Burke et al. 2014: 313).

Interviewing is an opportunity for the researcher of this study to gain insight into how people interpret their surroundings. Issues not adequately addressed in the individual interviews were clarified and discussed in-depth in the focus groups. During interviews, the researcher was using a tape recording and note writing to capture the appropriate responses from the interviewee on HCW management practices.

To increase the credibility of the data collected both focus group interviews and observation were conducted by the principal investigator. The focus group interview guide was pretested and Worabe Town was selected for pretesting because of its proximity to the study area which is found 60 kilometres far from the study area and the town contains health facilities like hospitals, health centres and clinics.

Qualitative data from observational and focus group interview data were transcribed into word processing and verbatim transcription was used and entered ATLAS.ti 8 software. In the qualitative data analysis of this study, different steps were followed, organising, and preparing the data for analysis by involving the transcribing interviews, technically observing all visual materials, typing of field notes, and sorting and arranging the data into different types depending on the sources of information, then reading and looking at all data. This step provides a general sense of the information and an opportunity to reflect on its overall meaning. It entails coding and organising the data, reading through all data organising, and preparing data for analysis.

The analysis was performed separately for each health facilities and finally summarised (Creswell 2014, 247).

3.8.1.2 Quantitative data collection and analysis phase

The quantitative data collection process included questionnaires and observational checklists. The quantitative phase of this study assessed three components. Solid HCW segregation practice, the availability of equipment for HCW segregation, temporary storage facilities, transportation to final disposal, and disposal facilities data were collected by using a structured questionnaire, observation, and assessment of HCW generation type and rate. Recycling or reusing practice, waste treatment, the availability of HCWM committee, and training data were collected by using quantitative data collection tools.

Ten environmental health professionals with at least a diploma and above were recruited for quantitative data collection including assessment of the type of waste generated separately from each health facilities found in Hossaena Town. The data collection instruments were piloted in two health facilities one government and one private health facility found outside of the study area.

To minimise the data entry mistakes, quantitative data was entered into EPI data version 3.1 and exported to statistical package for social science SPSS window version 27.0 for analysis. A numeric value was assigned to each response in a

database, cleaning the data, recoding, establishing a codebook, and visually inspecting the trends to check whether the data are normally distributed. Data were analysed quantitatively by using relevant statistical tools. Descriptive statistics and Pearson correlation test were used for the bivariate associations and analysis of variance to compare the HCW generation rate by the type of health facilities. Bivariate (correlation) analyses were used to assess the relationships between independent and dependent variables. Then, multiple linear regression analysis was established to check the simple correlation matrices between different variables for investigating the strength and form of the relationship between the dependent and independent variables included in the analysis.

3.8.2 Phase two compares or relates the findings from qualitative findings and quantitative findings

3.8.2.1 Data analysis in a convergent design

Data analysis in a convergent design consists of three phases:
Qualitative phase: First, analyse the qualitative data by coding the data and collapsing the codes into broad themes.
Quantitative phase: Second, analyse the quantitative data in terms of statistical results.

Third comes the mixed methods data analysis. This is the analysis that consists of integrating the two databases. This integration consists of merging the results from both the qualitative and the quantitative findings. The first approach was a side-by-side comparison of the research findings. A final procedure involved merging the two forms of data in a table or a graph and in a narrative form.

3.8.3 Interpretations of the study findings

Both data sets from quantitative and qualitative were interpreted to compare the result from the two data bases and notes whether there is convergence or divergence between the two sources of information (Creswell & Creswell 2018: 284).

The findings of this study were interpreted taking in to account national and international findings from other studies to provide meaning for the study purpose

3.8.4 Guidelines development

SHCWM guidelines were developed based on the research objectives of this study as well as research questions and considering the study results. More details about the preparation of these guidelines are provided in Chapter 5.

3.9 RESEARCH METHODS

A research method is a set of systematic technique used in research (Chinelol 2016:6). It is an activity designed to generate data by using activities like questionnaires, interviews, focus group discussion, and observation. Understanding the research methods helped the researcher of this study to be specific about the research and to make sure that this research comes from a valid source and has been collected and analysed appropriately (Greener & Martelli 2015:11). In the paragraphs below research methods aspects are described.

3.9.1 Population

Population is a large collection of individuals or objects or the full universe of people or things, events, or things of interest from which a researcher draws a sample and wants information to which results from a sample are generalised based on sample statistic, which should be easy to access and measure (Polit & Beck 2015: 365; Lawrence 2014: 247; Selvamuthu & Das 2018: 64; Sekaran & Bougie 2015: 232; Greener & Martelli 2015: 61).

3.9.1.1 Study population

Study population is the group of elements from which the researcher draws a sample Every element in the study population has an equal chance of being selected (Patricia 2017: 76). The study population for this study were all government and private health facility workers found in Hossaena Town during the data collection period.

3.10 SAMPLING

Sampling is the process of selecting a representative group of participants to represent the population (Polit & Beck 2015: 365; Johnson & Christensen 2014: 343). In this study, the researcher selected a sample to study the characteristics of a subset, or the sample selected from the larger group to understand the characteristics of the larger population. After the researcher determined the characteristics of the sample, he generalised from the sample to the population; that is, researchers make statements about the population based on the study of the sample.

A sample is usually much smaller in size than a population; hence, sampling can save time and money (Johnson & Christensen 2014:343; Howitt & Cramer 2016:536).

Parallel, nested, identical, and multilevel are the four major types of the sample relationship of the qualitative and quantitative samples. If the same people are participated in both qualitative and quantitative phase of the investigation, it is called an identical sample relation, and if qualitative and quantitative samples are drawn from the same population but it is different for qualitative and quantitative, this relation indicates a parallel relation. If the qualitative and quantitative samples are drawn from different levels of the population under study, this relation indicates a multi-level relation. A nested relationship of sample indicates that the research participants selected for quantitative phase is a subset of the qualitative phase of this study (Johnson & Christensen 2014:373).

3.10.1 Quantitative phase sampling procedure

Polit and Beck (2017: 367) describe that sampling is the process of identifying cases to represent the total population, to permit inferences about the population. The main purpose of sampling in quantitative research is to enable the researcher to make accurate generalizations about a population using sample data (Burke 2014: 345). Any combination of random sampling and non-random sampling can be used in mixed research. For example, random sampling can be used in the quantitative

phase and non-random sampling in the qualitative phase (Burke 2014: 667). If the researcher studies every individual in a population, this is actually conducting a census and not a survey. In a census, the whole population is studied, not just a sample, or subset, of the population.

Census is a study based on data from the whole population rather than a sample. A census is quite expensive and very difficult to conduct. Researchers rarely study every individual in the population of interest. Instead, they study a sample of the population. For the quantitative part of this study a census method of study, which is all health care facilities found in the town was studied.

The use of random sampling saves time and money compared to a census. Conducting a census for large populations is generally too difficult and too expensive. On the other hand, if a population is very small including all of the individuals in your research study is your best bet. The real power of random sampling comes when you are studying large populations (Burke 2014: 344). All health facilities and health facility workers who are available in the study health facilities and having a role in HCW management practice were included in the quantitative phase of this study.

3.11 INCLUSION CRITERIA

According to the Grove, Gray and Burns (2015:251) explanation, inclusion criteria are the particular characteristics that the subject or elements within the population are suitable for selection in a study sample. In this research prior to sampling, the researcher determines those especially extreme characteristics and properties that may distort results and/or affect the homogeneity of the sample (Boncz 2015: 26).

Sampled government and private health facilities that were classified under the three-health tier system and found in Hossaena Town, which have formal permission to give preventive curative and rehabilitative health services were included in this study. A comprehensive sampling method was used, which means that all health facility workers who have direct contact on HCW management practice were

included in this research study. This inclusion asserts the representativeness because everyone is included in this study (Burke & Larry 2017: 370).

3.12 EXCLUSION CRITERIA

If the elements lack specific characteristics in the population that causes them not eligible for selection in a study sample is referred to as exclusion criteria (Grove, et al. 2015: 251). The exclusion criteria applied for this study was health facilities that were not classified under the three-health tier system, and health facilities that are not volunteer to participate in this study, health facilities found out of the Hossaena city administration, and health facility workers who were absent at the time of data collection and not volunteer to participate in this study were excluded.

3.13 SAMPLING FOR QUALITATIVE PHASE

Sampling in qualitative research relies on a different set of approaches. Sampling in qualitative research is purposive and relies on different methods but, for the purpose of this study, mixed purposeful sampling method was used (Johnson & Christensen 2014: 376).

Sampling for qualitative studies depends on a different set of approaches. Qualitative research sampling is purposive and relies on different methods. For the purpose of this study, purposeful sampling method was used (Johnson & Christensen 2014: 376). To select the best cases for the study that produces the best data, purposeful sampling method is preferable. Research results are a direct result of the cases sampled (Patton, 2015: 265). This is a strategic approach to sampling in which information-rich cases are sought out to best address the research purpose and questions (Patton, 2015:264; Leavy 2017:14).

According to Sekaran and Bougie (2015: 257) studying a sample for qualitative research is as important as studying a sample for quantitative phase. For qualitative sampling the target population should be defined precisely fist. As a sampling technique, qualitative research generally uses non-probability sampling as it does not aim to draw statistical inference. The researcher of this study purposefully

selected the research participants who have experienced the solid health care waste practice or key concept being explored in this study.

3.14 SAMPLING UNIT

Johnson and Christensen (2014:182) highlighted that the research participants are individuals who actually participated in this study. It is subject under observation on which information is collected. The sampling unit for this research was health care facilities and healthcare workers found in all health care facilities found in Hossaena Town.

3.15 HEALTH FACILITIES PARTICIPATED IN THIS STUDY

Hospital, health centre, surgery centre, medium clinics and small clinics are providing services for the people of Hossaena town and the nearby population. At the time of data collection, 41 health facilities are available in the town and the researcher decided to include all health facilities in this study. One hospital, three government health centres, 17 medium clinics, 19 small clinics, and one surgical centre participated in this study. 4 (9.75%) of the health facilities are government-owned, and 37 (90.2%) are privately owned.

Ethiopia is a federation subdivided into ethno-linguistically based regional states composed of 9 National Regional States. Southern Nations Nationalities and Regional States (SNNPR) is one of the regional state found in the southern part of the country. The SNNPR is an extremely ethnically diverse region of Ethiopia, inhabited by more than 80 ethnic groups, of which over 45 (or 56%) are indigenous to the region (CSA 1996). These ethnic groups are distinguished by different languages, cultures, and socioeconomic organizations. Although none of the indigenous ethnic groups dominates the ethnic makeup of the national population, there is a considerable ethnic imbalance within the region.

The largest ethnic groups in the SNNPR are Wolayta (11.7%), Gurage (8.8%), Hadiya (8.4%), Selite (7.1%). Each ethnic group is numerically dominant in its respective administrative zone. The researcher purposefully selects Hadiya zone because of the third populous zone in the region and Hossaena town are the 2nd largest city in the region. Exceptionally to other zones in the region Hossaena town

are having all types of health facilities like comprehensive specialized hospital, government health centres, speciality centres, medium clinics and small clinics. Because of the above explanation the research purposefully selects Hossaena town for this study.

3.16 ETHICAL ISSUES RELATED TO SAMPLING

The researcher of this study provided sufficient information about the study and assurances about taking part to allow individuals to properly understand the implications of participation and to reach a fully informed, considered and freely given decisions about whether or not to do so, without the exercise of any pressure or coercion to full fill the principle of informed consent. Ethical issues in data collection for this study was like research participants should be respect for dignity subjected not be harm, privacy, confidentiality of the information obtained are respected. In this study, any type of communication in relation to the study has been conducted with honesty and transparency (John 2018: 121).

3.17 DATA COLLECTION APPROACHES AND METHOD

The main purpose of data collection in any study is to collect the essential information's to answer the questions being answered in this study. As a source of data mixed methods study needs qualitative and quantitative data collection, and the mixed methods researchers' needs to be familiar on both data collection process and chooses rigorous procedures In this study, multiple data sources are needed to collect and the data collection involves collecting both qualitative and quantitative data nearly at the same time, analysing the two data separately and then merging or comparing the results from the two data bases (Creswell & Plano 2018: 242,255,261; Leavy 2017: 175).

To conduct high-quality research in health-related studies, mixing of methods, procedures and other paradigm characteristics are an excellent way. In the data collection process, there are two kinds of mixing, Inter-method mixing and intra method mixing. If the researcher used two or more of the data collection technique in the study, it is inter method mixing. In the second kind of mixing, intra-method

mixing, both quantitative and qualitative data were obtained through the creative use of a single method of data collection. In this study, the researcher used inter-method mixing of data collection, that is data were collected by using semi-structured and unstructured questionnaires, focus group interviews, observational checklists adapted from different studies, document, and visual material analysis (Leavy 2017: 179).

3.17.1 Data collection for quantitative phase

Quantitative data collection aims to make generalisations to a population (Creswell & Plano 2018: 262). The quantitative phase of this study assessed six components. HCW segregation practices, the availability of equipment for HCW segregation, temporary storage facilities, transportation to final disposal, and disposal facilities data were collected by using a structured questionnaire, observation, and assessment of HCW generation. Recycling or reusing practice, waste treatment, the availability of HCWM committee, and training data were collected.

Ten environmental health professionals who had a diploma and above were recruited for quantitative data collection that is measuring the volume and type of waste generated separately from each health facilities and interviewing both health professionals and cleaning staffs was conducted by recruited data collectors. Portable electrical and rechargeable weighing scale was purchased and prepared for data collection. The weighing scale was calibrated by measuring the well-known weight two to three times per day. The data collection tool was pretested by the principal investigator on 5% of the study health facilities, which means in two health facilities, one government and one private health facilities found outside of the study area.

3.17.2 Data collection for qualitative phase

Two of the research questions that is, (1) What are the gaps in the existing Ethiopian national HCW management policies and (2) What are the interventions that can improve management practices of SHCWM in Ethiopia were answered by the qualitative data collection tools.

Creswell and Plano (2018: 262) forwarded that an in depth understanding from a few people seeks for qualitative data collection. Qualitative phase of the data collection for this study was conducted by using open-ended interview guide, focus group discussions(FDGs) and written document analysis. To increase the trustworthiness of the data collected, non-participant observation of HCW management practice was conducted by the researcher. Both focus groups and interviews were conducted in the respective health facilities of the participants.

Data collection practice was commenced with individual interviews followed by focus groups interviews. Interviewing is an opportunity for the researcher of this study to gain insight into how people interpret their surroundings regarding phenomenon under study(Burke & Jerry 2014: 313). Issues not adequately addressed in the individual interviews were clarified and discussed in-depth in the focus groups. During FGDs, the researcher used a tape recorder and note taking to capture the appropriate responses from the interviewee on HCW management practices.

Data collection by using Interview method is an opportunity for the researcher to understand how people interpret their surroundings. It is a qualitative tool for getting people talk about their personal feelings (Siah 2014: 146,147). During focus group discussions, the researcher used a tape recorder and note taking to capture the appropriate responses from the interviewee on HCW management practices.

Two focus group discussions for government health facilities having different roles in the institution one from management bodies and one other from health facility staff were conducted because of both the management level staff and other level of workers freely discussed the situation of HCW management practice without any fear to one another, and one FGDs for private health facilities were arranged for each health facility because of the small number of workers. Both focus groups discussions and open-ended interview were conducted in their natural setting of the research participants (Johnson & Christensen 2014: 313).

3.18 THE INSTRUMENT USED FOR FGDS

Data collection tools should be pretested with health facilities and individuals that have similar characteristics to the target study population (Hurst, Arulogun, Owolabi, et al. 2015: 56). The semi-structured focus group interview guide was first prepared in English language and translated into the Amharic language, which is the federal language of the country and locally utilised. One month before the actual study, the data collection tools were piloted in one hospital and one health centre 60 kilometres far from the study area that did not participate in this study to make the appropriate corrections before administering it to the main study population. Familiarity of the data collectors with the tool was also checked during piloting of the data collection tools.

The focus group discussions were conducted with different health professionals and health facility workers until the data became saturated, and audiotape was used to record the discussion as per the agreement with the participants. All the FGDs were conducted by the researcher and the experienced assistant moderator who were trained and appointed for the facilitation and note taking during the focus group discussion. The moderator facilitated the overall arrangement of the discussion including the appointment of the participants in all study health facilities one day before the actual FGDs were conducted. Before starting the FGDs, the researcher set and agreed on some rules like participation and motivating the participants to speak, respecting other ideas, and the moderator took the responsibility of the moderation of the FGDs. After each session of the FGDs, the audio-recorded information and notes recorded by the notetaker were checked for their consistency. Before starting all FGDs, informed consents were obtained from all participants at all health facilities. Each focus groups was completed in 55 minutes at private health facilities and 84 minutes in hospital and government health centres. All FGDs and in-depth interviews were conducted by using Amharic language which is the federal government language and transcribed verbatim.

Based on the research objectives and the research questions of this study, the FGDs were assessed following main themes:

1. What are the problems that you encountered in managing HCW?

2. What are the problems that you encountered in the collection and disposal of HCW?
3. How can the management of solid HCW be improved in your health facilities?
4. Do you have any recommendations for improving HCW management?

3.19 CREDIBILITY OF THE DATA COLLECTION TOOLS

To increase the credibility of the data collected, both focus group interviews and observations tools were piloted. Worabe Town was selected for piloting because of the nearest town to the study area which is found 60 kilometres far from the study area and the town contains health facilities like hospitals, health centres and clinics. Structured and semi-structured interviews were used for this research. Carefully prepared interview guide was utilised to allow the interviewee to understand the questions easily.

In this research each focus group was analysed separately. Separate analysis was more laborious, but it gives good information that will enable a comparison of the health facilities to take place so that the findings can show different locations have different priorities, problems or situations (Gillian & Catherine 2019: 187; Sharlene, 2018: 21).

3.20 STUDY SUBJECTS AND DATA COLLECTION METHODS

	Study objects	**Data collection methods**
1	Generation rate	Segregating wastes to each category Measuring each waste component
2	Collection, segregation, transportation, disposal practice	Observation by using standardised check list In-depth Interview for health facility workers and facility managers Focus group discussion for purposefully selected health facility workers
3	Institutional capacity (availability	Observation

	of the necessary materials and disposal facility) for HCW management	
4	HCW management policy	Document analysis

3.21 PRETESTING OF THE DATA COLLECTION TOOL

Pretesting is a method of checking the data collection tool to check if it is well understood by the respondents or not (Charlotte 2015: 1). Pretesting for this research played an essential role in identifying and potentially reducing measurement errors. It is important to test the data collection tools before the actual data collection starts. Pretesting of the data collection tools helped to identify specific tools that do not easily understood by the participants, or problems with the questionnaire that might lead to wrong answers. Another main purpose of pre-testing this data collection tool is to verify that the target audience understands the questions and propose response options as intended by the researcher (Thomas, Delphine, Patricia & Angele 2019: 2).

For this study the researcher pretested the data collection tool on 5 % of the sample size which means in two health facilities found outside of the study area, both focus group discussions and questionnaires were pretested. Silte zone, Worabe Town was selected for pretesting because of the nearest town to the study area which is found 60 kilometres far from the study area and the town has health facilities like hospitals, health centres and clinics. to check the clarity of the questions and the understanding of the participants.

3.22 DATA QUALITY MANAGEMENT

Before the actual data collection, all questionnaires were pretested and during the actual data collection time all questionnaires were checked for completeness, accuracy and clarity by the supervisors, and finally by the researchers of this studies. After checking the consistency and completeness of the questionnaires by the field workers , they submitted the filled questionnaires to the principal investigator. To

cross check the completeness of the collected data and to improve the quality of the data, the researcher rechecked all the completed questionnaires daily.

3.22.1 Anonymity and confidentiality of information collected

In research, confidentiality and anonymity of the participant information are a classic promise and concepts often contemplated together to be made and although their focus is slightly different. Confidentiality means prohibiting the personal information to the unauthorized persons or accessing and sharing personal information only as authorised by the person concerned. Typically, anonymity is deemed sufficiently established in this study personally identifiable information like names of the participants are changed by the codes to break connections between recordings and the people featuring in them, and the collected data were securely stored in the researcher office (Flick 2018: 287,472).

3.23 CHARACTERISTICS OF THE DATA COLLECTION INSTRUMENT

The data collection tools were adopted and reconstructed from different studies. Questionnaires, interviews, observation, and focus group discussions were used in this research. All the qualitative and quantitative data collection tools were translated from English to Amharic which is a national language and re-translated back to English by language experts to make sure the Amharic translation will be the same as the original English data collection tools.

3.24 ETHICAL CONSIDERATIONS RELATED TO DATA COLLECTION

Ethics are the moral principles or principles of right conduct that manages a person's moral decisions and behaviour. Research ethics is moral principles and legally acceptable in research. They are norms for conduct that distinguishes between acceptable and unacceptable, and right and wrong. Autonomy, beneficence, non-maleficence, and justice are the fundamental principles of ethics. Self-determination and freedom of action, doing what is best to the research participant, avoid doing harm and fair, equitable and appropriate treatment respectively for the above principles were practised (EMOH 2017: 47; Mahmoud 2014: 54).

Categories of health research from an ethical standpoint have four categories, namely, research involving human experimentation, research involving human subject but not experimentation, research involving experimentation on animal, and research not involving human subject or animal experimentation. This research was classified under research involving human subject but not experimentation. No experiment is practiced in this study. Ethical considerations in this study include free informed consent for the participants, confidentiality of information collected, and beneficence of the research participant was practised properly (Mahmoud 2014: 59).

Ethical approval and clearance were obtained from research and ethics committee of the Department of Health Studies, at UNISA. Written permission to conduct this study was obtained from Hadiya Zone Health Department, Hossaena Town Health Office, and from individual health facilities. All respondents are informed about the study procedures. The beneficence of the study and the interviews were conducted after obtaining their oral consent. Research participants were informed about the participation it was voluntary and they were informed of their right to withdraw from the study if they are not comfortable in the data collection process.

More importantly, participants are informed of no names of individual and health care facilities were mentioned in the study to ensure anonymity. To secure the confidentiality of this study, participants were informed that all the data collected would be stored in the password protected cabinet and shredded post data analysis and examination process.

3.25 RIGOUR OF THE STUDY: VALIDITY AND RELIABILITY/ TRUSTWORTHINESS

3.25.1 Quantitative phase

Producing reliable and valid knowledge in an ethical manner is expected from all studies. Conducting research in an ethical manner is ensuring the reliability and

validity. Quantitative studies are evaluated by the two criteria's which are reliability and validity (Leavy 2017: 113).

3.25.1.1 Validity

James (201: 39) forwarded that validity is a collection of truth about the measuring instrument or the test measures what is intended to measure. Research validity refers to the truthfulness or correctness of the inferences that are made from the results of the study (Burke 2014: 384). Internal validity and external validity are the two major components in research designing. For the quantitative part of this research, internal validity means the researcher of this study can say independent variables caused the dependent variables. External validity means that the researcher of this study can generalise the results of this study. It asks whether this research finding is applicable in other settings (DiClemente 2019: 609; Hank et al 2017: 17).Validity is more important than reliability (Hank 2017: 17). In addition, training was given to all data collectors and supervisors to properly understand the research questions, on how to approach the respondents and how to collect the appropriate data. In order to make valid, all observational checklists and questionnaire were logically related to the variables measured. In addition, calibration or standardisation of the measuring tool improved the validity of this study.

3.25.1.2 Reliability

According to Johnson and Christensen (2014: 240) reliability of the measurement estimates the consistency of the measurement or the degree to which an instrument measures the same way when repeatedly measured, it is used under the same condition with the same subjects. Concerning the quantitative part, this research wants to identify the effect created by some independent variables and the researcher wants to be able to generalise the result beyond the boundaries of this study. Reliability will be present if the same result will be obtained if the study will be conducted again.

To ensure the reliability of the data and the findings in this study, the researcher used a measuring tool that had previously been used by different studies (Kumar et al. 2015: 682; WHO 2014: 83; WHO 2017: 6). In addition, the training was given to all data collectors and supervisors to properly understand the research questions, on how to approach the respondents and how to collect the appropriate data.

3.25.2 Trust worthiness for the qualitative phase

Rigour is the quality or state of being valid and very exact, or the quality of being thorough and accurate, careful, or with strict precision. Trustworthiness is a goal of this study and at the same time, something to be judged during the study and after the research has been conducted. Techniques for establishing trustworthiness are placed under the following categories: credibility, transferability, dependability, and confirmability (Brigitte 2019: 255; Denzin & Lincoln 2018: 1380).

3.25.2.1 Credibility

The participants actual experience and the practical depiction achieved in this study, through continues observation and prolonged engagement to learn the context of the phenomenon in which it is embedded and to minimise distortions that might creep into the data (Forero, Nahidi, De Costa, et al. 2018: 3). Interviewers spent more time per site to engage with participants, interview protocols were tested and using two pilot interviews in two different health institution outside the study area, ensuring the data collectors have the required knowledge and research skills to perform their roles.

To ensure credibility, the researcher established trust with the research participants. Open FGDs concerning SHCWMP are conducted with the research participants using FGDs tool as a guide. All interviews were audio-recorded and transcribed in exactly the same words as were used originally. Credibility of this study was assured by adopting validated research methods to collect the data and analyse the data by using thematic analysis. The inclusion of different methods to collect data (focus groups) ensured good triangulation in this study (Costa, Reis & Moreira 2019: 106).

Transferability–According to Brigitte (2017: 257) citing Lincoln and Guba (1985), transferability is the ability of the study that transfers the research findings from one context to another. Transferability is a way of making the research findings useful in other contexts, thereby extending the findings beyond this research finding. The extent to which one can transfer findings from one context to another depends on the similarity. That is, the more similar the contexts are, the greater the extent to which findings can transferred from one context to the other. This is what is referred to as transferability.

Dependability–entails ensuring the findings of this research are repeatable if the inquiry occurred within the same cohort of participants, coders and context. Dependability in qualitative research closely corresponds to the notion of reliability in quantitative research (Lincoln and Guba 1985 cited in Brigitte 2017:255). In this study, dependability was ensured by validity checks, use of an interview schedule and audio recording of all interviews.

Confirmability- refers to the confidence that the results would be confirmed or corroborated by other researchers (Brigitte 2019: 255). Confirmability also relates to the degree of agreement between two or more researchers about the accuracy, meaning and relevance of data. Notes were taken during interviews and compared with transcribed data. Validity checks also helped to ensure confirmability. Finally, the researchers of this study ensured confirmability by disclosing the researcher's background and other predispositions that may influence the analysis of the data, as well as by recognising the limitations of the study (Costa, Reis & Moreira 2019:106).

3.26 DATA ANALYSIS

According to the recommendation of Creswell and Creswell (2018:289) the researcher of this study goes through similar sets of steps for the analysis of both the qualitative and quantitative data analysis; exploring the data, analysing the data, interpreting the analysis, and validating the data and interpretations of the results.

3.26.1 Quantitative data analysis

The data were entered into Epi data version 3.1 to minimise the data entering mistakes and exported to Statistical Package for Social Science (SPSS) window version 27.0 for analysis. Different tests are used to analyse data including frequencies, means, percentage, descriptive statistics, and Pearson correlation tests were used for the bi-variate associations and analysis of variance (ANOVA) are performed to compare HCW generation rate by the type of health facilities. Bivariate (correlation) analyses are used to assess the relationships between independent and dependent variables. Then, multiple linear regression analysis was employed to establish the simple correlation matrices between different variables for investigating the strength and form of the relationship between the variables included in the analysis.

3.26.2 Qualitative data analysis

Qualitative data from observational and focus group interview data were transcribed into word processing and verbatim transcriptions are used and entered to ATLAS.ti 8 software to structure, explore, code and retrieve the data. Numeric values were assigned to each response in a database, cleaning the data, recoding, establishing a code book, and visually inspecting the trends to check whether the data are normally distributed.

3.27 PHASE TWO – COMPARE OR RELATE

The assumptions of qualitative and quantitative data provide different information's (observation in the case of qualitative data and closed indeed data in the case of quantitative data). The researcher assumes that qualitative and quantitative data collection has both limitation and strength, the researcher considers how the strength from the two data collection technique can be combined to develop a strong understanding of this study problems or research question and, as well, overcome the limitations of each. In a sense, more insight into a problem is to be gained from mixing or integration of the quantitative and qualitative data (Creswell and Creswell 2018: 279).

In this study approach, the researchers of this study collected both qualitative and quantitative data, analysed them separately, and then compared the results to see if the findings are similar or dissimilar to each other. The key assumption of this approach is that both qualitative and quantitative data provide different types of information often detailed views of participants qualitatively and scores on instruments quantitatively (Creswell and Creswell 2018: 282).

According to Creswell and Creswell recommendation (2018: 285), there are several ways to merge the qualitative and the quantitative databases. The researcher of this study used a side-by-side comparison and merging the two forms of data in a table or graph this is called a joint display of data. The basic reason of displaying the two data base result jointly is to effectively merge in a single visual and to make interpretation of the display easy for understanding.

3.28 PHASE THREE – INTERPRETATION OF THE DATA

The results section of this study reports the findings from the analysis of both the qualitative and quantitative databases. The interpretation in the convergent mixed methods approach is typically written into a discussion section of this study, the discussion section includes a discussion comparing the results from the two databases and notes whether there is convergence or divergence between the two sources of information (Creswell & Creswell 2018: 286).

3.29 PHASE FOUR- GUIDELINES DEVELOPMENT

Guideline is a formal statement and document intended to guide people and organisation on how something should be done or what something should be. A guideline aims to streamline particular processes according to a set of routine or sound practice. Guidelines may be issued by and used by any organisations to make the actions of its employees or divisions more predictable, and presumably of higher quality. Solid HCW management guidelines are prepared by the researcher of this study to guide the health facility workers on how to segregate, collect, transport, store and dispose HCWs in a safe manner to protect the community and environment from infection and pollution.

3.30 METHODOLOGIES FOR GUIDELINES DEVELOPMENT

Guidelines are prepared to provide recommendation to inform the users about the how and when to do, the benefits and the harms of a specific intervention or situation to achieve the best outcome. The purpose of the guideline, the scope and the time frame of the development of the guideline are one differ from the other (Kowalski, Morgan, Falavigna, et al. 2018: 2).

Health and health related topics guideline development needs different methods and procedures. Evidence based guideline development needs a formal way of appraisal of literature while others also use a consensus of experts. For this study evidence-based guideline were considered to provide better recommendation for practice than consensus-based guidelines but are time consuming and expensive to create. The methodologies set for this study used the following steps. Before experts and partners are considered, a draft guidelines scope was developed by the principal investigator and specific key questions that the guidelines addresses are explicitly defined. Scoping is the process of defining what the guidelines will and will not include.

Once a draft scope is defined, partnering, or collaborating organisations were considered/secured and guidelines evaluation groups were formed from a panel of experts. This is followed by a standardised systematic review of the available literatures were conducted to ensure that the resultant practice guideline is objective, transparent and scientifically valid. Formulating draft recommendations were prepared based on several factors such as the quality of the gathered evidence, applicability, benefits versus harm, resource issues, and for each recommendation, the aggregate quality were assessed by collecting the feedback from the concerned bodies. An independent review committee was organised and, publishing and maintaining guidelines will be reviewed periodically to determine if an update, revision, or reaffirmation is needed (College of American pathologist laboratory quality solutions 2020:6-16; Gopalakrishna, Langendam, Scholten, et al. 2014:3-5).

3.31 SUMMARY AND CONCLUSION

The basic need for a research study is a properly articulated design. It provides sound reasoning for why the study is intended, identifies the specific objectives, and provides a logical plan for how those objectives will be met. The chosen paradigm for this study is pragmatism as the researcher believes that a pragmatic world view and its alignment to the mixed-methods research is most appropriate for this study because of pragmatism supports using both qualitative and quantitative methods, places the research question(s) at the centre of the inquiry. A mixed method research design was selected. Mixed methods research advances the systematic integration or mixing of quantitative and qualitative data within a single study. Both qualitative and quantitative data will provide different types of information and to compare the two results with the intent of obtaining a more complete understanding of a problem.

Both qualitative and quantitative data were collected simultaneously, to use the result to understand the research problems well. Merging the data, explaining the data and embedding the data types of integration were used for this study to better understand the research problem. Qualitative methods of this study generally aimed to understand the experiences and attitudes of health facility staff. Quantitative part of this study involved the process of collecting, analysing, interpreting, and writing quantitative information that will be found in this study.

CHAPTER 4

ANALYSIS, PRESENTATION AND DESCRIPTION OF THE RESEARCH FINDINGS

4.1 Introduction

Consistent with the purposes of this study, this chapter presented and discussed the results of the study's data in tables and narrative forms, and this chapter aims to present data descriptions and findings from the questionnaire, observation, measurement by using weight scale, and interviews. The interpretations of the findings are written in the discussion part of this study. The discussion section of this study included a report comparing the findings from the two databases (qualitative and quantitative) and notes whether there is convergence or divergence between the two sources of information. The findings are presented to answer the following research questions.

4.2 Research questions

1. What are the different types of HCWs generated in health care facilities?
2. What is the level of knowledge of the health care institution staff on SHCW?
3. What are the gaps in the existing Ethiopian national HCW management policies
4. What are your experiences of SHCW practices at different level in Hossaena Town?
5. What guidelines can be proposed to improve management practices of SHCW in Ethiopia?
6.

4.3 Data management and analysis

4.3.1 Data collection process

Two sets of data were collected; quantitative data are collected by using structured questionnaires. The quantity of solid HCWs generated data were collected by segregating the mixed waste transported from each service area to disposal sites. Qualitative data were collected by using FGDs, and observation of the SHCWM practice (SHCWMP) was observed qualitatively by the principal investigator.

4.3.2 Data cleaning, consistency, and completeness

In this study, appropriate and scientific care was taken to maintain the integrity of the data before, during, and after data collection by preparing the appropriate data collection tools, pretesting the data collection tools, providing training for data collectors, and appropriate data entry practice. Data were cleaned on daily during data collection practice, during data entry and before analysis for completeness and consistency.

4.3.3 Data analysis

Data analysis in a convergent mixed method design consists of three phases: primarily the quantitative data analysed in terms of statistical results; then the qualitative data analysed by coding the data and collapsing the codes into broad themes; finally the mixed-method data analysis, this is the analysis that consists of integrating the two databases. This integration consists of merging the results from both the qualitative and the quantitative findings.

4.3.3.1 Quantitative data analysis

After the data were entered to computer software SPSS version 27.0 by the researcher, and the analysis was performed with close technical support from an experienced person in data management and analysis. SPSS software greatly helped to run descriptive analysis including frequency mean and percentage, a new variable was created by using recorder and compute functions in SPSS. In most of the variables, percentages and means were used to report the findings with a 95% confidence interval (CI). After the quantitative data were entered into the SPSS version 27, the data were observed for the outlier, missing and inappropriate entries

were corrected from the hard copy of the data collection tools by using their unique code given to each questionnaire before starting the analysis.

4.3.3.2 Qualitative data analysis

According to Burke (2017: 186) explanation, qualitative data analysis is much more eclectic, and there is no single right way of analysing the data because of the nature of the data collected. The data in this study, that are collected from a qualitative comes from open ended interview and focus group discussions data are analysis requires coding and searching for relationships and patterns until a holistic picture emerges (Burke 2017: 186).

Qualitative data from open ended interview and focus group discussion data was transcribed into word processing and verbatim transcription was used and entered ATLAS.ti 8 software. Transcription is the process of transforming qualitative research data, such as audio recordings of interviews and field notes written from observations, into typed text.

Different steps were followed, organising, and preparing the data for analysis by involving the transcribing interviews, optically scanning materials, typing up field notes, cataloguing all visual material and sorting and arranging the data into different types depending on the sources of information, then reading and looking at all data, this step provides a general sense of the information and an opportunity to reflect on its overall meaning. Coding and organizing the data, reading through all data, organizing, and preparing data for analysis. The analysis was performed separately for each health facility (Creswell 2014: 247).

Thematic analysis is one of the common types of qualitative data analysis (Burke 2017: 780). Qualitative data analysis was started by coding the data and collapsing the codes into broad themes.

Thematic analyses were used to analyse the focus group findings of this study. It is the analysis of the major themes found in this study open ended interview and FGDs. The thematic analysis of the qualitative part of this research was following data familiarisation, initial code generation, search for themes based on the initial

coding, review of themes, theme definition and labelling, and report writing (Howitt 2016: 173). The observed practice of SHCWMP was analysed by using thematic analysis.

To describe and summarise the findings obtained from the samples of this study, descriptive analysis was conducted. Reliability statistics for constructs, frequencies and percentage distributions, means and modes of each item, spearman rho correlations, and chi-square test of association, were used to portray the respondents' responses. The tool used to assist the analysis was SPSS version 27 and thematic analysis for qualitative data.

4.4 RESEARCH RESULTS

The results are presented in five sections from nine data collection tools gathered from health facilities and workers and in line with the research questions.

4.4.1 Sample characteristics

Two different samples were identified for this research. For the qualitative part of this study, relatively small purposeful samples were considered and a relatively large sample (all health facilities') for the quantitative phase was used to enhance the generalisation of the quantitative result. Both of the samples were taken from the same population.

All health facilities were included in this study, and the generation rate of HCW and composition has assessed the practice of segregation, collection, transportation, and disposal system was observed quantitatively by using structured questionnaires. To ensure representativeness, various levels of health facilities were considered from the town.

4.4.2 Participant profile and response rate analysis

Data collection commenced with 556 of the health facility workers to complete the questionnaires, and properly filled questionnaires were 540 (97.1), from individuals

representing these 41 health facilities. Then, questionnaires were checked for completeness and consistency of all essential information. The questionnaires that were not properly completed were excluded from the analysis. The total excluded questionnaires were 16 (2.9%). 540 (97.1%) properly completed questionnaires were used for analysis.

The quantitative part of this research finding is presented in two sections by using different data collection tools used for data collection in this study. The first section presents the results from the data gathered from participants' questionnaires, and this is presented in statistical form. The second section comprises a data presentation from a checklist used to inspect SHCWM practices. The qualitative part of these research findings obtained using FGD were presented using thematic analysis. The findings of the study are organised according to the specific objectives identified by the study.

The participant distribution according to the level of a health facility is that five hundred forty participants were involved in this study, 303 (65.4%) of the participants were from government health facilities and 187 (34.6%) were from private health facilities. 258 (47.8%) of the research participants are from a government hospital and 95 or (17.6%) of participants are from three government health centres. 79 (14.6%) of the participants are from medium clinics, 92 (17%) of the participants are from small clinics and 16 (3%) of the participants are from the surgical centre see Table 1.

Three hundred forty-three (58%) of the respondents were female and 227 (42%) were male. The mean and median age of respondents is 29.09 (CI: 28.56-29.61) and 28 respectively, with a standard deviation of 5.82 (95%CI:5.38-6.40), minimum age of respondents was 18 and the maximum age of respondents was 56 years. The majority of the research participants, 215 (39.8%) were in the age group of 26-30.

Table 4.1: Health facilities and professionals participated in these study facilities

Type of health facilities		Nurse	GP	Lab	Cleaner	Midwifery	Specialist	Physiotherapist	Laundry	Pharmacy	Environmental	Anaesthesia	Psychiatry	Radiology	HO	Total
NEMMCSH	Number	104	18	7	50	33	3	2	11	1	3	12	3	6	5	258
	%	40.3	6.1	2.7	19	12.7	1.2	0.7	4.26	0.4	1.1	3.87	1.1	2.3	2	
Government health centres	Number	38	4	9	8	8	0	0	1	4	0	0	0	0	24	96
	%	39.5	4.1	9.3	8.3	8.3	0	0	1	4.1	0	0	0	0	25	
medium clinic	Number	24	1	18	16	5	0	0	0	0	0	0	0	0	15	79
	%	30.3	1.2	22.7	20.2	6.3	0	0	0	0	0	0	0	0	19	
Small clinic	Number	24	0	20	20	2	0	0	0	2	0	0	0	0	23	91
	%	26.3	0	22	22	2.1	0	0	0	2.1	0	0	0	0	25.2	
Hiwot Speciality Centre	Number	4	3	3	3	0	2	0	0	1	0	0	0	0	0	16
	%	25	18.7	18.7	18.7	0	12.5	0	0	6.25	0	0	0	0	0	
Total	Number	194	26	57	97	48	5	2	12	8	3	12	3	6	67	540
	%	35.9%	4.80%	10.6%	18.0%	8.9%	0.9%	0.4%	2.2%	1.5%	0.6%	2.2%	0.6%	1.1%	12.4%	100%

Out of 540 participants in this research, 343 (58%) of the respondents were female. This research is similar to the study conducted in KwaZulu Natal Province South Africa, and Egypt, in which female respondents were more than males and contrary to the study findings conducted in Palestine by Tabash, et al (Olaifaac, Govenderb, & Rossc 2018: 139; Gihan, Shimaa, & Rania 2018: 58; Tabash, Rim, Mahmoud, Elborgy, & Abu-Hamad. 2018:432).

Table 4.2: Health facilities and health facility workers participated in this study

Type of health facility	Facilities participated in this study		Health facility workers participated in this study		
	Number	%	Frequency	Percent	Cumulative Percent
Hospital	1	2.43	258	47.8	47.8
Government health centres	3	7.31	95	17.6	65.4
Medium clinics	17	41.46	79	14.6	80.0
Small clinics	19	46.34	92	17.0	97.0
Surgical Centre	1	2.43	16	3.0	100.0
Total	41	100	540	100.0	

The mean age of respondents in this study was 29.09 (CI: 28.56-29.61) with a standard deviation of 5.82 and (95%CI: 5.38-6.4). This result was lowest when compared to other studies conducted in Pakistan and Nigeria which are31 and 35.46 respectively (Ali, Anwar, Suhail, Dahri 2020:381; Awodele, Adewoye, & Oparah 2016: 269). The findings of this study are also nearly the same to the studies conducted in Debere markos Town Ethiopia, which is the mean age of the study participants was 30.4 (Deress, et al. 2018:4). The minimum age of respondents was 18 and the maximum age of respondents was 56. The majority of the staff were in the age group of 26-30 this is similar to the study findings of Bakshi et al. (Bakshi, Ghosh, Mukherjee, Chakraborty 2017:16). The mean number of years spent in the facility was 3.66 (95% CI: 2.99-3.73) years. This finding was not comparable to the study findings in Nigeria which is 9.73 years of service (Awodele, et al. 2016: 5).

4.4 3 Focus group discussion (FGD) participants

Focus group discussion is a type of group discussion in which a moderator or the researcher leads a discussion with a small group of individuals to examine, in detail, how the group members think, feel and interpret the surroundings about a topic (Johnson & Christensen 2014: 325). This study employed focus group discussion (FGD) for health facility workers in all levels of health facilities found in Hossaena Town to explore factors affecting SHCWMP in Hossaena Town. The main findings of FGDs data generated are presented, interpreted, discussed, and summarised. In the government health facilities, focus group participants were selected purposefully based on their profession, length of services they provide, and the kind of information of interest to the researcher because of the large amounts of health facilities workers. Professionals' educational backgrounds degrees and above are grouped together for the FGDs. These health care providers were an experienced group who have been providing sufficient information on the practice of SHCWMP, and other health care workers are grouped in other groups. In the private health facilities, the FGDs were conducted by using different professionals of the facilities in one FGD because of a little number of the workers found in the facilities.

Forty-five FGDs were conducted. Four of the FGDs were conducted with cleaners, another four were only health care providers because of the use of homogeneous groups promotes discussion. The rest 37 FGDs in private health facilities were mixed from health professionals and cleaners together because of the number of workers found in the private facilities.

Polit and Beck (2017: 720) and Creswell and Creswell (2018: 313) highlight that 6-10 participants are recommended for FGDs in the study of health-related topics. In this study, the discussion was conducted with purposively selected participants per group for government health facilities and randomly for private health facilities. About 185 health facility workers have participated in the FGDs from 41 health facilities. In four of the government health facilities eight FGDs that is two FGDs from one health facilities conducted and one FGDs were conducted in 37 of each of the private health facilities.

4.4.4 Analysis of the result obtained from focus group discussions

Focused group findings of this study were analysed by using thematic analysis. Thematic analysis is an analysis of the major themes that were found in this study interviews and other qualitative data (Howitt 2016: 162-176). Thematic analysis of this finding in some cases were amenable to simple quantification since a theme was coded as present or absent in, say, a percentage of the interviews.

According to Kiger and Varpio (2020) citing Braun and Clarke (2006), qualitative data can be analysed by using thematic analysis, which entails searching across a data set to identify, analyse, and report repeated patterns. It is a method for describing the data, but it also involves interpretation in the processes of selecting codes and constructing themes. To understand thoughts, experiences, or behaviours across a data set thematic analysis is the appropriate and recommended techniques. The thematic analysis of the qualitative part of this research followed the familiarisation of the data, initial code generation, preparing themes based on the initial code, reviewing of themes, definition and labelling, and report writing (Howitt 2016:173).

4.4.5 Professionals participated in this study

Nurses, cleaners, and health officers make up the largest number of professionals who are participated in this study. About 194 (35.9%), 97 (18%), and 67 (12%) of the respondents are nurses, HCW collection workers, and health officers, respectively in their profession. About 354 (65.5%) of the workers who participated in this study were from government health facilities and the rest were from private health institutions.

Table 4.3: Level of health facilities and professionals participated in this study

Level of health facilities	Professions														Total
	Nurse	GP	Lab	Cleaner	Midwifery	Specialist	Physiotherapist	Laundry	Pharmacy	Enviro	Anaesthesia	Psychiatry	Radiology	HO	
NEMMCSH*	104	18	7	50	33	3	2	11	1	3	12	3	6	5	258
Government health centre	38	4	9	8	8	0	0	1	4	0	0	0	0	24	95
Medium clinic	24	1	18	16	5	0	0	0	0	0	0	0	0	15	79
Surgical Centre	4	3	3	3	0	2	0	0	1	0	0	0	0	0	16
Small clinic	24	0	20	20	2	0	0	0	2	0	0	0	0	23	91
Total	194	26	57	97	48	5	2	12	8	3	12	3	6	67	540
% of Total	35.9 %	4.8 %	10.6 %	18.%	8.9%	0.9%	0.4%	2.2%	1.5%	0.6%	2.2%	0.6%	1.1%	12.4 %	100. %

*NEMMCSH – Nigist Eleni Mohamed memorial comprehensive specialised hospital.

4.4.6 Educational background and length of service provided in the facilities by the research participants

The smallest educational background working in health facilities is reading and understanding of written documents to facilitate the appropriate segregation of waste. The mean number of years spent in the facility was 3.66 (95% CI: 2.99-3.73) years. About 319 (59.1%) and 54 (28.5%) of the participants are first-degree and diploma holders. This finding was consistent with the study findings of Khalyan et al. in Saudi Arabia, 54.1% participants had degrees while 45.9% had diploma certificates (Kalyan, Reddy, & Al Shammari 2017:638). The highest number of the staff participated in this study were first degree holder next to diploma. This finding was similar to the study findings in eastern Ethiopia (Doylo, Alemayehu & Baraki 2018: 285).

4.4.7 Department staff participated in this study and the length of service provided

Outpatient, emergency, inpatient, laboratory, cleaning department, laundry, imaging, Anti-retroviral therapy (ART), pharmacy, physiotherapy, ophthalmology, central intensive care unit (CICU), radiology, and dental department staff participated in this study. The work experience of the participants revealed 153 (28.3%) participants , served their institution for less than one year. 26.3% of the participants were working at outpatient departments followed by cleaning, laboratory, and obstetric departments. One thousand forty-two (1042) workers are working in the facilities found in Hossaena Town; out of this 550 of them have direct contact with solid HCW generation rate and disposal. A large number of staff 976 (91.7%) are working in government health facilities than private health facilities. About 28,658 of patients have visited the health facilities in one month in Hossaena Town.

4.4.8 Health facility workers participated in HCW management practice

Figure 1 shows that 546 health facility workers are providing health services in 41 health facilities found in Hossaena Town. Out of this, 49.6% of the staff are from

Nigist Eleni Mohammed Memorial Comprehensive Specialised Hospital (NEMMCSH).

About 274 inpatient beds are available in the town, and out of these 94.5% of the beds are found in NEMMCSH.

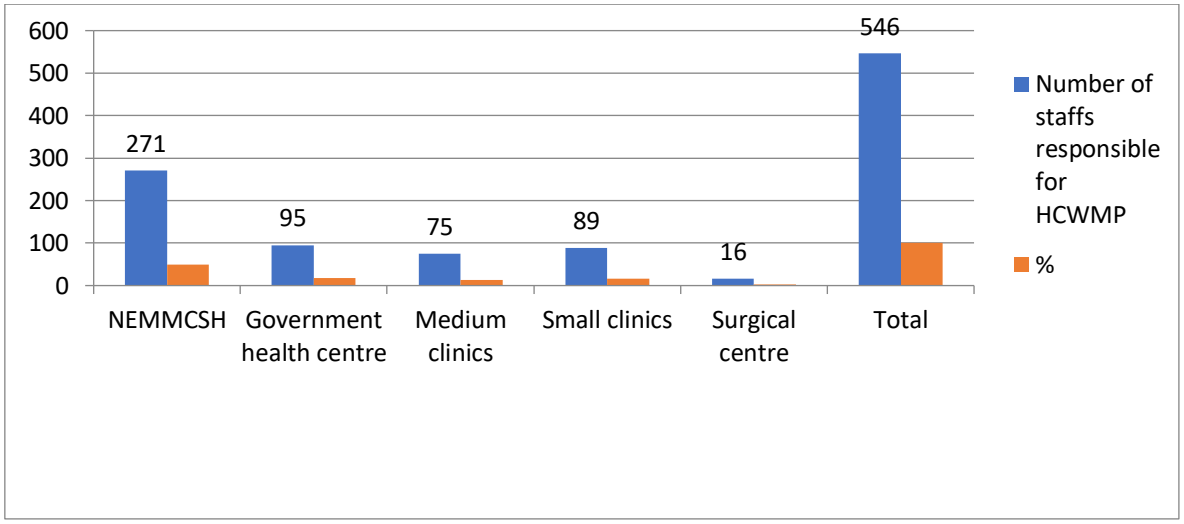

Figure 4.1: Health facility workers participated in HCWMP

4.5 PRESENTATION AND DISCUSSION OF THE FINDINGS

4.5.1 HCW generation and composition

HCW generation rate assessment was done at all study health facilities in the study area. Before starting to measure the generated solid health care wastes (SHCW) all solid HCWs generated before the study time was removed and disposed to a disposal site to get the accurate generation rate per day. The measuring and identification of SHCW were done for one week starting from Monday morning to the next Monday morning. Figure 4.2 shows the segregation practice of the mixed wastes transported to the disposal site. To get an accurate measurement of the solid wastes generated in each health facility the principal investigator checked the digital weight scale three times per day for accuracy.

Figure 4.2: Segregation practice of SHCW before measuring the weight

The HCW generation rate was proportional to the number of patients who visited the health facilities and the type of service provided. The highest number of patients who visited the health facilities was in NEMMCSH, and the type of service provided was diverse and the waste generation rate was higher than other health facilities. About 272, 18, 15, 17, and 20 average patients were visited the health facilities per day in NEMMCSH, government health centres, medium clinics, small clinics, and surgical centre respectively. This finding was consistent with the study findings in Vhembe District of Limpopo Province, which is dependent on the number of patients attended on a daily basis, type of the healthcare facility, the number of admission beds, and the type of services being rendered (Olaniyi, Ogola, & Tshitangano 2019: 6). In NEMMCSH the highest number of patients visited the health facilities, and the waste generation rate was higher than other health facilities. In addition, 272, 18, 15, 17, and 20 average patients were visited the health facilities per day. This finding was higher compared to the study findings of Myanmar about half of the primary health care (55.9%) provided health services to less than ten patients per day (Win, Saw, Oo, et al. 2019: 84).

4.5.2 What are the different types of solid HCWs generated in health care facilities?

Solid HCW is categorised into infectious and non-infectious waste. Infectious waste is a waste that contains pathogens (viruses, bacteria, fungi, or parasites) in sufficient concentration or quantity to cause disease in susceptible hosts. According to WHO,

infectious wastes are wastes contaminated by blood components, free-flowing blood, and other body fluids, dressings, bandages, swabs, gloves, masks, drapes, gowns, and other material contaminated with blood or other body fluids, and waste that has been in contact with the blood of patients (WHO 2014: 4).

The non-infectious solid HCW includes are not in contact with infectious agents, hazardous chemicals, or radioactive substances, and do not pose a sharp hazard. If it is not mixed with infectious agents nearly 85% of all waste from healthcare facilities is non-hazardous waste and is usually similar in characteristics to household solid waste. More than half of all non-hazardous waste from health facilities are paper, cardboard, discarded food, textiles, and plastics (WHO 2014: 8). In the study, health facilities glove, IV bag and IV-line, syringe and needles, vials, gauze, paper and cardboard, plastic and rubber, organic or vegetables, plastic bottles, leftover food, laboratory samples, laboratory slides, urine cup, diapers, wooden spatula, metal tin, and mixed wastes that are difficult to segregate are the types of wastes generated in hospital.

A total of 272 inpatient beds are available in the town, 95% of the inpatient beds are found in NEMMCSH. About 33 (80.5%) of health facilities in Hossaena Town have no inpatient services; these are medium and small clinics (private institutions). A total of 439.78 kilograms of waste are generated per day. Orthopaedic ward, obstetric ward, neonatal intensive care unit, laboratory, and kitchen are generated much amount of solid HCWs compared to others which are, 56.1 kg, 53 kg, 34.4 kg, 34.08 kg, 31.7 kg of wastes generated daily respectively.

Paper and cardboard (141.65 kg), leftover food (81.71 kg), and contaminated gloves (42.96 kg) are the leading HCW generated per day. Even though the generated HCW is transported by mixing both infectious and non-infectious solid waste to the disposal site, the researcher segregates the mixed generated waste into infectious and non-infectious wastes. The results showed that 128.22 kg (29.1%) and 311.5 kg (70.9%) of wastes are infectious and non-infectious wastes respectively. Diapers and metal tins used for powder milk packages are exclusively generated from the Neonatal Intensive Care Unit and Paediatrics Department.

4.5.2.1 Daily generation rate, the average number of patients, and average HCW generation per patient per bed in NEMMCSH

One hundred forty-three patients were admitted on average in different wards per day, and the average daily generation rate of solid HCW per patient per bed per day was 1.67 kg. The orthopaedics ward generates 2.24 kg of waste per patient per bed per day, and the least SHCW generation rate per patient per bed per day was observed in the maternity ward which is 0.55 kg per patient per bed.

The average daily generation rate of solid HCW per patient per bed per day was 1.67 kg. These findings show a less generation rate compared to the findings of the study conducted in Iran which is 2.72 kg of waste per patient per bed per day (Rafiee et al. 2016:6) and higher than the study findings in Nigeria and Addis Ababa which is 0.181 and 0.668 kg per patient per day respectively (Awodele, et al. 2016:5; Debere, Gelaye, Alamdo 2014: 4). The highest solid health care waste generation (SHCWG) per patient per day was observed in the orthopaedic ward which is 2.24 kg per patient per bed per day. This finding was contrary to the study conducted in the study by Asrat et al. and Rafiee et al. respectively which is the highest SHCWG were observed at obstetric ward and operation theatre (Meleko, et al. 2018:130; Rafiee et al. 2016:6).

4.5.2.2 HCW generation per patient per day in the study facilities

The minimum number of patients visited per day in health facilities was five and the maximum number of patients visited the health facility was 283. The minimum and maximum HCW generation rate per health facility per day was 0.7 kg and 439.78kgs respectively. The average SHCW generation rate per day in the town was 532 kg.

4.5.2.3 The average number of patients visited the health facilities and healthcare waste generation

A total of 994 patients per day visited the health facilities found in Hossaena Town. Table 17 shows that 362 (36.7%) of the patients are treated in the government

health facilities which is one hospital and three government health centres found in the town.

About 165 kg (31.2%) of the generated wastes are infectious and 366.48 kg (68.8%) of the waste generated has non-infectious or household waste. Only 2 (4.8%) of the facilities generate infectious waste below the mean and the rest of the health facilities generate infectious solid HCW above the mean. Government health facilities generate more waste compared to private health facilities.

About 165 kg (31.2%) of the generated wastes per day in the study health facilities were infectious and 366.48 kg (68.8%) of the waste generated is non-infectious or household waste. This finding was contrary to WHO's findings, which is 15 % of the generated wastes are infectious, which is twofold greater than the WHO study(WHO 2014:3).In contrast to the WHO's findings, other studies conducted in Ethiopia and Iran by Asrat, et al. and Rafiee et al. show greater than 57% and 42.2 % of the generated wastes respectively were infectious and which is greater than the study findings of this research (Meleko, et al., 2018:129; Rafiee et al. 2016:6). This indicates that the segregation of different types of wastes at the source of generation was not properly implemented in the studied health facilities.

4.5.2.4 Average SHCW generation per the level of health facilities

Average HCW generation in government health centre was 5.33 kg per day. Medium and small clinics generate a very small amount of solid HCW compared to the government health centres which is 1.2 and 2.03 kg of SHCW per day per facility respectively. This finding was consistent with the study findings of Khan et al in Pakistan which show that the generation rate of SHCW is 2.01 kg/day/clinic (Khan, Khan, Ahmed, Shaikh, Peng, & Cheng 2019:5). In this study site, government health facilities generate more waste compared to private health facilities. This finding was consistent to the study findings of Debre et al. in three government and three private health facilities in Addis Ababa (Debere, Gelaye, Alamdo & Trifa: 2014:4). Contrary to the study findings done in Mongolia, which shows in the private health facilities, the percentage of medical wastes was higher in the public facilities (Shinee, Gombojav, Nishimura, Hamajima, Ito, 2018:440).

Table 4.4: Infectious and non-infectious solid HCW generated in the study health facilities

Health facilities	Number	Infectious waste generated		Non-infectious waste generated		Average total SHCW generation per day per facility
		KG	%	KG	%	
Hospital	1	128.22	77.2	311.5	84.99	439.72 kg
Health centres	3	6.8	4.09	9.2	2.51	5.33 kg
Medium clinics	17	15.3	9.21	20.38	5.56	1.22 kg
Small clinics	19	14.7	8.85	23.9	6.52	2.03 kg
Surgical centre	1	1	0.60	1.5	0.40	1.4 kg
Total		166.02		366.48		

4.5.2.5 Number of patients visited the health facilities and infectious waste generation rate

Among the participating health facilities in this study, five, 283, and 994 are the number of minimum patients, maximum number of patients, and all patients visited the health facilities per day in the town respectively. The HCW generation rate shows 0.7 kg, 439.78 kg, and 532 kg of wastes have generated the minimum, maximum, and overall HCW generation rate per day. 166 kg (31.2%) of solid infectious wastes is generated per day in the town. The mean infectious waste generated per day per health facility was 4 kg.

4.5.3 What is the level of knowledge of the health care institution staff on SHCWM?

4.5.3.1 Knowledge of the staff on role and responsibilities of SHCWM practice

In this research, only those who have direct contact have participated in this research and 434 (80.4%) of the respondents are agree on, they have roles and

responsibilities for appropriate SHCWM practice, and the rest (19.6%) are disagreed their responsibility to manage HCWs properly, even though they are responsible.

Health facility workers in NEMMCSH and medium clinics are knowing their responsibilities better than others and their result shows above the mean. Table 26 shows 84.5%, 74.5%, 81%, 73.9% and 75% in NEMMCSH, government health centre, medium clinics, small clinics and surgical centre respectively.

4.5.3.2 The benefit of training for HCW management practice

WHO (2017:21) and Kumar, Somrongthong, and Shaikh (2015:2) emphasise regular, appropriate, and on-going training, supervision, and sufficient staffing are fundamental to ensure appropriate knowledge, attitude and safe practice for improving and maintaining HCW management services in healthcare facilities. About 41.7% (95% CI: 37.7-46) of the research participants are trained in HCW management practice. More trained staff are available in NEMMCSH, and small clinics, which is above the mean. Less than half of the staff are trained on SHCWMP. This finding was divergent from the findings of Oyekale and Oyekale in Nigeria shows training on the management of HCW were attended by 67.2% and 53.2% of the healthcare facilities from Cross River and Imo states, respectively (Oykale & Oykale 2017: 1).

4.5.3.3 Knowledge of health facility workers regarding the availability of policy on SHCWM

HCWM training for health facility workers, patients, and visitors, raising public awareness, establishment of a legal and policy framework are essential elements of successful HCWM. The availability of HCWM policy drives decision making at political level, mobilise government effort and resource used to create condition to make change in health facilities. A national policy document should form the basis for developing the law and should be complemented by technical guidelines developed for the implementation of the law (WHO 2014: 41, 47). About 374 (69.3%) of the respondents agreed that there is SHCWM policy in Ethiopia. The more

knowledge which is above the mean (72.9%) on the presence of the policy is reported from NEMMCSH.

4.5.3.4 Knowledge about what to do in case of an accident

Self-reported level of knowledge on what to do in case of an accident revealed that 438 (81.1% CI: 77.6-84.3%) of the respondents knew what to do in case of an accident. Government health centres staff and medium clinics staff knowledge about what to do in case of an accident was above the mean (88.4% and 82.3%) respectively, and the rest were below the mean. The action performed after an occupational accident revealed that 56 (35.7%) of the respondents are nothing done after any kind of exposure to an accident. Out of 56 respondents who have done nothing after exposure, 47 (83.92%) of the respondents answered yes for their knowledge about what to do in case of an accident. Out of 157 respondents who have been exposed to occupational accidents, only 59 (37.6%) of the respondents performed the appropriate measures, 18 (11.5%), 9 (5.7%), 26 (16.6%), 6 (3.8%) of the respondents are taking prophylaxis, linked to the incident officer, consult the available doctors near to the department, and test the status of the patient (source of infection) respectively and the rest were not performing the scientific measures, that is only practicing one of the following practices washing the affected part, squeezing the affected part to remove blood, washing the affected part with alcohol.

4.5.3.5 Average knowledge on SHCWM practice in the study health facilities

Knowledge of SHCWM practice was assessed by using three questions, do you know there is a policy on SHCWM, do you think the current practice of HCW management is environmentally friendly, do you know what to do in case of an accident. The mean appropriate SHCWM knowledge among health facilities was 66.2%. The mean knowledge of the staff on HCW management practice (69.3%) was above the mean in NEMMCSH and others were below the mean which is 63.3%, 61.6%, 61.3%, and 60.7% in health centres, medium clinics, small clinics, and surgical centres respectively.

Table 4.5: Knowledge of health facility workers in case of an accident

Variable	Health facilities	Response	Frequency	%	95% Confidence Interval	
					Lower	Upper
Do you know what to do in case of an accident?	NEMMCSH	no	53	20.5	15.5	26.0
		yes	205	79.5	74.0	84.5
		Total	258	100.0	100.0	100.0
	Government health centres	no	11	11.6	5.8	18.9
		yes	84	88.4	81.1	94.2
		Total	95	100.0	100.0	100.0
	Medium clinics	no	14	17.7	10.1	27.2
		yes	65	82.3	72.8	89.9
		Total	79	100.0	100.0	100.0
	Small clinics	no	19	20.7	13.0	28.3
		yes	73	79.3	71.7	87.0
		Total	92	100.0	100.0	100.0
	Surgical centres	no	5	31.3	9.6	56.3
		yes	11	68.8	43.8	90.4
		Total	16	100.0	100.0	100.0
	Overall /mean	**no**	**102**	**18.9**	**15.7**	**22.4**
		yes	**438**	**81.1**	**77.6**	**84.3**
		Total	**540**	**100.0**	**100.0**	**100.0**

4.5.3.6 Knowledge on the involvement of the staff in SHCWM practice

Segregation, educating the patient and attendants, protecting the environment from pollution, and I don't know are the answers provided for the question on the involvement of individual staff on SHCW management. In addition, 229 (42.4%) of the staff response shows their involvement in the segregation of SHCW and 192 (35.6%) of the respondents don't know their involvement in SHCWMP on the institution.

Table 4.6: Involvement of the staff on SHCWM practice in different levels of health facilities

Variable	Please describe your involvement in SHCWM?					
Health facilities	**Response**					
	Proper disposal	**Segregation**	**Educating the people**	**Protecting the environment**	**I don't know**	**Total**
NEMMCSH N=1	33 (12.7%)	111 (43.02)	35 (13.56)	7 (2.71)	72 (27.9)	**258**
Government health centres N =3	5 (5.26)	34 (35.7)	9 (9.47)	5 (5.26)	42 (44.2)	**95**
Medium clinics N=17	4 (5.06)	38 (48)	5 (5.26)	1 (1.05)	31 (32.6)	**79**
Small clinics N= 19	5 (5.43)	39 (42.3)	5 (5.43)	2 (2.1)	41 (44.5)	**92**
Surgical centre N=1	1 (6.25)	7 (43.75)	1 (6.25)	1 (6.25)	6 (37.5)	**16**
Total	**48 (8.88)**	**229 (42.4%)**	**55 (10.1)**	**16 (2.96)**	**192 (35.55)**	**540**

4.5.3.7 Knowledge of the research participants on national policy aspects related to SHCWM

Kumar, Somrongthong, Ahmed, and Almarabheh (2018: 2) found that a positive relationship between the knowledge and practice of the health facility workers (r=0.541 and P=<0.001). This signifies that the increase in knowledge of health workers about HCWM was positively related with their practices. However, 251 (46.5%) of the respondents did not know the national policy of SHCWM practice. Therefore, 17 (13.1%), 69 (12.8%), 95 (17.9%), 54 (10%), 251 (46.5%) of the respondent's knowledge on national policy of SHCWM was red for infectious, yellow for infectious, segregation of waste, and preventing from air pollution respectively. About 108 (41.8%), 41 (43.15%), 43 (54.43%), 48 (52.17%), 11 (68.75) of the respondents were lack of knowledge on Ethiopian national SHCWMP for NEMMCSH, government health centres, medium clinics, small clinics, and surgical centres respectively.

4.5.3.8 Knowledge of the research participants on local policy aspects related to SHCWM practice

Research participants' knowledge were assessed about the local policy of SHCWM practice. 365 (67.59%) of the respondents answered they don't know about the local policy of SHCWMP. This answer shows a deficiency of knowledge by 21.11 % from the national policy to local policy. The highest lack of knowledge was observed in NEMMCSH, next to surgical centre, medium clinics, small clinics, and government health centres.

Furthermore 46 (8.5%) of the respondents responded that SHCWM policy contained that plastics wastes should not be burned,

41 (7.6%) are responding that the policy contained SHCW disposal should not pollute the surrounding air, 88 (16.3%) are responding that the policy contained SHCW should be segregated based on the type.

Greater than half of the respondents did not know about the local SHCWM policy. lack of knowledge on local policy was observed in NEMMCSH compared to other health facilities.

4.5.3.9 Understanding of health facility workers regarding current SHCWM practice

Health facility workers' understanding of overall SHCWM practice was assessed by asking, 'Do you think the current practice of SHCWM needs improvement?' Four hundred forty-nine (83.1%) of the health facility workers are not satisfied with the current solid waste management practice at the different health facility levels and they recommend changing it to a scientific one. 82.6%, 87.4%, 89.9%, 75%, 81.3% of the respondents are not comfortable or they need to improve SHCWM practices in NEMMCSH, government health centres, medium clinics, small clinics, and surgical centres respectively.

Table 4.7: Level of recommendation to improve the current practice

Variable	Health facilities	Response	Frequency	%	95% Confidence Interval	
					Lower	Upper
Do you think the current practice needs improvement	Overall /mean	no	91	16.9	13.9	20.8
		yes	449	83.1	79.2	86.1
		Total	540	100.0	100.0	100.0
	NEMMCSH	no	45	17.4	12.4	22.5
		yes	213	82.6	77.5	87.6
		Total	258	100.0	100.0	100.0
	Government health centres	no	12	12.6	6.3	19.4
		yes	83	87.4	80.6	93.7
		Total	95	100.0	100.0	100.0
	Medium clinics	no	8	10.1	3.8	16.5
		yes	71	89.9	83.5	96.2
		Total	79	100.0	100.0	100.0
	Small clinics	no	23	25.0	16.3	34.8
		yes	69	75.0	65.2	83.7
		Total	92	100.0	100.0	100.0
	Surgical centres	no	3	18.8	.0	37.5
		yes	13	81.3	62.5	100.0
		Total	16	100.0	.0	100.0

4.5.3.10 Factors contributed to improper SHCWM in the facilities

Lack of safety box, lack of colour-coded waste bins, lack of training, and no problems are the response to the question problems encountered in managing SHCWMP. 250 (46.9%), 232 (42.7%) of the respondents recommend the availing of safety boxes and training respectively.

4.5.3.11 Availability of IPC team in the facility

Only 4 (9.8%) of the facilities reported having infection prevention and control (IPC) team in the study health facilities. This finding was not comparable to the study findings conducted in Pakistan that is 30% of the study health facilities were having infection control teams (Khan, et al. 2019:5). These study findings were similar to the study findings conducted in Pakistan by Khan et al (2016: 40) confirmed that the IPC teams were almost absent at all facilities.

4.5.3.12 Focus group participants' response for appropriate SHCWMP

4.5.3.12.1 Patients and visitors lack of knowledge on SHCW segregation practice

Cleaners in the comprehensive specialized hospital suggested
"Personal responsibilities of patients and visitors on solid HCW disposal should be explained to help appropriate safe waste management practice and maintained good hygiene."

Nurses in the comprehensive specialized hospital and government health centres suggested
"Providing waste management training and creating awareness are the two aspects to improve SHCW segregation practice."

Doctors from comprehensive specialized hospital and surgical centre said that
"Training upgrades and creates awareness on hygiene for all workers."

The public awareness creates good HCWM practice and minimizes risks from poor hygiene practice and protects the people living near to waste management areas from human scavengers (WHO 2014: 223).

All of the facilities complain that visitors, attendants, and patients have poor knowledge on SHCW segregation practice, they do not read the labels posted on SHCW containers.

Health facility mangers from comprehensive specialized hospital said that
"HCW containers are not colour-coded, but we are trying to label infectious and non-infectious in Amharic languages."

40 (97.5%) of the health facilities were not providing health education on SHCW management practice for the patient and visitors. One of the facilities (WUNEMMCSH) has given health education to patients and visitors, but it was not continuous and some of the attendants waiting areas were missed in the health education programme.

4.5.4 What are the gaps in the existing Ethiopian national HCW management policies?

4.5.4.1 Policies on HCW management practice

The availability of HCW management policy report reveals that 69.3% (95% CI:65.4-73) of the staff are aware of the presence of SHCWM policy in the institution. Availability of HCW management policy was 188 (72.9%), 66 (69.5%), 53 (67.1%), 57 (62%), 10 (62.5%) in NEMMCSH, government health centre, medium clinics, small clinics, and surgical centre respectively. The availability of HCW management policy was above the mean in NEMMCSH and government health centres.

4.5.4.2 National SHCWM policy and instructive poster for SHCWM

The availability of the policy on SHCWM practice shows that 265 (49.4%) of the staff agree with the availability of policies on HCW management, and 5.2% of the staff are not aware of the availability or not of the policies. This finding was convergent with the qualitative observation that shows the availability of written national adopted/adapted SHCWM policies was observed at all study health facilities. About 240 rooms were observed, 28 (11.7%) of the rooms have posters or a written document of the national policy document that used for the management of SHCWMP, and the rest of the observed rooms were without the SHCWM policy.

Table 4.8: The availability of guidelines and instructive posters

Variables	Response	Frequency	Percent	95% Confidence Interval	
				Lower	Upper
Do you have the guidelines on HCWM?	No	247	45.7	41.4	49.8
	Yes	265	49.1	45.1	53.4
	I don't know	28	5.2	3.4	6.9
	Total	540	100.0	100.0	100.0
Do you have instructive posters on HCWM?	No	289	53.5	49.4	57.4
	Yes	251	46.5	42.6	50.6
	Total	540	100.0	100.0	100.0

4.5.4.3 Recommendation of the study participants, on what to include in the guidelines

Open-ended response on SHCWM practice of health facility workers was collected by using the prepared interview guide and the response was analysed by using thematic analysis. All the answered questions were tallied on the paper and exported to excel software for thematic analysis.

All of the study participants from comprehensive specialized hospital, government health centre, medium clinic, small clinic and surgical centre staff recommend

"appropriate segregation practice at the point of generation"

"health facility must avail all the necessary supplies that used for SHCWMP, punishment for those violating the rule of SHCWMP",

and

Nurses from comprehensive specialized hospital and medium clinic recommend *"waste management technologies should be included in solid waste management guidelines, and enforcement should be strengthened."*

Furthermore, 285 (52.8%), and 112 (20.7%) of the respondents recommended that health facilities must have the necessary supplies for SHCWMP, and punishment for those violating the rules should be included in the guidelines.

The availability of written national or adopted/adapted SHCWM policies was observed at all study health facilities. 28 (11.7%) of the rooms have either a poster or a written document of the national policy document. But all of the staff working in the observed rooms have not seen the inside content of the policy. The presence of the policy alone will not bring change to SHCWMP. This finding shows the presence of policy in the institution was good compared to the study findings in Menelik II Hospital in Addis Ababa shows HCWM regulations, as well as any applicable facility-

based policy and strategy were not found (Debalkie & Kumie 2017:45). But the finding of this study was less compared to the study findings in Pakistan which are 41% of the health facilities had the policy document or internal rules for the HCWM (Khan, et al. 2019:5).

Fifty-three percent of the respondents responded they have knowledge of the national policy of SHCWM practice. These findings were nearly similar to the study findings in India in which 55% of the study participants were familiar with the existing HCW management policy systems in India (Feridoz, & Krishnan 2018:3131). But the qualitative observational result of this study shows that the practice of waste management was not similar to the findings of the respondent's answer.

4.5.5 What are your experiences of SHCWM practices at different levels in Hossaena Town?

4.5.5.1 Poor segregation practice of SHCW

WHO recommends that appropriate colour-coded waste receptacles be available in all medical and other waste-producing areas of all health facilities, allowing for waste segregation and disposal at the point of generation, and reducing the need to transport waste through a health service area (WHO 2017:5).

4.5.5.2 HCW segregation practice

HCW segregation is the first step in every HCW management system (HCWMS). Based on the characteristics of the generated waste in the health care and research facilities it should be segregated into different fractions, by the person who produced each waste item (WHO 2014:64, 78).

4.5.5.2.1 Observational findings for SHCW segregation, collection, temporary storage, treatment, and disposal practice

Observation is the process or the action of observing or watching something or someone of the behavioural patterns in certain situation in order to gain information about the phenomena of interest. Observation is one of the mechanisms of collecting information about people practice (Johnson & Christensen 2014:327).

4.5.5.2.2 Observational findings of SHCW segregation practice

Solid health care waste management practice (SHCWMP) was observed by the principal investigator for all of the study health facilities. About 240 health care providing rooms were observed in 41 health facilities. Table 24 shows that 29.6% of the observed rooms were from outpatient departments and 40.4% of the observed health facilities were from medium clinics.

Health facility leaders were asked about the presence of segregation practice in the facility, and their response was HCW segregation practice was not implemented in 78% of the health facilities. But the qualitative observation indicated that inappropriate segregation was practised in 98.3% of the solid HCW containers. This finding was contrary to the study findings in Pakistan. The study shows that 27% of the under-study hospitals were separating the infectious and non-infectious waste at the level of source (Qadir, Murad, & Faraz 2016:802).

Three hundred and one (55.7%) of the respondents responded to the availability of colour-coded waste bins in the facilities, and 239 (44.3%) of the respondents reported that there were no colour-coded waste bins in the facilities, but the observational finding confirmed that there is a separate container only in 2 (4.9%) (government hospital and surgical centre) of the health facilities for infectious and non-infectious waste segregation practice and the rest were collected and generated SHCW by using single and non-colour coded containers. This finding was similar to the study findings of Debalkie and Kumie at Menelik II Referral Hospital in Addis Ababa (Debalkie Kumie 2017: 45). One out of the four government health facilities and one out of the 37 private health facilities uses colour-coded waste bins. This finding was contrary to the study findings of Berihun and Solomon in Addis Ababa. All government health facilities use two types of colour-coded labelling containers, and these findings are similar for private health facilities that are all private health

facilities are used uncovered plastic buckets of any type for on-site waste storage until collected for disposal (Berihun & Solomon 2017: 4).

The absence of colour-coded waste bins was observed at medium and small clinics in the study areas. This is because the clinics are privately owned, and the regulatory bodies have poor controlling mechanisms. This finding was similar to the study findings of Khan et al. in Pakistan, no colour coding or labelling procedure was found (Khan, Cheng, Khan, & Ahemd 2019: 5).

The main problem that encountered in the effective management of SHCWMP was a lack of awareness and commitment in relation to appropriate SHCW segregation practices. Providing practical-based SHCWM refresher training and continues follow-up will improve the management of waste. This idea was supported by the study findings of Kist et al. 2017 (560).

Table 4.9: HCW segregation practice

Variable	Response			
	Yes		No	
	Number	%	Number	%
Does the waste segregate at the point of generation?	4	1.7	236	98.3
Does the colour of general HCW bin black?	23	9.6	217	90.4
Does the colour of the infectious waste bin yellow?	23	9.6	217	90.4
Containers used for sharp waste is yellow and puncture resistant?	23	9.6	217	90.4
Are the containers used for sharp is it disposable?	22	9.2	218	90.8
Does the waste container label non-infectious or infectious	16	6.7	224	93.3
Does the temporary waste storage bin easily cleanable	240	100	0	0
Does the temporary waste storage bin have a cover	125	52.1	115	47.9
Is the temporary waste storage bin pedal/foot operated	16	6.7	224	93.3
Is the temporary waste storage bin at an arm reach	0	0	240	100

4.5.5.3 Underutilisation of foot-operated or non-hand touch waste disposal bins

WHO (2014:81) in the book of "*Safe management of wastes from healthcare activities"* recommends SW disposal containers should have covers or lid operated by foot or elbow to prevent hand contamination. In addition, of 300 (55.5%) of the respondents, foot-operated dust bins are available in their health care facility to dispose of the generated solid HCW, and the rest of the respondents indicated that there are no foot-operated dustbins in the facility. The mean availability of foot-operated dust bins was 55.6% (CI: 51.5-59.5) and 212 (82.1%), 46 (48.4%), 17 (21.5%), 16 (17.4%), 9 (56.2%) in NEMMCSH, government health centres, medium clinics, small clinics, and surgical centre respectively.

4.5.5.4 Poor hand washing practice

Hand hygiene is the key component to interrupting the chain of infection. Washing hands before and after touching contaminated surface areas is recommended because the hands of healthcare providers are the most frequent cross contamination route for health facility acquired infections. Hand hygiene, both hand washing and hand disinfection should be seen as the primary preventive measure that is the responsibility of all healthcare personnel (WHO 2014: 206-210).

The availability of hand washing facilities near SHCW generation sites was observed by the researcher. About, 17 (3.1%) of health facility workers had the facility of hand washing near to the HCW generation and disposal site. Furthermore,10 (3.9%), 2 (2.1%), 2 (2.5%), 2 (2.1%), 1 (6.6%) of health facility workers had the facility of hand washing near the HCW generation site in NEMMCSH, government health centres, medium clinics, small clinics, and surgical centre respectively. This finding was nearly the same to the study findings conducted in Myanmar, the availabilities of hand washing facilities near to the solid HCW generation were absent at all service areas (WIN, Saw, Oo, et al. 2019:86). The observational result was convergent with the response of facility workers' response regarding the availabilities of hand washing facilities near to the solid HCW generation sites.

4.5.5.5 Inconsistent use of solid HCW collection materials

WHO in (2014 and 2017 87; 181; 8) states that the availability and accessibility of standard sharp container, other waste receptacles and personal protective equipment, goes hand-in-hand with training. Health care waste generators, collectors, transporters, and disposal workers should have to have adequate PPEs like gloves, strong and closed shoes, coveralls, and masks. In addition to the availability proper utilization should be checked.

About 392 (72.6%) of the respondents agree on the availability of one or more of personal protective equipment (PPE) in the facility, and the rest are not agreeing on the availabilities of PPEs. The availability of PPEs in different levels of health facilities shows 392 (72.6%), 212 (82.2%), 56 (58.9%), 52 (65.8%), 60 (65.2%) 12(75%) health facility workers in NEMMCSH, government health centres, medium clinics, small clinics, and surgical centres respectively agree to the presence of PPEs in their departments. The availability of PPEs in this study was nearly two-fold when compared to the study findings in Myanmar which is 37.6% of the staff are availed with PPEs.

The analysis further shows that the availability of masks for health care workers was above the mean in NEMMCSH, and surgical centre, and in other health facilities, the availabilities of masks were below the mean.

4.5.5.6 Inconsistent utilisation of personal protective equipment in health facilities

Using essential PPEs based on the risk is recommended by World Health Organization (WHO 2014). The mean availability of gloves in health facilities was 343 (63.5% (95% CI: 59.3-67.4). Private health institutions are better at providing gloves for their workers, 67.1%, 72.8%, and 62.5% in medium clinics, small clinics, and surgical centres respectively which is above the mean. Respondents agree that there is a shortage of gloves to give service in NEMMCSH and government health centres. Masks are the most available PPE for health facility workers compared to others. About 65.4%, 55.6%, and 38% of the staff are available with gloves, plastic aprons, and boots respectively.

The mean availability of masks, heavy-duty gloves, boots, and aprons were 71.1%, 65.4%, 38%, and 44.4% in the study health facility. This finding shows less availability for masks and higher availabilities for utility gloves, boots, and plastic aprons which is 35.71% for utility gloves, 14.28% for boots, and 7.14% availability of plastic aprons (Banstola, et al., 2017: 51). This is because of the advent of COVID-19 health facility workers were enforced to use PPEs to provide service for patients. Health facility workers were asked for the presence of different personal protective equipment's and 38% of the respondents agreed regarding the provision of boots in the facility, but qualitative observational findings of this study show that all health facility workers have no boots or footwear during SHCWM practice. However, a better result was found from (Hosny, Samir, & El-Sharkawy 2018 (58) which showed that 29.6% of the respondents were provided with plastic boots.

4.5.5.7 HCW segregation practice

The segregation practice of SHCW was checked by observing the available SHCW bin in each room. Only 4 (1.7%) of the rooms SHCW bins are collected the segregated (non-infectious wastes segregated at black bin and infectious wastes segregated at yellow bin) based on the WHO standard. Colour-coded waste bins, black for non-infectious and yellow for infectious wastes were available at 23 (9.6%) of the rooms. About 90% of the sharp containers are reusable and 100% of the waste storage bins were plastic buckets and it was easily cleanable. Only 6.7% of the waste bins are pedal operated and properly covered and the rest were fully opened, or tiny hole was prepared on the cover of the container. All of the HCW disposal bins in each health facility and at all service areas were away from an arm's reach distance of the waste generation places and this is contrary to WHO SHCWM guidelines (WHO 2014:185).

4.5.5.8 Segregation of SHCW at the point of generation

A total of 240 rooms were observed for the segregation practice of SHCW. Government health centres, medium clinics, small clinics, and surgical centres SHCW segregation practice was not appropriate, and all types of solid wastes were

collected at the single container found near to the generation area, and there was no colour coded solid waste storage dust bins. However, in NEMMCSH in most of the service areas colour-coded waste containers are available however; the waste segregation practice was not done in accordance with the standard. Only 3 (10%) of the dust bins were collected in line with the appropriate wastes according to the WHO standard, and the rest were mixed with infectious and non-infectious SHCW.

Health facility managers were asked for HCW segregation practice and 9 (22%) of the facility leaders answered that there is appropriate solid HCW segregation practice in their health facilities. But during observation, only 4 (1.7%) of the rooms in two (4.9%) of the facilities, SHCW bins are collected in line with the segregated wastes (non-infectious wastes segregated at black bin and infectious wastes segregated at yellow bin) based on the WHO standard. The findings of this study show there is a poor segregation practice and all kinds of solid wastes were collected together.

This finding was similar to the study findings conducted in Addis Ababa by Debre et al. (2014) and contrary to the study findings conducted in Nepal, and India which shows 50% and 65-75% of the surveyed health facilities were practicing proper waste segregation systems at the point of generation without mixing general wastes with hazardous wastes respectively (Banstola, et al., 2017: 71; Debere, et al. 2014: 4; Anita, Sanjiv, Molly, & Ajay 2016: 2).

Table 4.10: Health facility manager response to SHCWM practice

Variable	Response			
	Yes		No	
	Number	%	Number	%
HCW generation rate assessment done last year?	0	0	41	100
Does the facility reuse waste?	1	2.43	40	97.57
If yes, how many kilograms of solid HCW reused?	50.6kg			
If yes, which type of waste reused?	plastic bottle			
Is there a waste segregation practice?	9	22	32	78
Does the facility have onsite sterilization of waste?	0	0	41	100
Does the facility have a waste reduction policy /strategy?	0	0	41	100

Does the facility have a mercury elimination strategy?	0	0	41	100
Do you have a waste management policy?	8	19.5	33	80.5
Do you have a program for purchasing mercury alternative materials?	0	0	41	100
Does the facility have a waste recycling policy?	0	0	41	100
Are the waste volume tracked?	0	0	41	100
Does the facility perform a waste audit in the last one year?	0	0	41	100
Does the committee form to investigate waste management?	4	9.8	37	90.2
Does the committee have a plan for performance monitoring?	1	25	4	75
Does the committee meet at least monthly?	0	0	4	100
Does your facility provide waste management training?	3	7.3	38	92.7
Is there an operational standard of waste management?	3	7.3	38	92.7
Is there a HCW trainer in this institution?	1	2.4	40	97.6
Do you have an environmentally friendly purchasing policy to encourage waste reduction?	0	0	41	100
Do you have a cytotoxic waste handling procedure	1	2.4	40	97.6
Is there an operating budget for labour?	41	100	0	0
Is budget available for consumables?	30	73.2	11	26.8
Is there an adequate program for immunisation of hep B, and C?	4	9.8	37	90.2
Does this facility have an environmental management office?	2	4.9	39	95.1
Is there a written training plan for a refresher training?	1	2.4	40	97.6
Are you aware of any legislation on HCWM?	5	12.2	36	87.8
Does waste management include in the employment job description?	1	2.4	40	97.6
Do you have a record of waste management injury?	1	2.4	40	97.6
Do you incinerate waste in your facility?	41	100	0	0
Do you have a plan to eliminate incineration?	1	2.4	40	97.6
Do you think current practice needs improvement?	41	100	0	0
Do you have a policy for PPE to be used by the worker?	5	12.2	36	87.8

4.5.5.9 SHCW collection practice

In 40 (97.6%) of the health facilities, infectious wastes were collected daily from the waste generation areas to the final disposal points. During observation in one of the study health facilities, infectious wastes were not collected daily and left for days.

Utility gloves, boots, and aprons were totally not available for cleaning staff during the collection and transportation of solid HCWs in all study health facilities. About 29.3% of the facilities' cleaning staff had a face mask and 36.5% of the facilities removed waste bins from the service area when ¾ full and the rest were not removed or replaced the container by the new one. There was a separate container only in two of the health facilities for infectious and non-infectious waste segregation practice and the rest were segregated and collected by using single and non-colour coded containers.

Except for the three government health facilities, all (90.2%) of private health facilities collect and transport SHCW generated in every service areas were transported to the disposal place by the collection container (no separate container to collect and transport the waste to the final disposal site). In the government health facilities, cleaners have another large in size container to collect and transport the generated wastes to the disposal sites. The generated waste was collected at every working shift. This finding was similar to the study findings of Debre markos Town (Deress, et al. 2018: 4). At all of the facilities in the study area, SHCW was transported from the service areas to the disposal site were manually by carrying the collection container and there is no trolley for transportation. This finding was contrary to the study findings conducted in India which showed the generated waste from the site of generation was moved through the chute to the carts placed at various points in the hospital premises by the sanitary workers (Anita, Sanjiv, Molly, Ajay 2016: 2).

All of the facilities in the study area, SHCW was transported from the service areas to the disposal site were transported manually by carrying the collection container and there is no trolley for transportation. This finding was contrary to the study findings conducted in India which show segregated waste collects in the carts by using the inbuilt chutes placed at different points (Anita, et al.2016: 2).

4.5.5.10 Temporary storage practice for SHCW

Only 2 out of 41 health facilities have temporary solid waste storage points at the facility and the rest 39 have no temporary waste storage points. One of the

temporary storage places was clean and the other one was not properly cleaned, and it was untidy. Two (100%) of the temporary storage areas were not fenced and had no restriction to an authorised person. Temporary storage areas were available only in two of the health facilities that are away from the service provision areas.

4.5.5.11 On-site treatment of SHCW and availability of water supply

Waste treatment is the process of making and minimizing the potential hazard caused to human beings and the environment (WHO 2014: 105). Sixty-three (11.7%) of the respondents have inappropriately answered the question of onsite treatment practice was practiced in their health facilities. Observational findings revealed that pre-treatment of SHCW before disposal was not practised at all of the study health facilities. This study finding was contrary to the study findings conducted in Mangalore depicted pre-treatment of the waste was done in 46% of the hospital (Pullishery, Panchmal, Siddique, & Abraham 2016: 31). In addition, 95% of the facilities had no water supply that is used for hand washing during and after generation, collection, and disposal of solid HCW.

This finding was contrary to the study findings in Pakistan hospitals which showed that all health facilities have an adequate water supply near to the HCW management sites (Farooq, Omar, Shahid, et al. 2017:137).

4.5.5.12 Sharp waste management

Sharp injuries from medical wastes to health professionals and sanitary service personnel were estimated by the United States Agency for Toxic Substances and Disease Registry. Most of the injuries are caused during the recapping of used needles before disposal into sharps containers (WHO 2014:32). Nearly half of the respondents, 245 (51.5%) are recapping needles after providing injection to the patient. Recapping was more practised in NEMMCSH and surgical centre which is 57.5% of the staff in two health facilities are recapping of needles after administering injection.

In government health centres, medium clinics and surgical centre, the recapping of used needles was practised below the mean which is 47.9%, 48%, and 43.8% respectively. This finding was good compared to the study findings of Doylo et al. in western Ethiopia, 91% of the health workers are recapping needles after injection (Doylo, Alemayehu & Baraki 2019:288). The research finding shows that there is no significant association between the training and recapping of needles after injection.

4.5.5.13 Observational findings of sharp waste management practice

Sharp waste collection practice was observed in 240 rooms in the study health facilities and 9.2% of the rooms are using the disposable sharp container. This finding was low compared to the study findings of Doylo et al. in eastern Africa, which is 23.5% of the facility rooms were using disposable sharp containers (Doylo, et al. 2019: 288). About 60%, 13.3%, 8.2%, and 15.7% of the sharp containers in NEMMCSH, government health centres medium clinics, and small clinics respectively were using disposable sharps containers, sharps were disposed together with the sharp's container, and surgical centre was using reusable sharp collection container. All disposable sharps containers in medium clinics and small clinics were using non-puncture-resistant or simple packaging carton boxes.

About 60% and 13.3% of the disposable sharps' containers in NEMMCSH and in the government health centre respectively use purposefully manufactured disposable safety boxes.

4.5.5.14 Injury-related to HCW management practice

A total of 70 injuries were reported to the health facility manager in the last one year, and 44 of the injuries were reported by health professionals, and the rest of the injuries were reported by supportive staff. These injuries were reported from 35 health facilities and the remainder of six health facilities did not report any cases of injury related to waste management.

Table 4.11: Needle sticks injury reporting and occurrence

Health facilities	Reported injuries to the facilities	Have you been pricked in the last 12 months		Have you ever been injured
		Health care workers injured	Supportive staffs injured	
NEMMCSH	4	6	2	103
Government health centres	4	5	1	19
Medium clinics	31	48	11	67
Small clinics	28	38	10	58
Surgical centre	3	7	1	14
Total	**70**	**104**	**25**	**261**

4.5.5.15 Unreported needle stick injuries in the facilities

Questionnaire data showed that 129 (23.8%) of the staff needle stick injuries have occurred on health facility workers within one year of the period prior to the data collection. This finding was a little bit smaller than the study findings of Deress et al (2018:3). In Debre markos town northeast Ethiopia which is 30.9% of the worker has exposed to needle stick injury one year prior to the study. But reported and registered needle stick injuries in the health facilities shows less reported and only 70 (54.2%) of the injuries are reported to the health facilities. This finding showed underestimation of the risk and the problem and it was supported by the study conducted in Menilik II hospitals in Addis Ababa (Debalkie & Kumie 2017: 48). 50%, 33.4%, 48%, 52%, 62.5% of the needle stick injuries were not reported in NEMMCSH, government health centres, medium clinics, small clinics, and surgical centre respectively to the health facility manager.

Table 4.12: Needle sticks injury and the presence of satisfactory procedures in case of an accident

Variable		Have you been pricked by a needle last 12 months?				
				No	Yes	Total
Satisfactory procedures are present in case of an accident	Hospital	No	Count	91	41	132
			% Of Total	35.3%	15.9%	51.2%
		Yes	Count	89	37	126
			% Of Total	34.5%	14.3%	48.8%
		Total	Count	180	78	258
			% Of Total	69.8%	30.2%	100.0%
	Government health centre	No	Count	40	8	48
			% Of Total	42.1%	8.4%	50.5%
		Yes	Count	38	9	47
			% Of Total	40.0%	9.5%	49.5%
		Total	Count	78	17	95
			% Of Total	82.1%	17.9%	100.0%
	Medium clinics	No	Count	23	8	31
			% Of Total	29.1%	10.1%	39.2%
		yes	Count	37	11	48
			% Of Total	46.8%	13.9%	60.8%
		Total	Count	60	19	79
			% Of Total	75.9%	24.1%	100.0%
	Small clinics	No	Count	42	8	50
			% Of Total	45.7%	8.7%	54.3%
		Yes	Count	35	7	42
			% Of Total	38.0%	7.6%	45.7%
		Total	Count	77	15	92
			% Of Total	83.7%	16.3%	100.0%
	Surgical centre	No	Count	8	0	8
			% Of Total	50.0%	0.0%	50.0%
		Yes	Count	5	3	8
			% Of Total	31.3%	18.8%	50.0%
		Total	Count	13	3	16
			% Of Total	81.3%	18.8%	100.0%
	Mean/ average	No	Count	204	65	269
			% Of Total	37.8%	12.0%	49.8%
		Yes	Count	204	67	271
			% Of Total	37.8%	12.4%	50.2%
		Total	Count	408	132	540
			% Of Total	75.6%	24.4%	100.0%

4.5.5.16 Response regarding procedures in case of an accident

Any incidents and near misses including needle stick injury, splash of body fluid, and inappropriate segregation of solid waste should be reported to environmental health officers or incident officers in the facility. The cause of the incident should be investigated properly by the incident or environmental health officer to eliminate or minimise further injuries for health facility workers, patients and visitors (WHO 2014: 187,296). About 271 (50.2% (CI: 45.7-54.6) of the respondents agreed that satisfactory procedures are available in case of an accident while the remaining 269 (49.8% (CI: 45.4-54.3) of respondents did not agree on the availability of satisfactory procedures in case of an accident. The availability of satisfactory procedures in case of an accident is above the mean in medium clinics, which is 60.8%. About 132(24.4%) of the staff were pricked by needle stick injury during providing health services. Nearly half of the respondents 269 (49.8%) who have been exposed to needle stick injury did not get satisfactory procedures after being pricked by a needle and those who have not been pricked by a needle stick injury for the last one year. 204 (37.8%) were not agreed to the presence of satisfactory procedures in the case of a needle stick injury. In NEMMCSH, 30.2% of the research participants were pricked by needle sticks injury within one year of period and 48.8% of those who were pricked by needle stick injuries did not agreed upon by the presence of satisfactory procedures in case of needle sticks injury in the study hospital. About 17.9% and 49.5%, 24.1% and 60.8%, 7.6% and 50% of the respondents were pricked by needle stick and they did not agree on the availability of satisfactory procedures in case of accidents respectively, in government health centres, medium clinics, small clinics, and surgical centre respectively.

Nearly 1/3 (177 or 32.7%) of the staff were exposed to needle stick injuries. Needle stick injuries in health facilities show less reported and only 73 (41.4%) of the injuries were reported to the health facilities preceding 12 months of the data collection. This finding is a little bit higher than the study finding of Deress et al. (2018:3) in Debere markos Ethiopia the research participants encountered needle stick injuries are 23.3%.

Table 4.13: Exposure to needle stick injuries

Variable	Health facilities	Response	n	% (95%CI)
Have you been exposed to needle stick injuries?	NEMMCSH	Yes	103	39.9 (CI:33.9-45.3)
		No	155	60.1 (CI:54.7-66.1)
		I don't know	0	0
		Total	**258**	**100**
	Government Health centres	Yes	19	20 (CI:11.6-28.4)
		No	76	80 (CI:71.6-88.4)
		I don't know	0	0
		Total	**95**	**100**
	Medium clinics	Yes	26	32.9 (CI:22.2-43.0)
		No	53	67.1(CI: 57.0-77.8)
		I don't know	0	**0**
		Total	**79**	**100**
	Small clinics	Yes	25	27.2 (CI:18.5-35.9)
		No	67	72.8 (CI:64.1-81.5)
		I don't know	0	0
		Total	**92**	**100**
	Surgical centres	Yes	4	25(CI:6.3-46.7)
		No	12	75 (CI:53.3-93.8)
		I don't know	0	0
		Total	**16**	**100**
	The mean exposure rate to needle stick injury	**Yes**	**177**	**32.8%(CI:29.1-37)**
		No	**363**	**67.2%(CI:63-70.9)**
		I don't know		
		Total	**540**	**100**

Seventy-three injuries were reported to the health facility manager in the last one year, and 44 of the injuries were reported by health professionals, and the rest of the injuries were reported by supportive staff. These injuries were reported from 35 (85.3%) health facilities and the rest (6) health facilities have no report. These study findings were better than the study findings of Khan Cheng, Khan, & Ahemd (2019:5) in which 1/3 of the facilities were having reporting system for an incident, and almost the same percentage of the facilities was having post-exposure procedures, in both public and private sectors.

Table 4.5: The presence of satisfactory procedures in case of an accident

Variable	Health facilities	Response	n	% (95%CI)
Satisfactory procedures are present in case of an accident?	NEMMCSH	Yes	126	48.8 (CI:42.2-56)
		No	132	51.2 (CI:44-57.8)
		I don't know	0	0
		Total	**258**	**100**
	Health centres	Yes	47	49.5 (CI:40.6-59.4)
		No	48	50.5 (CI:40.6-59.4)
		I don't know	0	0
		Total	**95**	**100**
	Medium clinics	Yes	48	60.8 (CI:50.6-72.2)
		No	31	39.2(CI: 27.8-49.4)
		I don't know	0	**0**
		Total	**79**	**100**
	Small clinics	Yes	42	45.7 (CI:34.8-55.4)
		No	50	54.3 (CI:44.6-65.2)
		I don't know	0	0
		Total	**92**	**100**
	Surgical centres	Yes	8	50(CI:25-75)
		No	8	50 (CI:25-75)
		I don't know	0	0
		Total	**16**	**100**
	The mean knowledge of the availability of policy regarding HCW management policy	**Yes**	**271**	**50.2%(CI:45.7-54.6)**
		No	**269**	**49.8%(CI:45.4-54.3)**
		I don't know	**17**	**3.1%(CI:1.7-4.6)**
		Total	**540**	**100**

4.5.5.17 Exposure of health facility workers to needle stick injury

SW generated during health service provision to patients and clients contain a higher chance of infection than other types of waste. Health professionals, sanitation workers and the general public are affected by inappropriate disposal of sharp waste and poses significant risk of disease transmission. Needles and syringes should be segregated and stored in puncture resistant and disposable card boxes (WHO 2014: 82). Indiscriminate handling and management of SHCW may have a serious environmental pollution and serious public health problems. Safe disposal and management of SHCW is the main components of environmental health protection. Needle stick injuries are the most hazardous category waste among the infectious waste, because of the ability to puncture the skin, the muscle and the blood vessels and cause infections. Sharps waste contains items that could cause puncture wounds and cuts. These include needles, syringes with needles, broken glass ampoules, scalpel and blades, infusion sets (WHO 2017:87; Matee & Manyele 2016: 82). 177 (32.7% (CI:29.1-37) of the respondents were exposed to needle stick injury

while working in the current health facilities. About 103 (58.1%) and 26 (32.9%) of the needle stick injury was reported from WUNEMMCSH and medium clinics which is above the mean. In addition,132 (24.7% (95% CI:20.7-28.1) of the respondents are exposed to needle stick injury within one year of the period. 78 (30.2%), 17 (17.9%), 19 (24.1%), 15 (16.3%), 3 (18.8%) of the staff are injured by needle sticks from NEMMCSH, government health centres, medium clinics, small clinics, and surgical centre staffs respectively within one year of service.

4.5.5.18 Inconsistent readiness for safety procedures in case of an accident

To improve SHCWMP, all health facility staffs including managers should be trained on health care waste management practice and they should be aware of reporting. Health care waste related practices including in appropriate segregation, injuries, accidents, accidents and incidents, spillages, near misses, and any incidents involving sharps should be reported to incident officer or any designated person. Any incident resulting from SHCW should be registered by using a standard document (WHO 2014:187). The mean availabilities of satisfactory procedures in case of accidents were 321 (59.4% (CI: 55.4-63.7). Out of this, 13.7% of the staff was injured by needle sticks within one year before the survey. With the except of NEMMCSH, the mean availabilities of satisfactory procedures were above the mean which is 50%, 60%, 77.2%, 66.3%, 81.3% in NEMMCSH, government health centres, medium clinics, small clinics, and surgical centre respectively.

Within one year of the study period, 129 (23.8%) needlestick injuries occurred, but needle stick injuries in the health facilities were less reported and only 70 (39.5%) of the injuries are reported to the health facilities. These findings were good compared to the study findings of the southwest region of Cameroon, which is 50.9% (110/216) of all participants had at least one occupational exposure (Ngwa, Ngoh, & Samuel 2018:1). This study showed there is a very high exposure to needle stick injury compared to the study findings in Brazil which showed 6.1% of the research participants were injured (Ream, Tipplea, Salgadoa, & Souza 2016: 274).

4.5.5.19 Vaccination status of the health facility workers

Hepatitis B, COVID-19 and tetanus toxoid vaccinations were the response that the respondents provided in an open-ended question on which vaccine they took. The finding shows that 220 (40.8%) of the respondents were vaccinated to prevent themselves from health facility acquired infection. Furthermore, 156 (70.9%) of the respondents were vaccinated to prevent themselves from Hep B infection. In addition, 59 (26.8%) of the respondents were vaccinated to prevent themselves from two infections that are Hep B and COVID-19. This finding was nearly the same as the study findings of Deress et al. (2018: 3), in Ethiopia, 30.7% were vaccinated, and very low compared to the study findings of Qadir, Murad, & Faraz (2016:804) in Pakistan and Sahaand Bhattacharjya (2019: 369) India which is 66.7% and 66.2% respectively.

Table 4.6: Vaccination status of health facility workers

Variable	Response	Frequency	Percent	95% Confidence Interval	
				Lower	Upper
Did you receive any protective vaccination to prevent infection?	no	319	59.2	54.6	63.3
	yes	220	40.8	36.7	45.4
	Total	540	100.0	100.0	100.0

4.5.5.20 Average SHCWM practice in the study health facilities

Appropriate HCW management practice was assessed by using 12 questions, availability of colour-coded waste bin, foot-operated dust bin, elbow or foot-operated hand washing basin, personal protective equipment, training, role and responsibility of the worker, the presence of satisfactory procedures in case of an accident, incinerator, vaccination, guideline, on-site treatment and the availability of poster. The mean of appropriate mean HCW management practice was 55.6%. The mean of SHCWM practice based on the level of health facilities was summed and divided into 12 variables to get each health facility level of waste management practice. In addition, 64.9%, 45.6%, 49%, 46.9%, and 51.8% was the mean for appropriate HCW management practice in NEMMCSH, government health centres, medium clinics, small clinics, and surgical centre respectively. In NEMMCSH, the practice of

SHCWM shows above the mean and the rest was below the mean of SHCWM practice.

4.5.5.21 Health facility manager response to SHCWM practice

Health facility leaders have interviewed 42 questions about the HCW management practices of their respective health facilities. However, SHCW generation rate assessment was not done at all health facilities found in Hossaena Town. Figure 3 shows only one health facility out of 41 health facilities recycled plastic bottles, and 50.6 kg of wastes were generated and recycled by private organisations outside the facility per day. This finding is similar to the study findings of Debalkie and Kumie (2017: 45) in Addis Ababa health facilities, reusing and recycling of SHCW was not employed by any of the health facilities except recycling of plastic water bottles. Health care waste minimisation at the source of generation, reusing and recycling was not employed by any of the case teams except recycling plastic water bottles. HCW generation rate assessment was not done at all health facilities found in Hossaena Town.

Figure 4.3: Plastic bottles segregation and loading to transport for recycling

HCW segregation practice was done only in 9 (22%) of health facilities. Table 49 depicts that solid waste sterilisation before disposal, waste reduction policy, mercury elimination strategy, purchasing mercury alternative materials, waste recycling policy, waste audits, HCW management committee meetings were not practised in all of the health facilities in the study area.

4.5.5.22 The inconsistent practice of pedal/foot operated solid HCW collection bin

The availability of foot-operated SHCW bins was observed, government health centres, medium clinics, and small clinics SHCW storage bins were not pedal/foot-operated and all of them were not standard SHCW storage bins. This finding was contrary to the WHO recommendation that SHCW collection containers should have well-fitting lids, preferably operated by a foot pedal (WHO 2014: 83). In NEMMCSH, 90% of SHCW segregation bins are foot/pedal operated and the rest were not.

4.5.5.23 HCW treatment and disposal practice

Solid waste treatment before disposal was not practised at all of the study health facilities. There was an incineration practice at all of the study health facilities and WHO in 2014 recommends three types of incineration practice for SHCWM, dual-chamber starved-air incinerators, multiple chamber incinerators, and rotary kilns incinerator. Brick incinerators, single-chamber, and drum incinerator do not meet the Stockholm Convention guidelines of the best available technique requirements (WHO 2014: 121). The findings of this study show that the entire incinerator found in the study health facilities does not meet the minimum standards of solid HCW incineration practice and they have no air inlet to facilitate combustion. Eleven (26.8%) of the health facility had an ash pit for disposal of burned SHCW and the majority 30 (73.2%) of the facility dispose of the incinerated ash together with burned needles into the municipal waste disposal site. One out of 11 health facilities with an ash pit, one of the incinerators was built on the ash pit and the incinerated ashes were disposed of in the ash pit directly. Pre-treatment of SHCW before disposal was not practised at all health facilities.

Table 4.7: SHCW disposal practice in the different labels of health facilities

Variable	Response	NEMMCSH		Government health centres		Medium clinics		Small clinics		Surgical centre	
		n	%	n	%	n	%	n	%	n	%
Does the facility have an ash pit for incinerated SHCW?	Yes	1	100	2	66.6	4	23.5	5	26.3	1	100
	No	0	0	1	33.3	13	76.5	14	73.6		
	total	1	100	3	100	17	100	19	100	1	100

4.5.5.24 HCW incineration practice

Most of the medical wastes generated are incinerated. Incineration of the generated solid medical waste by health facilities creates a problem to health and environment. Health care waste open burning and incineration of solid waste is a major source of dioxins to the environment and emit toxic air pollutants and ash residue. Concerning to the health of the people from medical waste incinerator and the problem related to the health hazard due to emission, health care facilities should rethink medical waste treatment technology choices. As stated by health care without harm, non-incineration treatment technologies are a growing and developing field. About 468 (96.7%) of the staff were aware of the presence of an incinerator in the facilities. 6.2% of the staff in NEMMCSH were not aware of the facilities have an incinerator for SHCWMP.

4.5.5.25 Availabilities and type of incinerators in the study facilities

All government health facilities used incineration to dispose of solid waste. In addition, 88.4% and 100% of the solid wastes are incinerated in WUNEMMCSH and government health centres respectively. This finding was not similar to the other studies because of using other technologies like autoclave microwave and incineration was used for 59-60% of the waste (Ghasemi & Yusuff, 2016: 20). Furthermore, 41 (100%) of the facilities were using incinerators and only 5 (12.2%) of the incinerators were constructed by using brick for incinerating the generated solid wastes without considering the emitting gases to the atmosphere and the residue chemicals and minerals in the ashes.

In Ethiopia incineration of SHCW has been accepted as an appropriate and efficient method of SHCW disposal, but incineration can generate secondary wastes and dangerous pollutants if it is not properly treated and if the treatment facilities are not properly designed, constructed and operated. Polyvinyl chloride (PVC), Polychlorinated dibenzo-dioxins (PCDD), Polychlorinated biphenyls, hexachlorobenzenes and dioxins and furans are toxic substances generated during incineration and burning of SHCW. These chemicals and minerals are hazardous pollutants and cause cancer and liver failure. All government health facilities used incineration to dispose of solid waste. About 88.4% and 100% of the wastes were incinerated in WUNEMMCSH and government health centres respectively. This finding is contrary to the study findings in USA and Malaysia which are 49-60 % and 59-60 are incinerated respectively and the rest will be treated by using other technologies (Anoushiravan et al. 2019: 277; Ghasemi & Yusuff, 2016: 20).

All the study health facilities used a brick barrel type of incinerator. All of the incinerators found in the study health facilities did not meet the minimum standards of solid HCW incineration practice. These findings were similar to the study findings of Nepal and Pakistan. The HCW treatment system in health facilities was found very unsystematic and unscientific which cannot guarantee that there is no risk to the environment and public health, as well as safety for personnel involved in HCW treatment (Banstola, et al., 2017: 71). Most of the incinerators in the study facilities were not properly constructed, operated and maintained, resulting in poor performance (Pullishery, et al. 2016:32; Khan, et al. 2016: 8).

Figure 4.4: Barrel and brick incinerators at private health facilities

All government health facilities used incineration to dispose of solid waste. All the generated sharp wastes are incinerated by using brick or barrel incinerators shown in Figure 4.4. This finding was consistent with the findings of Matee and Manyele (2016: 89) in Tanzania depicted that all the generated sharp wastes are incinerated. All the brick incinerators were constructed without appropriate air inlets to facilitate combustion except in NEMMCSH which is constructed with 4-meter height. These findings were similar to the findings of Tadese and Kumie at Addis Ababa (Tadesse & Kumie 2014: 10).

4.5.5.26 Ash pit as a final disposal of incinerated SHCW

A properly constructed ash pit is necessary for incinerated wastes and 13 (31.7%) of the facility has ash pits for incinerated wastes while the rest of the health facilities have no ash pit. This finding was similar to the study findings in Debere markos Town which shows most of health care facilities (HCFs) had no constructed ash pits for incinerated SHCWs and they were disposing in the latrine and sending to the municipal solid waste disposal sites together with household wastes (Derees et al. 2018: 6).

4.5.5.27 Environmental friendliness of HCW management practice

Respondents' understanding of the environmental friendliness of HCW management practice was assessed and the result shows that more than half, 312 (57%) of the research participants do not agree with the environmental friendliness of the waste disposal practices in the health facilities. The most disagreement of environmental friendliness was observed in NEMMCSH, where only 100 (38.8%) of the participants agreed the practice was environmentally friendly of the service. In contrast, 44 (46.3%), 37 (46.8%), 40 (43.5%), 7 (43.8%) of the participants agreed on the environmental friendliness of HCW management practice in government health centres, medium clinics, small clinics, and surgical centres respectively.

4.5.5.28 HCW management training

WHO and ministry of health Ethiopia highlighted HCWM induction and continues training should be provide for all health facility workers on a routine basis to update their knowledge, attitude and practice of prevention and control of health care waste related diseases. Training should include awareness raising about the health and environmental hazards of waste, safe handling of waste, the purpose of immunization, safe waste handling procedure, preventing infection following exposure with post-exposure prophylaxis, and use of PPE, reporting of exposures and injuries (WHO 2014: 189; MOH Ethiopia 2021: 6). Data analysis indicated that 225 (41.7% (95% CI: 37.2-45.9) of the respondents were not receiving any SHCWM practice training. In addition, 125 (48.4%) and 39 (42.4%) of the staff were trained on SHCWM practice in NEMMCSH and small clinic staff respectively. This result showed above the mean. 27 (28.4%), 30 (38%), 4 (25%) of the staff are trained about HCW management practice in Government health centre, medium clinics and surgical centre respectively. The training has been significantly associated with needle stick injury and the more trained staff are the less exposed to needle stick injury. Furthermore, 196 (36.4%) of the respondents answered the question yes for the availability of trainers in the institution, 43.8% of the NEMMCSH staff agreed on the availability of trainers on SHCWM which is above the mean and 26.3%, 31.6%, 31.5%, and 25% for the government health centres, medium clinics, small clinics, and surgical centre respectively, which is below the mean.

Trained health professionals are more compliant with SHCWM standard, and the self-reported study findings of this study showed that 41.7% (95% CI: 37.7-46) of the research participants are trained in HCW management practice. This finding was higher compared to the study findings of Sahiledengle in 2019 (4) in the southeast of Ethiopia which show that 13% of healthcare workers are received training related to HCWM and significantly low when compared to the study findings in Egypt which is 71% of the respondents were trained on SHCW (Gihan, Shimaa, & Rania 2018: 58).

Table 4.7: Training on HCW management

Variable	Health facilities	Response	n	% (95% CI)
Before you start work, do you receive training on HCW management practices?	NEMMCSH	Yes	125	48.4 (CI:41.9-54.3)
		No	133	51.6 (CI:45.7-58.1)
		I don't know	0	0
		Total	258	100
	Health centres	Yes	27	28.4 (CI:18.9-37.9)
		No	68	71.6 (CI:62.1-81.1)
		I don't know	0	0
		Total	95	100
	Medium clinics	Yes	30	38 (CI:26.6-48.1)
		No	49	62 (CI: 51.9-73.4)
		I don't know	0	0
		Total	540	100
	Small clinics	Yes	39	42.4 (CI:32.6-52.2)
		No	53	57.6 (CI:47.8-67.4)
		I don't know	0	0
		Total	540	100
	Surgical centres	Yes	4	25(CI:6.3-50)
		No	12	75 (CI:50-93.8)
		I don't know	0	0
		Total	540	100
	The mean trained staff on HCW management	Yes	225	41.7(CI:37.7-46)
		No	315	58.3% (54-62.3)
		I don't know	0	0
		Total	540	100

4.5.5.29 Meeting related to SHCWM improvement practice

About 395 (73.1%) of the respondents agreed that there is no meeting conducted in the facility or in their working department to improve SHCWMP.

4.5.5.30 The role and responsibilities of health care workers in SHCWM practice

In many countries around the world, knowledge, and responsibilities for HCW have become more important among government and private medical practitioners and civil society. Health care workers and health facility managers are accountable for every waste they generate in the health care provision facilities. Poor standards of health care service due to indiscriminate and erratic disposal of solid health care waste in the health facilities are recognised as a source of avoidable nosocomial infection (WHO 2014: 1). The correct segregation of HCW is the responsibility of the person who produces each waste item, regardless of their position in the organisation. Healthcare facility management is responsible for making sure there is suitable segregation, transport and storage system, and that all staff adheres to the correct procedures (WHO 2014: 78). All the research participants who participated in this study either generate or manage HCWs generated in the study institution, but 434 (80.4% (95% CI: 77-83.5) of the respondents agreed that their responsibility is to manage properly the generated solid HCW and the rest, even though they are responsible for appropriate management of solid HCW generated in the institution, responded that for they have no role or responsibility for any solid waste management practices.

4.5.5.31 Focus group participant response for problems encountered in managing HCWs

4.5.5.31.1 Lack of supplies used for SHCWMP

WHO recommends PPEs to be always worn by health service providers during HCW generation, collection, transportation, and disposal of SHCWM practices. PPEs are used to make barriers between the worker and the hazard (WHO 2014:185).

Supplies like gloves are used to protect hands, a mask for mouth and nose, an apron to protect the body from an infectious agent, boots to protect the foot, and a google to protect the eyes of the worker.

Three out of four government health facility leaders and 17 (45.9%) of private health facility leaders/owners of the clinic and 141 of the FGDs participants complained about the absence of some of the PPEs like boots, and aprons to protect themselves from infectious agents.

Private health facility nurses, laboratory technicians, and cleaners said
“Mask, disposable gloves and changing gowns are a critical shortage at all health facilities.”

Cleaners in private health facilities are more exposed to infectious agents because of the absence of personal protective equipment. Except for the cleaning staff who are working in the private surgical centre, all cleaning staff 40 (97.56) of the health facilities complain about the absence of changing gowns and no boots in the facilities.

Focus group participants indicated that health facilities did not volunteer to supply PPEs for the cleaning staff.

Cleaners at private health facilities said
“We cannot purchase PPE by ourselves because of the salary paid for the cleaning staff.”

4.5.5.31.2 High expense and inflation of cost for PPE and treatment plant

The cost of purchasing health care is inflated and prevalent in all the countries around the world. Worldwide in the past decades, health care cost inflation exceeded the average growth in GDP. Multiple factors are contributed for this inflation such as the improvement of living conditions, economic development, the development of health care technology the changing health care financing system, and so on (Liu,

2016: 6). Demand and supply cost inflation affects the interpretation of accessibility of goods (Paez, Higgins & Vivona 2019: 1).

Cost inflation and high cost of purchasing PPEs like glove and boots are complained by all of (41) the health facility owners.
"the reason for the absence of some of the PPEs like boots, goggles, and shortage of disposable gloves are owing to cost inflation from time to time and sometimes absent from the market are the reason why we do not supply PPE to our workers."

Thirty-four (82.9%) of the facility leaders indicated that there is a high expense and even unavailability of some of the PPEs are the reason for not providing PPEs for the workers.

"*Medical equipment's and consumables importers and whole sellers are selective for importing health supplies and because of a small number of importers in the country and specifically, in the locality, we cannot get materials used for HCW management practice even disposable gloves*."

One of the facility leaders from a private clinic reported that before the advent of Coronavirus (COVID-19) PPEs were cheaper and could get it without difficulty. After COVID-19 pandemic, Ethiopia declared that people outside of the health facility collects PPEs like glove and mask and storing privately at the home.

"PPEs were getting expensive and unavailable in the market because of the increment of the needs. Incinerator construction materials cost inflation and the ownership of the facility building are other problem for private health facilities to construct standard incinerator."

4.5.5.31.3 Compliant of the nearby community regarding the smell of incinerated waste

WHO (2014: 45) highlighted that the proper functioning of the incinerator includes, constructing the incinerator away from the residential and populated areas, minimizing the generation rate, and the appropriate segregation practice, appropriate

engineering design concerning the generation rate per day, proper operation, staff training to properly operate and management are the key requirements.

Residential, recreational and industrial zoning system are not practising in Hossaena Town because of this, all government and private health facilities are found inside the town, and communities are complaining the smell of incinerated wastes and three of the private health facilities leaders reported that they are enforced to close the clinic and changing the site/place of the clinic to other sites because of the complaint of the nearby communities.

4.5.5.31.4 Lack of water supply in the town

Other issues raised during FGDs were the lack of water supply that health facilities encounter. WHO (2014: 89) highlight that water supply for the appropriate waste management system should be mandatory at any time in all health service delivery points.

Thirty-nine (95.1%) of the health facilities complain about the absence of water supply to improve HCW management practice and infection prevention and control practice in the facilities.

"We get water once per week and most of the time the water was available at night and if we are not fetching as schedule, we can't get water the whole week".

4.5.5.31.5 An inappropriate waste collection system in the town

Collection is one of the activities to be performed in the cycle of safe management of waste. SHCW collection time should be fixed based on the quantity and the type of waste generated. Infectious waste should be collected in a separate container to the general and hazardous waste. Infectious waste should be collected daily (WHO 2014: 86).

All the generated SHCWs in the government health facilities was disposed in the compound of the health facilities, but all private health facilities because of the complaint from the nearby community only syringes and sharp wastes were incinerated in the compound of the health facilities. The rest of the wastes is transported to the town solid waste disposal sites, and this was practiced by the private company in Hossaena Town municipalities. But owing to the shortage of collection cars and the capacity of the contractor, solid HCW generated from the private health facilities was collected twice per week and sometimes once per week. This practice was confirmed by the principal investigator during the qualitative observation of the facilities, and the investigator observed and smelled unwanted odour, unsightly and used for habitation of insects and rodents.

4.5.5.31.6 Shortage of dust bins in the facilities

According to the WHO recommendation health care waste collection bins should be easily accessible and even at an arm reach distance for patients, visitors and health care providers. Infectious waste collection containers should be placed as close as possible to the generation area. For the safety of the patient and health workers, health care waste segregation bins should be placed on the trolley or near to the bed side (WHO 2014: 223).

All of FGDs participants except in NEMMCSH and in two of the private health facilities confirmed that covered and foot-operated dust bins were absent or in a critical shortage compared to the needed one.

Private clinic nurses and cleaners said
“Waste bins are open and not colour-coded. Flies and other insects are attracted by the practice. Empty waste bins are replaced without cleaning and disinfecting by using chlorine solution.”

Other issues raised during focus group discussions were that incineration is not the final disposal method and it needs additional disposal sites, lack of technology, costly to construct a brick incinerator, lack of knowledge for health facility workers, shortage of cleaners, absence of environmental health professionals in health

centres and all private clinics, continues exposure of the staff for needle stick injury, foully smell, human scavengers, unsightly, fire hazard, and lack of water supply in the town are the major teams that FGD participants raised and forwarded the above issue as a problem to improve SHCWMP.

4.5.5.31.7 Other problems encountered in managing SHCW properly

Focus group participants, during the discussion, raised issues that are not comfortable to manage SHCWs properly in their institution.
Two of the 37 Private health facilities are working in their own compound and the rest 35 were rental, because of this they have got difficulty to construct an incinerator, and ash removal pits and they are not confident to invest in SHCWM systems.

Staff negligence and involuntary to abide by the rule of the facilities were raised by four of the government health facilities and difficult to punish those who are violating the HCW management rules because of the health facility leaders were not giving appropriate attention to the problem.
Focus group participants forwarded recommendation on which interventions can improve the management of SHCW and recommendations are summarised as follows:

“ PPE should be available in quality and quantity for all health facility workers who have direct contact on SHCW.”

“Scientific based waste management technologies should be availed for health facilities. “

“Continuous induction HCW management training should be provided to the workers. Law enforcement should be strengthened.”

“Communal HCW management sites should be availed specially for private health facilities.“

“HCWM committee should be strengthened.”

“Non-infectious wastes should be collected communally and transported to the municipal SHCW disposal places.”

“Leaders should be knowledgeable on the SHCWM system, and they should supervise the practice continuously.”

“Patient and client should be oriented daily about HCW segregation practice.”

“Regulatory bodies should supervise the health facilities before commencing and periodically in between the service “

The above are the themes that FGD participants discussed and forwarded for the future improvements of SHAWMP in the study areas.

Based on the above recommendation to improve SHCWMP, the proposed intervention was prepared in the next chapter that is guideline development.

4.5.6 Summary of the research findings

The analysis of this study was conducted based on the research question. All health facilities were included in this study. About 41 health care facilities and 549 health care workers have participated in this study.

Most of the research participants, 215 (39.8%) are in the age group of 26-30. Nurses, cleaners, and health officers make up the largest number of professionals participated in this study. A total of 272 inpatient beds are available in the town, 95% of the inpatient beds are found in NEMMCSH. The HCW generation rate was proportional to the number of patients who visited the health facilities and the type of service provided. A total of 45 FGDs were conducted, and 4-6 participants have participated in each of the health facilities.

HCW generation rate assessment was done at all study health facilities in the study area. The average daily generation rate of solid HCW per patient per bed per day was 1.67 kg. The orthopaedics' ward generates the largest amount of solid waste, 2.24 kg of waste per patient per bed per day and the least SHCW generation rate per patient per bed per day was observed in the maternity ward which is 0.55 kg per patient per bed. The minimum HCW generation rate per health facility per day was 0.7 kg and the maximum solid HCW generation rate was 439.78 kg. The average HCW generation rate per day in the town was 532 kg. About 55.7% of the respondent agrees to the availability of colour-coded waste bins.

The availability of hand washing facilities near SHCW generation sites was observed by the principal investigator. In addition, 17 (3.1%) of health facility workers had the facility of hand washing near to the HCW generation and disposal site. The availabilities of PPEs are poor, mask and disposable gloves are the most available PPEs compared to other types of PPEs. The segregation practice of SHCW was checked by observing the available SHCW bin in each room. Only 4 (1.7%) of the rooms SHCW bins are collected the segregated wastes. In 40 (97.6%) of the health facilities, infectious wastes were collected daily from the waste generation areas to the final disposal points.

Only two out of 41 health facilities have temporary solid waste storage points at the facility. Nearly half of the respondents 245 (51.5%) are recapping needles after injection. Sharp waste collection practice was observed in 240 rooms in the study health facilities. About 50% of the respondents agreed that satisfactory procedures are available in case of an accident.

In addition, 32.8% of the respondents were exposed to needle stick injury while working in the current health facilities, 40.8% of the respondents were vaccinated and 70.9% of the respondents are vaccinated for Hep B.

The mean of appropriate mean HCW management practice was 55.58%. HCW generation rate assessment was not done at all health facilities found in Hossaena Town. Data analysis indicated that 41.7% of the research participants were not taking any SHCWM practice training. More trained staff are available in NEMMCSH, and small clinics, which is above the mean. The mean appropriate SHCWM knowledge among health facilities was 66.2%.

4.5.7 Conclusions

This chapter analysed findings and discussed the outcomes of the study findings with local and international research findings. Quantitative findings of this study were not convergent in most of the data collection tools to the qualitative findings. Needle stick injuries were not properly reported to the facilities, most of the staff were not trained, poor HCW segregation led to inappropriate disposal of infectious waste.

The next chapter will present guidelines for appropriate solid healthcare waste disposal.

CHAPTER FIVE

DEVELOPMENT OF PRACTICE GUIDELINES FOR SOLID HEALTH CARE WASTE MANAGEMENT PRACTICE IN ETHIOPIA

5.1 INTRODUCTION

This chapter presents practice guidelines on SHCWM practice for private and government health facilities in Hossaena Town. The guideline is any formal document that contains recommendations about health service provision, whether these are public health, clinical, or policy recommendations (WHO 2012: 1). These guidelines were designed based on the study findings and the current knowledge available and reviewed in the literature. There were no specific guidelines for SHCWM practice in Ethiopia. Both private and public health facilities' HCW segregation practice was not based on the standard. Almost all hospitals used incineration as a treatment and disposal of solid waste. All the incinerators were found inefficient to use as a treatment of solid waste. Barrel and brick types of incinerators were used. Private health facilities dispose of their solid HCWs to municipal solid waste disposal sites except for sharp wastes.

5.2 THE PURPOSE OF THESE GUIDELINES

The purpose of these guidelines is to show the gap on SHCWMP and to provide the scientific recommendation to health facility workers, health facility managers, and regulatory bodies from the lower level to the national health system. These guidelines meet the national and international standards to safeguard the general public and the environment. These guidelines are considered all types of SHCW generated collected transported treated and disposal practice.

5.3 OBJECTIVES OF THE GUIDELINES

The objectives of these guidelines are to improve and maintain public health safety by: Minimising solid HCW generation rate and impacts on the surrounding environment. Setting standardised SHCWM practices and specifying roles and responsibilities of HCW generator, handler managers and policy maker.

5.4 SCOPE OF THE GUIDELINES

Scoping the guidelines is the process of defining what the guidelines include and what they will not include in the area of practice or policy to which the guidelines apply, the action and intervention of interest (WHO 2012:10). These guidelines are intended for use by all healthcare providers, health facility managers, and private health facility owners for the appropriate and scientifically acceptable SHCWM practice.

5.5 THE GUIDELINES' DEVELOPMENT AND ALIGNMENT PROCESS

According to WHO (2014: 1) a guideline is any document developed for recommendations of public health or clinical practice policy. The guideline document informs the intended end user of the guideline how they can do in specific situations to achieve the best health outcomes possible, individually or collectively.

According to the WHO recommendation the guideline development process must followed the following principles.

1. Guidelines address an area of uncertainty and an unmet need for guidance.
2. The process of developing recommendations is explicit and transparent: the user can see how and why a recommendation was developed, by whom, and on what basis.
3. The process of developing guidelines is multidisciplinary and includes all relevant expertise and perspectives, including input from stakeholders.
4. The processes and methods used in each step of guideline development aim to minimize the risk of bias in the recommendations.
5. Recommendations are based on a systematic and comprehensive assessment of the balance of a policies or intervention's potential benefits and harms
6. Guidelines should be tailored to a specific audience. (The audiences that WHO guidelines can target include public health policy makers, health programme managers, health-care providers, patients, caregivers, the general public and other stakeholders.) (WHO 2014: 2).

These guidelines were developed based on the findings of this study, the discussion of the findings and the extensive literature review. The development process of these guidelines requires sufficient resources in terms of people with a wide range of skills, including expert environmental health professionals, health services researchers, and environmental officials.

The draft guidelines developed were shared with experts working on public health and environmental health activities at district, zonal regional and national levels. A total of 16 different professionals were participated in the evaluation of these guidelines.

Health care workers providing health services also gave feedbacks on the guidelines developed. Finally, the guidelines were shared with public health and environmental health experts to check for their comprehensiveness, their feasibility and applicability in the local situation.

The comprehensiveness of the guideline, the practicability, scientific groundings of the guideline was evaluated. 103 proposed actions were provided for experts and 101 of the proposed actions were accepted by the expert group and the rest two are removed from the guidelines.

These guidelines are developed to contribute for the improvements of solid health care waste management practice in the facilities.

The process followed to develop these guidelines is depicted

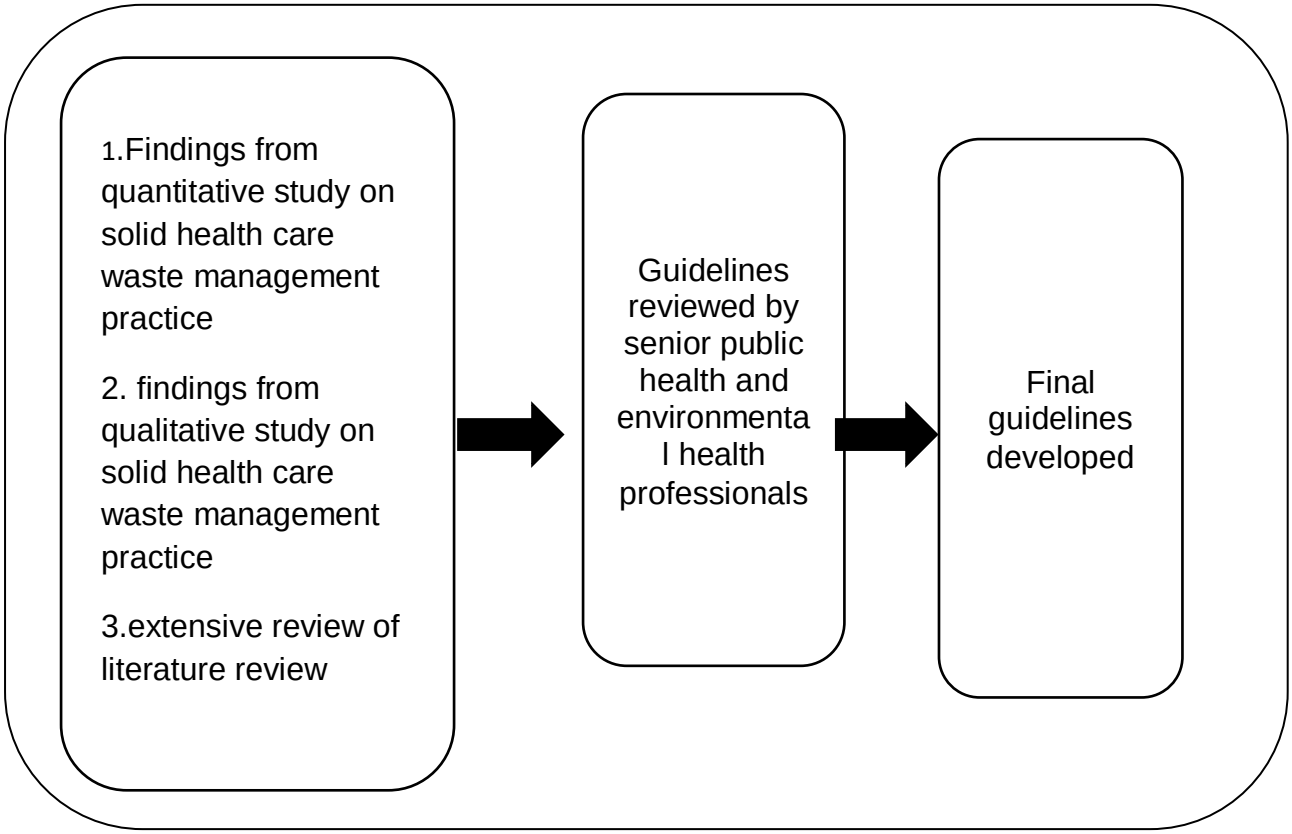

Figure 5.1 The process of guideline development

The final guidelines were tested in NEMMCSH for one month and the comments from practical users were evaluated and incorporated into the guideline.

The final guidelines were shared with Hossaena town administration office to consider adoption and utilisation of the guidelines at all health facilities in the town.

5.6 PROPOSED GUIDELINES

These guidelines are presented in a tabular form that highlights the key areas of challenge to the health care facilities and health care workers. The table has been incorporated key areas of challenge to the appropriate HCWM practice.

Table 5.1 Key areas of challenge to the appropriate HCWM practice

Key areas of challenge to	Guideline statement	Findings from the study	Recommended actions
Poor segregation of SHCW generated in health facilities.	To improve colour coded segregation practice of solid HCW generated	Absence of colour coded waste bins.	The institution should avail colour coded containers Black for non-infectious solid wastes, Yellow for infectious solid wastes, and red for highly infectious, and wastes that are soaked by blood and for amputated organs, especially in delivery wards, emergency, and operation theatre) this type of wastes should be dispose in separate pit (placenta pit)
		Absence of safety boxes	Sharp wastes should be separately collected on a puncture resistance disposable container.
			Availing yellow hard cardboard boxes (safety box) for sharp wastes
			HCW collection bins should be foot-operated
		Health facility workers lack of knowledge on the segregation of solid waste.	Providing induction training for newly employed health facility workers on how to segregate health facility wastes based on the World Health Organisation recommendation and periodic reorientation should be given to strengthening.

Key areas of challenge	Guideline statement	Findings from the study	Recommended actions
			Providing orientation for patients, clients, and visitors, on the topic of how to segregate the generated wastes.
		Absence of health education program for patients and clients.	Assigning focal person to facilitate health education activity or hiring health education professionals.
			Incorporating HCW segregation practice on the daily health education program.
			Evaluation should be done weekly for the effectiveness and efficiency of the health education program.
		Absence of reminder poster that used to remind segregation practice.	Preparing and availing easily understandable posters at each solid waste generation site.
		Absence of health facility workers' evaluation on HCWMP.	Health facility workers should be evaluated weekly, and HCW segregation practice should be incorporated on balance scorecard evaluation system.

Key areas of challenge	Guideline statement	Findings from the study	Recommended actions
		Biohazard symbols were not posted on the disposal container.	Biohazard symbols should be posted on the disposal container in addition to the colour coding symbols of the containers.
			Corrosive -This substance cause damage to living tissues including the eye and skin. 
			Flammable -These substances sensitive to fire and properly store to minimize fire hazard 
			Explosive 
			Very toxic- this substance is very dangerous to health when inhaled or ingested 

Key areas of challenge	Guideline statement	Findings from the study	Recommended actions
			Oxidising -this substance easily facilitates the burning of the material by providing oxygen 
			Dangerous for the environment-dangerous both to the animal and plant 
Poor collection of wastes from all generation sites.	To improve the collection practice of SHCW generated from all service areas in the facility	Cleaners collect the segregated waste together in one dust bin	The segregated solid wastes should be collected according to the segregation practice (wastes stored on black containers should be collected by using a black coloured container, wastes stored on yellow containers should be collected by using the yellow-coloured container, and wastes stored on red containers should be collected by using the red coloured container).
			Sharp waste should be collected separately in a puncture resistance disposable container.
		Absence of separated waste collection	Availing large-size colour coded collection containers for transportation.

		containers.	
Key areas of challenge	**Guideline statement**	**Findings from the study**	**Recommended actions**
		Lack of follow-up and control of waste collectors.	Collection systems and practices should be supervised and controlled by environmental health officers.
		Negligence of waste collectors leads to needle stick injury.	Training /orientation should be given to cleaners on collection practice to protect from needle stick injury during
			emptying the segregation containers to the collection containers.
		There is no fixed collection time at all health facilities that participated in this study	SHCW collection time should be fixed and respected based on the infectious nature of the waste and the quantity of the waste generated
			Non-infectious waste should not be collected together with infectious wastes
			Infectious waste should be collected separately until the final disposal site.

Key areas of challenge	Guideline statement	Findings from the study	Recommended actions
Poor transportation of solid HCW from generation sites to the final disposal sites.	To improve the transportation practice of SHCW from generation to disposal.	Solid waste was transported from generation to final disposal sites by using open dust bins.	Waste transportation containers should be separate from waste collection containers, and they should be tight-fitting covers.
		All health care facilities have no transportation wheel to minimise accidents for cleaners and other health facility communities.	Waste transportation wheels should be availed at all health facilities to facilitate the easy transportation of solid waste.
SHCW incineration.	To improve HCW treatment practice.	Health facilities use substandard barrels and brick incinerators.	Small scale incinerators should be avoided
			4–5-meter height brick incinerators with appropriate construction (availing air inlet and ash removal door) should be constructed.
			Health facilities or town health offices should plan for new technologies; that do not harm the human health as well as the environment.
		Incinerators were built less than 5 meters to the service provision	Town administration should build a standard incinerator for the management of solid waste outside the town to

		buildings,	minimise the release of

Key areas of challenge	Guideline statement	Findings from the study	Recommended actions
SHCW incineration.	To improve HCW treatment practice.	especially in private health facilities.	un acceptable chemicals and minerals (dioxin and furans).
			All health facilities in the town should be abiding by the rule.
		Private health facilities were providing health services inside the community this leads to complaints of the nearby community due to smoke generated from the poorly constructed incinerator.	The practical accomplishment of this standard incinerator that will be constructed outside the town and zoning should be practiced in the town (residential, commercial and health service provision areas should be separated).
Ash pit	To improve the final disposal of incinerated wastes in health facilities.	97.6% of health facilities have no ash pit for incinerated wastes in the facilities.	As stated above in this guideline communal incinerators should be constructed with standard ash pits considering the groundwater level or individual health facilities should be constructed final disposal ash pits individually to avoid the exposure of the community to an unacceptable level of chemicals and minerals resulting from incomplete

			incineration.
Key areas of challenge	**Guideline statement**	**Findings from the study**	**Recommended actions**
Knowledge	To improve the knowledge of health facility workers on management of SHCW generated in the facility.	Lack of knowledge on segregation, collection, transportation, and disposal of SHCW.	Induction and continuous in-service training should be provided to all staff that is participated from generation to disposal of wastes.
			Training should include how to prevent health facility acquired infection, how to handle infectious waste and preventive vaccination.
Vaccination.	To improve the vaccination status of the health facility workers.	Only 40% of the staff are taking one or more of the vaccinations Less than 1/3 of the staff are vaccinated for COVID-19.	Knowledge assessment should be done periodically to prepare training based on the gap.
			All health facility workers who have contact with patients and HCWs should be vaccinated for the available vaccine in the facilities.
			Non-vaccinated workers should not be allowed to provide health services in the facilities.

Key areas of challenge	Guideline statement	Findings from the study	Recommended actions
		Less than 1% of the staff is vaccinated for the Hep C vaccine.	Regulatory bodies should supervise all health facilities, and the vaccination status of the facility workers to take corrective actions for those who do not respect the guidelines.
Guidelines and instructive poster for SHCWM.	To avail SHCWM guidelines and instructive poster.	Observational findings revealed that more than half of the service areas are not supplied with SHCWM guidelines or instructive posters for SHCWM.	SHCWM guidelines should be availed at all service areas.
			Instructive posters should be posted at all service provision rooms to remind the workers and patients what to do for SHCWMP.
			Department and facility heads should be checked the availability of guidelines and Instructive posters at each service provision room.
			Regulatory bodies should check the availability and utilisation of the guidelines and instructive posters before renewal of the service provider license.

Key areas of challenge	Guideline statement	Findings from the study	Recommended actions
On-site treatment of SHCW.	To improve the onsite treatment of SHCW before disposal to minimise unacceptable infections.	Observational findings showed that none of the facilities treat the generated solid waste before disposal.	All infectious solid wastes should be disinfected by using 0.5% chlorine solution before disposal.
			Sharp waste should be immersed in 0.5% chlorine solutions for 10 minutes before disposal.
			Syringe and needle should be flashed 2-3 times in 0.5% chlorine solution before disposal this should be destroyed HIV/AIDS, Hep B, Hep C, and other viruses.
			Regulatory bodies should perform accidental supervision for proper implementation of the guidelines.
Accident related to SHCW and reporting system.	To prevent work-related accidents.	1/4th of the health facility workers was exposed to needle stick injury.	Sharp waste disposal training should be provided for all health facility waste management staff.
			Sharp waste containers should be placed at an arm's reach of the sharp waste generation areas.
			-Recapping should be avoided at all service provision sites.

Key areas of challenge	Guideline statement	Findings from the study	Recommended actions
		Absence of satisfactory procedures in case of an accident.	Accidents or incidents should be registered and reported to incident officer. Action plan should be prepared to minimise further injuries.
			Health facility leaders and owners should assign focal person and establish a committee to avail satisfactory procedures to manage the occurrence of any accidents in the facilities.
		Poor reporting to incident officers.	All health facility workers are responsible to report immediately if any accidents occurred.
			Health facilities should assign a responsible body for registering the accidents and taking care of the injured staff.
			Health facilities should assign trained doctor or health officer to manage the occurred incidents in the facilities.

Key areas of challenge	Guideline statement	Findings from the study	Recommended actions
Personal protective equipment.	To avail the necessary PPEs and to improve utilisation of PPEs.	Poor availability and utilisation of PPEs.	Health facilities should be availing all of the necessary PPEs (glove, mask, boots, plastic apron, goggles).
			Controlling the proper utilisation of the available PPEs should be conducted by the responsible bodies in the facilities.
			Re-usable PPEs should be decontaminated by using 0.5% chlorine solution.
			Non-reusable and disposable personal protective equipment's should be disposed of properly.
Sharp waste management.	To improve sharp waste management.	No decontamination process before sharp waste disposal.	All sharps should be decontaminated in 0.5% chlorine solution before disposing to the safety box.
		Lack of safety box.	All sharp collection containers should be disposable/ nonreusable.
		Reuse of the sharp container.	All sharps after incineration should be buried in secured areas.
Recapping of sharps.	To improve the safe disposal of needles.	Half of the respondents have used the recapping practice of needles after injection.	Training should be given to all health professionals to avoid recapping of needles after injection.
			Health facilities leaders should punish those who

Key areas of challenge	Guideline statement	Findings from the study	Recommended actions
			are not respecting the guidelines
			Availing safety boxes near to the SHCWM practice.
Temporary storage practice.	All health facilities have temporary waste storage areas. This practice facilitates the process of final disposal practice.	All of the health facilities have no temporary SHCW storage places.	Temporary SHCW storage places should be availed by all health facilities
			All temporary SHCW storage places should be clean.
			The collected solid wastes should be disposed of daily to prevent unwanted smells and the attraction of insects and rodents.
Daily generation rate.	To prepare a plan for minimising the generation rate	A large amount of waste is generated from government health facilities.	Unnecessary activities that increase wastes should be minimised
			Reduce the waste generation rate, reuse some of reusable materials, recycle if possible

Key areas of challenge	Guideline statement	Findings from the study	Recommended actions
	To minimise the generation rate of SHCW		Selecting less wasteful supplies and motivate to reuse and recycle
			Use of physical rather than chemical cleaning methods (e.g., steam disinfection instead of chemical disinfection).
			Strengthening the environmentally preferable purchasing system.
Training	To increase the knowledge of the staff on SHCWM practice.	Only 1/3 of the research participants were trained on SHCWM.	Health facilities should be allocating budget for training.
			Training plan should be prepared by the facility leaders.
			Regulatory bodies should monitor the knowledge of the facility workers and the training should be evaluated properly.
		The absence of a trainer in the facilities.	Zonal health department should prepare a training for private health facilities.
		Lack of budget for training.	Health facilities should allocate budget for training on HCW management.

Key areas of challenge	Guideline statement	Findings from the study	Recommended actions
Hand washing facilities.	To improve hand hygiene practice.	-97% of the facility workers have no hand washing facility near SHCW generation sites.	All health facilities should avail functional hand washing facilities near to the service provision areas.
			continues monitoring should be done for the utilisation of handwashing facilities.
			Motivation or rewarding should be facilitated for those who have good hand hygiene practices.
Patient and visitors	To minimise the number of visitors and visiting time should be specific.	No health education services for patients and visitors.	Health education should be provided to all patients and visitors on SHCWMP.
		More than 5 visitors for one patient at a time.	Visitors should be minimised and visiting time should be specific to minimise unnecessary risks exposed to visitors and caretakers.
		Poor segregation practice of SHCW by visitors and caretakers.	Health education should be provided to visitors and caretaker

Key areas of challenge	Guideline statement	Findings from the study	Recommended actions
Meeting related to SHCWM improvement practice	To make SHCWM an agenda for the facility.	There is no meeting held in all facilities to improve SHCWMP.	Solid HCW management practice should be an agenda for the health facility senior management team.
			Government health facilities should establish an infection prevention and control (IPC) committee.
			All departments should have a meeting related to SHCWMP to improve health facilities SHCWMP.
			The meeting should be written in a minute book and filed properly.
Procedures in case of an accident.	Establishing a procedure to manage the accidents or incidents properly.	Half of the research participants are not agreed with the presence of satisfactory procedures in case of an accident in the facilities.	Health facilities should be assigned trained health professional/s to manage the occurrence of any accidents or incidents in the facilities.
			Availing post-exposure prophylaxis at all times in the facilities.
			Accident/incidents registration books should be prepared, and all accidents and incidents should be registered.
			Risk assessment should be done monthly in the facility to minimise the occurrence of accidents or incidents.

Key areas of challenge	Guideline statement	Findings from the study	Recommended actions
Water supply.	To recommend and enforce the availability and accessibility of a clean and safe water supply.	Water supply is not easily available in the facilities Hand washing basins are not constructed near to the service provision areas.	Clean and safe water should be availed 24/7 in the facilities.
			Hand washing basins should be constructed or renovated in each service provision area.
			Hand hygiene compliance should be monitored by the trained health professionals in the facility.
			Motivating or rewarding mechanisms should be established for the best performer on hand hygiene.
Instructive posters.	Availing reminder and instructive posters.	Absence of instructive posters near to the solid waste generation sites.	The approved instructive poster should be posted at all SHCW generation sites.

Key areas of challenge	Guideline statement	Findings from the study	Recommended actions
Reuse /recycle	To encourage the facility or other organisations to reuse or recycle non-infectious solid wastes.	Only one facility in the town. has receive plastic bottles waste for recycling.	Reusing/recycling should be planned.
			Reusable or recyclable wastes should be separately stored to minimise contamination by microorganisms and chemicals.
		No recycling/ reusing of solid wastes.	Town health office should communicate organisations that reuse or recycle wastes.
Disposal	To improve the final disposal system.	Infectious wastes from private health facilities were disposed of together with the municipal HCW disposal sites.	Health facility HCW disposal sites should be separately constructed, and final disposal should be based on the international standards.
Environmental friendliness	To improve the environmental friendliness of the solid HCW disposal practice.	Carcinogenic wastes like blood bags, IV bags, and IV lines, mercury-containing wastes are incinerated inside the town or in the community.	Communal disposal site outside the town should be constructed by the town health office.
			Carcinogenic wastes should be buried, and incineration should be avoided.

Key areas of challenge	Guideline statement	Findings from the study	Recommended actions
HCWM planning	To prepare the plan for the purpose of appropriate HCWMP	There is no plan to improve SHCWM service.	Health facilities should have prepared a plan for the appropriate management of solid waste
Re-use/recycling.	To minimise the volume of disposable wastes from the institution.	No recycling practice of wastes except NEMMCSH for plastic bottles.	Recycling of wastes after decontamination and cleaning should be planned and practiced.
On-site transport.	To improve the onsite transportation practice of SHCW.	Onsite transportation wastes are practiced by using uncovered plastic buckets.	All wastes should be transported from generation areas to disposal places by using covered container and it should be transported by using a trolley.

5.7 IMPLICATIONS FOR HEALTH FACILITY MANAGEMENT

These guidelines will be helpful for the health facility managers to improve SHCWM practice in all institutions in the town. Health care providers, patients, visitors of the health facilities, and community will benefit from the practical applicability of these guidelines.

5.8 DISSEMINATION OF THE GUIDELINES

These guidelines will be disseminated to all government and private health facilities in the town by arranging a meeting for all health facility representatives. The zonal health department will take the responsibility to disseminate these guidelines to other health facilities outside Hossaena Town.

5.9 EVALUATION FOR THE DEVELOPED GUIDELINES

The guidelines were evaluated by different groups purposefully selected individuals from university, zonal health department staff and town municipality staff. A total of 16 different professional in two groups participated in the evaluation of these guidelines. They were distributed a week before the meeting to the meeting participants, a one-day guideline evaluation meeting was prepared by the principal investigator.

The comprehensiveness of the guidelines, the practicability, two different technical teams evaluated scientific groundings. After the intensive discussion with the proposed guidelines two of the teams were agreed with the 101 (98%) recommended actions out of 103 proposed actions and one recommended action out of 103 recommended actions were agreed with the researcher and other one recommended action was not agreed by the two of the teams. Finally, the researcher decided to include the recommended actions in the guidelines. The final guidelines were tested in NEMMCSH for one month and the comments from practical users were evaluated and incorporated into the guidelines. The final guidelines were shared with Hossaena Town administration office to consider adoption and utilisation of the guidelines at all health facilities in the town.

5.10 CONCLUSION

This chapter presented the evidence-based developed guidelines, based on the study findings and literature review. These guidelines are needed to promote the appropriate SHCWM practice to minimise the burden of needle stick injury, to increase the level of knowledge of the staff and the community.

CHAPTER 6

CONCLUSIONS, LIMITATIONS, AND RECOMMENDATIONS OF THE STUDY

6.1 INTRODUCTION

This chapter presents a summary of the study findings, conclusions and outlines of recommendations drawn from the study findings, as well as the limitations of the study. The aim of this study was to assess SHCWM practices from generation to final disposal and developing guidelines to improve SHCWM practices in Ethiopia.

6.2 RESEARCH DESIGN AND METHOD

The convergent mixed method design was used for this study, quantitative data were analysed by using statistical software and qualitative data were analysed thematically.

6.3 SUMMARY AND INTERPRETATION OF THE RESEARCH FINDINGS

6.3.1 Research participants and data collection process

Health facility workers (540 in number) from 41 health facilities in Hossaena Town which is found in the southern part of Ethiopia was participated in this study. Quantitative and qualitative data were collected by using open-ended and closed-ended questionnaires, observation, and focus group discussions. About 303 (65.4%) of the participants were from government health facilities and 187 (34.6%) were from private health facilities. Three hundred forty-three (58%) of the participants are female and 227 (42%) are male. Most of the research participants, 215 (39.8%) are in the age group of 26-30. Nurses, cleaners, and health officers make up the largest number of professionals who are participated in this study.

Nurses, health officers, laboratory professionals, and cleaners are the most frequently available health facility workers found in almost all private health facilities. The mean number of years spent in the facility was 3.66 years. Most of the study participants, 153 (28.3%) served their institution for less than one year.

6.3 Findings related to utilisation of colour-coded waste bins

Availability of colour-coded waste bins was asked for respondents and observation was conducted to confirm the availability. But the qualitative observation showed 97.6% of the health facilities were not using the colour-coded waste bin and this leads to mixing of infectious and non-infectious solid HCW together and the mixed HCWs are more contaminated than segregated SHCW. In addition, private clinics are disposing of SHCW except sharps to the municipal solid waste disposal (SWD) dumping site, and this affects the solid waste disposal crew and the municipal disposal sites.

6.3.3 Findings related to foot-operated/ SHCW collection bins

Nearly half of the service areas had no foot-operated dust bins availed near the SHCW generation sites. Observational findings show that except NEMMCSH, foot operated HCW segregation containers/ bins were not availed in the facilities. Most of the containers were opened.

6.3.4 Findings related to elbow control/foot-operated hand washing basins

Only 3.1% of the service areas have hand washing basins near to the HCW generation areas. Shortage of water and hand washing basins are the reason for poor hand hygiene practices for SHCW handlers.

6.3.5 Findings related to the availability of personal protective equipment

WHO recommends the availability of proper waste equipment, such as sharp containers and PPEs to go hand-in-hand with training. About 72.6% of the respondents agreed on the availability of one or more of PPE in the facility. Private health facilities are better in providing gloves for health workers, but poor compared to government health facilities for providing masks. Observational findings confirmed that even though there is a critical shortage of personal protective equipment, poor utilisation of the available PPEs was observed. COVID-19 pandemic was contributed more for the shortage of some PPEs like gloves and masks because of individuals other than health facility workers are collected and stored PPEs in the house. The availability of masks was above the mean in NEMMCSH and in private clinics.

6.3.6 Findings related to training on HCW management practice and the presence of satisfactory procedures in case of an accident

Less than half of the respondents were trained on SHCWMP. More knowledge was observed in NEMMCSH when compared to other health facilities. Half of the respondents agreed that there are

satisfactory procedures in case of any accidents related to work. In addition, 24.4 of the staff are pricked by needle stick injury during providing health services. Nearly half of the respondents 269 (49.8%) who have been exposed to needle stick injury do not get satisfactory procedures after being pricked by a needle and those who have not been pricked by a needle stick injury for the last one year. The most injured staff by needle stick injury were reported from NEMMCSH. Moreover, 83.1% of the health facility workers who participated in this research were not satisfied by the current SHCWM practice.

6.3.7 Findings related to HCW management policy

The majority of the staff respond they are aware of what to do in case of any work-related accidents.

6.3.8 Findings related to SHCWM Policy

Greater than 2/3 of the research participants are aware of the presence of SHCWM policies. But nearly 1/3 of the participants who were exposed to any work-related accidents were doing nothing after exposure to injury. This result showed that knowledge and practice were showing that divergent. Only 37% of the respondents were a response to the appropriate action they will perform if they were exposed to occupational injury. I will take prophylaxis, consult the available doctors, and test the status of the patient (source of infection) were the appropriate answers they respond. Greater than half of the participants disagreed on the environmental friendliness of the SHCWM practice in the respective health facilities.

6.3.9 Findings related to sharp waste management and vaccination

Nearly half of the respondents are recapping needles after injection. Recapping was more practiced in NEMMCSH and surgical centre which is 57.5%, and 57.5% respectively, and above the mean. Health facility workers are taking Hepatitis B, COVID-19, and tetanus toxoid vaccinations to prevent themselves from infections related to SHCWM practice.

Nearly half of the research participants responded for they have guidelines that are used for management of SHCW generated at the facility, but the observation shows 11.7% of the service provision rooms have some part of the national guidelines either posted on the wall or availed on the table of the service provider. In addition, 251 (46.5%) of the respondents had no knowledge of

the national policy of SHCWM practice. Most of the respondents do not know the national and local HCW management policy.

6.3.10 Findings related to factors that contributed to improper SHCWM in the facilities

Lack of safety boxes, lack of colour-coded waste bins and lack of training are the response to the question problems encountered in managing SHCWMP.

6.3.11 Focus group discussion

Forty-five FGDs were conducted in all health facilities, FGDs were conducted in individual health facilities. 3to 7 participants have participated in each FGD.

6.3.12 Findings related to the problems encountered for managing HCW

The absence of some of the PPEs like boots and aprons to protect themselves from infectious agents. Masks, disposable gloves and changing gowns are a critical shortage at all health facilities. High expenditure and inflation of cost are complained by all of the facility leaders to avail PPEs. Shortage of water supply, patients and visitors lack of knowledge, inappropriate waste collection system, staff carelessness for appropriate SHCWMP, and shortage of dust bins are the problems observed in this study.

6.3.13 Conclusions

The research findings of this study reveal that solid HCW segregation practice was not performed properly in the health facilities. All kinds of SW were collected together in a single container. There is no separate colour-coded container in almost all facilities except one. HCWs were collected and transported using a non-standard container and hence both the collection and transportation systems were ineffective to protect the people and environment from contamination. The knowledge of health facility workers was poor, even the theoretical knowledge was not practised properly by some of the research participants. Incineration was used as the final disposal system and this practice was inefficient and ineffective, they are using a small brick incinerator and barrel incinerator which is releasing the most dangerous, carcinogenic, and teratogenic wastes to the environment. Overall, SHCWM practice was not properly managed and given attention properly

from the Ministry of Health level to the local authority. Ethiopian Ministry of Health and other concerned bodies should have to think carefully and urgently.

6.3.14 Recommendations

6.3.14.1 Recommendations of guidelines and training

In the light of the finding of this research, there are several gaps regarding proper SHCWM practice. The following recommendations consider the different aspects of SHCWMP that need to be addressed to ensure standard SHCWMP that is used to protect the environment and the public. Standard HCW management guidelines should be availed that used to guide the health facility staff on how to manage the generated solid waste in the facilities. Induction training should be given to all newly hired staff and refreshment training should be given at least annually. Regulatory bodies at different levels should conduct a strict supervision of the facilities readiness on SHCWM capacity before licensing health facilities.

6.3.14.2 Recommendation of colour-coded waste bins and waste management technologies

Availing standard colour-coded dust bins are a prerequisite for the appropriate segregation practice of solid waste generated at health facilities. Health facilities should be allocating adequate budget to purchase colour-coded waste bins. Poor final disposal of SHCWM was observed in the study facilities, and this should be improved by constructing appropriate HCW management technologies that are used to eliminate or minimise the negligible quantity of releasing hazards to the environment and the people. There are no specific guidelines for SHCWM in Ethiopia. Ministry of Health of Ethiopia should be prepared and avail SHCWM guidelines to all health facilities nationwide and the implementation of the guideline should be strictly followed. All health facilities are recommended to avail closed and secured temporary waste storage sites to facilitate the disposal practice.

6.3.14.3 Recommendations of using the town waste collection firms

Private health facilities use the town waste collection firm to dispose of wastes other than sharp. The study finding shows the municipal waste collection system was not organised and there is no appropriate timetable for collection owing to this reason infectious wastes were stored for days. Daily collection of HCW should be strengthening the town municipality.

6.3.14.4 Recommendation to invite private companies to improve SHCWMP

Standard SHCW management practices should be constructed, but the private health facilities cannot construct this kind of technologies. Private companies should be motivated to construct a private HCW management system that will be used to manage all HCWs generated in the town.

6.3.14.5 Recommendation to minimise needle stick injuries

Needle stick injuries are reported from all health facilities and unreported accidents were many in each health facility. To minimise this situation, health facilities should identify the reason that exposed the facility workers to injury and the recommended practice should be strengthened. The hospital HCW management emphasises the duty of care as one of the responsibilities of the HCW generator. Employers should be entrusted with the responsibility of providing a safe working environment, protection of public health and the environment.

6.3.14.6 Recommendation to improve the management of injured health facility workers

Knowledge of the facility workers after exposure to infection was poor and health facility leaders should be strictly followed and improve the management of victims to minimise healthcare-acquired infection. In addition, prevention of HCW-related infection to the health facility workers should be given attention and the availability of preventive vaccines should be a priority agenda for all health facilities. Health professionals should be vaccinated at health science college for hep B, hep C, and other preventive vaccines before practicing any health care services.

Health facility leaders will think and practice a solid waste minimisation strategy. The incinerators used for the treatment of HCWs should be properly designed and constructed to burn waste completely.

6.3.14.7 Recommendations for policy makers

Policy makers from the Ministry of Health and Regional Health Bureau should be revised and standardised the health facilities' HCW management practice. Further research studies should be considered in the rural part of the health facilities. There is a critical shortage of budget in the rural government health facilities. HCW minimisation and appropriate management plans should be prepared from top to bottom of the health service provision sites. National HCW management

weeks or months should be assigned by the Ministry of Health and all health facilities should be celebrating the day by providing awareness.

6.3.15 Contribution of the study

The findings of this study apparently showed the current SHCWMP in the study area are not appropriate and showed that waste producers lack knowledge towards safe and appropriate SHCWM system for health facilities. The study exposed inadequate personal protection to infections from disease-causing organisms generated from inappropriate management of SHCW and the pollution of the atmosphere and lithosphere from the chemicals and minerals generated from SHCW.

The study resulted in the development of the guidelines which will assist to improve solid healthcare waste management and contribute towards protection of the community health through the guidance provided by proposed guidelines.

6.3.16 Limitation of the study

This study was performed in one town found in the southern part of the country and it is not representative of the country and difficult to generalise the findings to other hospitals or health systems in Ethiopia. Another limitation of this study was private drug stores and private pharmacies were not incorporated in this study.

6.3.17 Concluding remarks

Healthcare service provision settings inevitably generate wastes that may be hazardous to health or have harmful environmental effects. Some of them, such as sharps, cultures from medical laboratories or infected blood, carry a higher potential for infection and injury than any other type of waste. The absence of proper management measures to prevent exposure to hazardous HCW results in important health risks to the general public, and health facility workers. The study found that SHCWM knowledge and practice were poor, Lack of personal protective equipment, inappropriately constructed SWM final disposal system, lack of protective vaccines for health facility workers, poor attention to report and manage health facility injuries related to SHCWMP, lack of water supply, and absence of SHCWM guidelines and poor attention given from regulatory bodies.

The Ethiopian government are responsible to prepare a short and medium national strategy for HCWM system to improve the current situation. In particular, special attention should be paid to the following points: At each administrative level, clear individual and institutional responsibilities should be established. Appropriate, environmental-friendly, and affordable technologies should be selected for the treatment and disposal of HCW, considering both technical and financial resources available in the country. Adequate awareness and training programmes for nurses and planners, hospital administrators, medical staff, and environmental health officers should be developed. Moreover, specific monitoring and administrative procedures should be set up and adequate resources should be allocated to ensure proper management of the HCW.

REFERENCES

Adama, M, Esena, R, Fosu-Mensah, B & Yirenya-Tawiah, D. 2016. Heavy metal contamination of soils around a hospital waste incinerator bottom ash dumps site. *Journal of Environmental and Public Health* 16,1–8.

Adekunle, O, Romona, DJ, & Andrew, JR. 2018. Knowledge, attitudes and practices of health care workers about health care waste management at a district hospital in KwaZulu-Natal. *South African Family Practice* 60 (5):137–145.

Adesina, OA, Sonibare, JA, Diagboya, PN, Adeniran, JA and Yusuf, RO. 2018. Spatiotemporal distributions of polycyclic aromatic hydrocarbons close to a typical medical waste incinerator. *Environmental Science & Pollution Research* 25:274-282.

Adu, RO, Gyasi, SF, Essumang, DK, Otabil, KB. 2018. Medical Waste-Sorting and Management Practices in Five Hospitals in Ghana. *Journal of Environmental and Public Health. (* 2)

Agbiji, E, & Landman, C. 2014. Overcoming fragmentation and waste in health care systems in Africa: Collaboration of health care professionals with pastoral caregivers. *Theological Studies* 70 (2):1–11.

Alabanese, JA, Ruiz, MP. 2016. *Solid waste as a renewable resource methodologies*. CRC Press, Taylor & Francis Group.

Alili, A, Krstev, B, Krstev, A, Stamenov, G, Stoilov, Z 2018. The hazardous medical waste treatment technologies, location and origin. *Natural Resource and Technology* 279-284.

Ali, A, Anwar, R, Suhail, A, Dahri, W. 2020. Hospital waste management practices at Pakistan field hospital level II in united nations mission in Liberia. *Pakistan Armed Forces Medical Journal* 70 (2): 379-84.

Allison, 2015. Solid Waste Management in the Pacific: Institutional Arrangements.

Alvi, MH. 2016. A manual for selecting sampling techniques in research.

Anita, P, Sanjiv, A, Molly, M, Ajay, KA. 2016. Bio-medical waste managment in a tertiary care Hospital: An overview. *Journal of Clinical and Diagnostic Research* 10 (11):1–4.

Anderson, DM, Cronk, R, Best, L, Radin, M, Schram, H, Tracy, JW, & Bertram, J. 2020. Budgeting for environmental health services in healthcare facilities: A Ten-Step model for planning and

costing. *International Journal of Environmental Research and Public Health* 2020.17 (2075): 1.

Angus, NO, Callistus, CE, David, UA, Ifeanyi, E, Obiora, SE, Christian, Chibuzo, I, & Chika, FU. 2016. Healthcare waste management in selected government and private hospitals in South East Nigeria. *Asian Pacific Journal of Tropical Medicine* 6 (1):84–89.

Anita, P, Sanjiv, A, Molly, M, & Ajay, KA. 2016. Bio-medical waste managment in a tertiary care Hospital: An Overview. *Journal of Clinical and Diagnostic Research* 10 (11):1–4.

Anoushiravan, MB, Monireh, M, Mohammad, R, Saeed, N, Parviz, N, Hamidreza, Z. 2019. Polycyclic aromatic hydrocarbons formation during the fast pyrolysis of hazardous health-care waste. *Chemosphere* 227: 277–288.

Ata, R, Kamyar, Y, Mohammad, H, Saeid, P, Amirhosein, M, Masud, Y, Mehran, K, & Ramin, N. 2016. Assessment and selection of the best treatment alternative for infectious waste by modified sustainability assessment of technologies methodology. *Journal of Environmental Health Science & Engineering* 14 (10):1–14.

Awodele, O, Adewoye, AA, & Oparah, AC. 2016. Assessment of medical waste management in seven hospitals in Lagos, Nigeria. *BMC Public Health* 16 (269).

Bakshi, R, Ghosh, N, Mukherjee, R, Chakraborty, S. 2017. Assessment of knowledge and practice of biomedical waste management among health care personnel in a rural tertiary care hospital of Darjeeling District, West Bengal, India. *Journal of Comprehensive Health 6 (1).*

Banstola, D, Banstola, R, Nepal, D, & Baral, P. 2017. Knoweledge, attitude and practice of health care institutions and theire staff involved in hospital solid waste management. *Journal of Institute of Medicine* 39 (3):7–52.

Bello IA, Ismail NB, Kabbashi NA. 2016. Solid waste management in Africa: A review. *International Journal of Waste Resource* 6: 216.

Berihun, D & Solomon, Y. 2017. Preliminary assessment of the status of hospital incineration facilities as a health care waste management practice in Addis Ababa City, Ethiopia. *Adv Recycling Waste Management* 2 (4).

Binaya, S, Gopal, KG, Dhiraj, M, Nirmal, S. 2015. Development and implementation of HCW management policy at Civil Service Hospital, Nepal. *Journal of Pharmacy Practice and Research* 45:57–63.

Boncz, I. 2015. Introduction to research methodology.

Bougie, R & Sekaran, U. 2016. *Research methods for business. A skill-building*. 7TH edition. *John Wiley & Sons Ltd.*

Brigitte, SC, 2017. Rigor or reliability and validity in qualitative research: Perspectives, strategies, re-conceptualisation, and recommendations.

Burke, J, & Larry, C. 2014. Educational research, quantitative, qualitative, and mixed method approaches. 5thedition. SAGE Publications, Inc.

Caniato, M, Tudor, T & Vaccari, M 2015. International governance structures for HCW management: A systematic review of scientific literature. *Journal of Environmental Management* 153: 93–107.

Cassell, C., Cunliffe, A.L. and Grandy, G. eds., 2017. The SAGE handbook of qualitative business and management research methods. Sage.

Catherine, C, Ann, LC, & Gina, G. 2018. The SAGE Handbook of qualitative business and management research methods. London EC1Y 1SP 55 City Road, SAGE Publications Ltd.

Charlotte, EH. 2015. The importance of pretesting questionnaires: Afield research example of cognitive pretesting the exercise referral quality of life scale. *International Journal of Social Research Methodology 1-12.*

Chinelo, I. 2016. Fundamentals of research methodology and data collection.

Cohen, L, Manion, L & Morrison, K. 2018. *Research methods in education*. 8th edition.

College of American pathologist laboratory quality solutions. 2020. Evidence-based guideline development methodology manual. Pathology and laboratory quality centre for evidence-based guidelines.

Costa, AP, Reis, LP, Moreira, A. 2019. Computer supported qualitative research new trends on qualitative research. *Advances in Intelligent Systems and Computing.*

Creswell, JW. 2014. *Research design qualitative, quantitative, mixed method approach*. 4th edition. SAGE Publications, Inc.

Creswell, JW, & Creswell, JD. 2018. *Research design, qualitative, quantitative, and mixed methods approachs*.5th edition, SAGE Publications, Inc.

Creswell, JW, & Plano, CV. 2019. *Designing and conducting mixed methods research*. 3rdEdition. SAGE Publications, Inc.

Cypress, BS 2019. Rigor or reliability and validity in qualitative research: Perspectives, strategies, re-conceptualization, and recommendations. *Dimensions of Critical Care Nursing 36* (4):157.255.

Daniel, S & Mebin, G. 2019. Knowledge and practice of waste disposal management in dental clinics in Chennai', *Drug Invention Today*, 12 (2).

Debere, MK, Gelaye, KA, Alamdo, AG & Trifa, ZM. 2014. Assessment of the HCW generation rates and its management system in hospitals of Addis Ababa, Ethiopia. *BMC Public Health* 13 (28):1-9.

Dennis, H. 2016.*Introduction to qualitative methods in psychology*.3rd edition. Pearson Education Limited Loughborough University.

Denzin, NK, & Lincoln, YS, 2018. *The SAGE handbook of qualitative research*.5th Edition. SAGE Publications, Inc.

Dehghania, MH, Ahramia, HD, Nabizadeha, R, Heidarinejadd, & Zarei, A. 2019. Medical waste generation and management in medical clinics in South of Iran. *Elsevier Journal* 6:727-733.

Deress, T, Hassen, F, Adane, K, & Tsegaye, A. 2018 Assessment of knowledge, attitude, and practice about biomedical waste management and associated factors among the healthcare professionals at Debre Markos town healthcare facilities, Northwest Ethiopia. *Journal of Environmental and Public Health 2018.*

Diclemente, RJ, 2019. *Health behaviour theory for public Health principles, foundations, and applications*. 2nd edition.

Dolores, ET, Ana, LM, Miguel, C H, Amaya, LG. 2018. Using indicators as a tool to evaluate municipal solid waste management: A critical review*. Waste Management* 80:51-63.

Doylo, T, Alemayehu, T, & Baraki, N. 2019. Knowledge and practice of health workers about HCW management in public health facilities in eastern Ethiopia. *Journal of Community Health* 44:284–291.

Edmonds, WA & Kennedy, TD. 2017. *An applied guide to research designs. Quantitative, qualitative, and mixed methods*. Second edition, Nova South eastern University, SAGE Publications.

Elliott, SW, & Marianne, SL. 2015. Medical waste management: A review. *Journal of Environmental Management* 163:98–108.

Ephrem, S, & Mekonnen, M. 2017. Assessment of dioxin and furan emission levels and management practices in Addis Ababa, Ethiopia. *Journal of Health and Pollution.*7.(15):85–95.

Epestin, E. 2015. *Disposal and management of solid waste pathogens and diseases*. CRC Press Taylor & Francis group. Broken Sound Parkway NW, Suite 300.

Eyup, Nk. 2018. Estimations and analysis of medical waste amounts in the city of Istanbul and proposing a new approach for the estimation of future medical waste amounts. *Waste Management* 81: 168–176.

Eze, CT, Nwagwe, OR,Ogbuene, EB, Eze, HI. 2017. Investigating groundwater contamination following the disposal of hospital wastes in a government reserved area, Enugu, Nigeria. *Bulletin of Environmental Contamination & Toxicology* 98:218–225.

Farooq, MT, Omar, N, Shahid, F, Khizar, S, Khan, A, Ashfaq, N, & Manzoor, I. 2017. Assessment of hospital waste management protocols in tertiary care hospitals of Lahore. *Biomedical* 33 (2) 1-9.

Fawaz, P, Ganesh, SP, Sabin, S, & Anna, A.2016. Awareness, knowledge and practices on bio-medical waste management among health care professionals in mangalore. A cross sectional study. *International Archives of Integrated Medicine*, 3 (1):29–35.

Fazzo, L, Minichilli, F, Santoro, M, Ceccarini, A, Seta, MD, Comba, P, & Martuzzi, M. 2017. Hazardous waste and health impact: A systematic review of the scientific literature. *Environmental Health* 16 (107).

Federal negarit gazeta of the federal democratic republic of Ethiopia. Proclamation number 300/2002. Environmental pollution control proclamation 2002; 1959-1966. Federal negarit gazeta of the Federal Democratic Republic of Ethiopia. Proclamation number 299/2002. Environmental impact assessment proclamation 2002; 1951-1958.

Feridoz, JK, & Krishnan, M. 2018. Knowledge and awareness of biomedical waste management among dental students and auxiliary staff - A questionnaire study. *Drug Invention Today*10 (2) 3129-3134.

Flick. U. 2018. The sage handbook of qualitative data collection tools.

Forero, R, Nahidi, S De Costa, J Mohsin, Fitzgerald, G, & Gibson, N. 2018. Application of four-dimension criteria to assess rigour of qualitative research in emergency medicine. *BMC Health Service Research*.

Fuller, WH & Warrick, AW. 2018. Soils in waste treatment and utilization. Pollutant containment, monitoring, and closure.

Ganesh, CS, Masita, AS, & Saraswathy, S. 2018. Knowledge and risk perceptions of occupational infections among health-care workers in Malaysia. *Safety and Health at Work* 8:246–249.

Ghasemi, MK, & Yusuff, RB. 2016. Advantages and disadvantages of healthcare waste treatment and disposal alternatives: Malaysian scenario. *Polish Journal of Environmental Studies 25 (1):*17-24.

Ghersin, ZJ, Flahery, MR, Yager, P & Cummings, BM. 2020. Going green: decreasing medical waste in a paediatric intensive care unit in the United States. *The New Bioethics* 26 (2): 98-110.

Gihan, H, Shimaa, S & Rania, E. 2018. An intervention significantly improve medical waste handling and management: A consequence of raising knowledge and practical skills of health care worker. *International Journal of Health Sciences* 12 (4): 56–67.

Gilbert, JM & Noble, B. 2016. Waste to energy technologies for solid waste management: a case study of Uganda. *Agricultural Engineering International CIGR* 18 (3):136–146.

Gillian, S & Catherine, C. 2019. *Qualitative organisational research: Core methods and current challenges.* SAGE Publications, Inc.

Gopalakrishna, G, Langendam, MW, Scholten, RJ, Bossuyt, PM & Leeflang, MM *Guidelines for guideline developers: A systematic review of grading systems for medical tests*.

Greener, S &Martelli, J. 2015. *An introduction to business research methods*. 2nd edition.

Grove, SK, Gray,JR, & Burns, N. 2015. *Understanding nursing research building an evidence-based practice*.

Hangulu, L & Akintola, O. 2017. Perspectives of policymakers and stakeholders about health care waste management in community-based care in South Africa: qualitative. *BMC Health Services Research* 17 (290) :1-13.

Hank, JS, Joseph, R, Gary, C, Matthew, N, Tyler, H, Aaron, F, Wesley, W. 2017. Quantitative research methods for political science, public policy and public administration. 3rd edition. 1:259.

Helelo, AB, Senbeta, AF, & Anshebo, ST. 2019. Assessment of solid waste management practices in Hawassa University campuses, Ethiopia. *Journal of applied science and environmental management* 23 (6) 1081-1086.

Howitt, D. 2016. *Introduction to qualitative methods in psychology*.3rdedition. Loughborough University.

Howitt, D & Cramer, D. 2017. *Research methods in psychology*. 5th Edition, Pearson.

Hua, S, Hu-Chen, L, Ping, L, Xue-Guo, X. 2017. An integrated decision making approach for assessing healthcare waste treatment technologies from a multiple stakeholder. *Waste Management* 59:508–517.

Hurst, S, Arulogun, OS, Owolabi, MO Akinyemi, R, Uvere, E, Warth, S Ovbiagele, B. 2015. Pretesting Qualitative Data Collection Procedures to Facilitate Methodological Adherence and Team Building in Nigeria *International Journal of Qualitative Methods* 53-64 (14).

Hussein, IA & Mona, SM. 2018. Solid waste issue: Sources, composition, disposal, recycling, and valorization. *Egyptian Journal of Petroleum* 27:1275–1290.

Ibrahim, AB, Muhamad, NI, & Nassereldeen, AK. 2016. Solid waste management in Africa: A review. *International Journal of Waste Resource* 6 (2):1-4.

James, PS, 2017. A Guide to quantitative and qualitative dissertation research. 2nd edition. Dissertation Research Guide.

Jean, GT. 2014. HCW management: A multi speed development in the sub-Sahara African region. *Pan African Medical Journal* 17 (305):1-2.

Jemil, S, Makadia, AJ, Mukesh, GG. 2014. Importance of clinical posting for awareness on bio-medical waste in medical and paramedical students. *International Journal of Medicine and Public Health* 4 (4):377-379.

Jill, F. 2017. Breadth of the socio-ecological model. *Journal of Agro-Medicine*22: 295-297.

John, D. 2018. *The ultimate guide to writing a dissertation in business studies: A step-by-step assistance*.

Johnson, BR & Christensen, L. 2014. *Educational research: Quantitative, qualitative, and mixed-method approaches.* 5th edition. Edited by Reid, H, Theresa, A, Rachael, L, Laura, B. SAGE Publications, Inc.

Judith, S & Burke, J. 2017. How to construct a mixed methods research design? *Köln Z Soziol*.

Karki, S, & Niraula, SR. 2020. Perceived risk and associated factors of healthcare waste in selected hospitals of Kathmandu, Nepal. *PLos One* 15(7):2.

Kalyan, L Reddy, V, & Al Shammari, F. 2017. Evaluation of biomedical waste management in primary health care centres in Saudi Arabia: A knowledge, attitudes and practices study. *Eastern Mediterranean Health Journal* 23 (9) 637-640.

Khan, BA, Khan, AA, Ahmed, H, Shaikh, SS, Peng, Z & Cheng, L. 2019. A study on small clinics waste management practice, rules, staff knowledge, and motivating factor in a rapidly urbanising area. *International Journal of Environmental and Public Health,* 37 (9) 863–875.

Khan, BA, Cheng, L, Khan, A, & Ahemd, H. 2019. Healthcare waste management in Asian developing countries: A mini review. *Waste Management & Research* 37 (9):863-875.

Khan, EM, Sabeeh, SM, Chaudhry, MA, Yaqoob, A, Rana, SM, & Kumar, R. 2016. HCW management in Pakistan: A situation analysis and way forward *Pakistan Journal of Public Health* 6 (3):35-44.

Khan, MI, Khan, EA, Irfan, SA, & Muhammad, A. 2016. Wastes management practices in selected public and private hospitals of Peshawar, Khyber Pakhtunkhwa. *Journal of Medical Study.*2 (1).

Kidane, G, Fiseha, G, Mohamned, M, & Linda, G. 2018. State of waste management in Africa. *Africa Waste Management Outlook*: 1-225.

Kiger, ME& Varpio, L. 2020. Thematic analysis of qualitative data: AMEE Guide No. 131 Medical teacher.

Kistan, J, Ntlebi, V, Made, F, Kootbodien, T, & Wilson, K. 2020. Health care access of informal waste recyclers in Johannesburg, South Africa. *PLoS ONE* 15 (7): 2.

Kist, LT, Rosa, FR, Moraes, JAR, Machado, EL. 2017. Diagnosis of hospital waste management in vale do riopardoriogrande do sul, brazil. *Revista de Gestão Ambiental e Sustentabilidade – GeAS.7 (3) 554-569.*

Kowalski, SC, Morgan, RL, Falavigna, M, Florez, ID, Ikobaltzeta, IE, et al. 2018. *Development of rapid guidelines: Systematic survey of current practices and methods*. Health research policy and system.

Kontogianni, S, & Moussiopoulos, N. 2017. Investigation of the occupational health and safety conditions in Hellenic solid waste management facilities and assessment of the in-situ hazard level. *Safety Science* 96:192–197.

Krishnaveni, M. 2018. KAP study about bio medical waste management practice among dental practitioners in urban area of Andhra Praesh. *Journal of Dental Specialities* 6 (1):66–68.

Kumar, A, Duggal, S, Gur, R, Rongpharpi, SR, Sagar, S, Rani, M, Dhayal, D, & Khanijo, CM. 2015. Safe transportation of biomedical waste in a health care institution. *Indian Journal of Medical Microbiology* 33 (3):383-386.

Kumar R, Somrongthong R & Ahmed J. 2016. Impact of waste management training intervention on knowledge, attitude and practices of teaching hospital workers in Pakistan. *Pakistan Journal of Medical Science* 32 (3):705-710.

Kumar, S, Zhang, Z, Kumar, M, & Ronghua, A. 2019. *Biological processing of solid waste.* Taylor & Francis group.

Kumar, S. 2016. *Municipal solid waste management in developing countries*. Taylor & Francis group.

Leavy, P. 2017. *Research design: Quantitative, qualitative, mixed methods, arts-based, and community-based participatory research approaches*. 2nd edition editor Sharlene, NH & Patricia, L. The Guilford Press New York.

Liu, K, 2016. The Effects of social health insurance reform on people's out-of-pocket health expenditure in China. The mediating role of the institutional arrangement. School of labour and human resources Renmin University of China.

Linda, G, Mohamed, TA, Kidane, GG, Jamidu HY, Suzan O, Oladele, O. 2019. Solid waste management in Africa: Governance failure or development opportunity?

Lourdes, TK, Fernanda, RR, Jorge, AR & Enio LM. 2018. Diagnosis of hospital waste management in vale do riopardoriogrande do sul, brazil. *Rev. Gest. Ambient. Sustentabilidade, Sao Paulo*, 7 (1):1-17.

Majid, U. 2018. Research fundamentals: Study design, population, and sample size. *URNCST journal* 2 (1): 1-8.

Manzoor, J & Sharma, M. 2019. Impact of biomedical waste on environment and human health. *Environmental Claims Journal* 31 (4): 311-334.

Marsum, Anies, Bagoes, Widjanarko, B & Wahyuningsih, NE. 2020. Effectiveness of autoclave combination treatment with Andosol soil to decrease the number of bacillus cereus. *Systematic Review Pharmacy* 11 (2):662-668.

Martin, OA, Ebenezer, OS, & Samuel, TA. 2017. Landfill externalities and property values dilemma emerging insights from three Ghanaian cities. *Journal of Contemporary African Studies* 35(3):349–369.

Maryam, KG, & Rosnah, BM. 2016. Advantages and disadvantages of healthcare waste treatment and disposal alternatives:Malaysian scenario. *Polish Journal of Environmental Studies* 25 (1):17–25.

Matee, VE & Manyele, SV 2016. Assessment of sharps waste management practices in a referral hospital. *African Journal of Environmental Science and Technology* 10 (3) 86-95.

Mattoo, AM, Hameed, S, Butt, AM, 2019. Healthcare waste management: Current knowledge, attitude, and practices “A study at secondary and tertiary care hospitals” *Pakistan Journal of Medicine* 58(4) 187-192.

Meleko, A, Tesfaye, T & Henok, A. 2018.Assessment of HCW generation rate and its management system in health centers of Bench maji zone. *Ethiopian Journal of Health Science* 28(2):125-134.

M.Com. 2016. Research methodology. Part – II.

McCusker & Gunaydin, S. 2019. *Research using qualitative, quantitative or mixed methods and choice based on the research.* SAGE Publications, Inc.

Meleko, A, Tesfaye, T & Henok, A. 2018.Assessment of healthcare waste generation rate and its management system in health centres of Bench Maji zone. *Ethiopian Journal of Health Science* 28(2):125-134.

Meylan, G, Lai, A, Hensley, J, Stauffacher, M & Krutli, P 2018. Solid waste management of small Island developing states-the case of the Seychelles: A systemic and collaborative study of Swiss and Seychellois students to support policy. *Environmental Science and Pollution Research* 25: 35791-35804.

Mohammad, MH & Habibur, RM. 2018. Assessment of healthcare waste management paradigms and its suitable treatment alternative: A case study. *Journal of Environmental and Public Health* 2018: 1–16.

MOHE. 2019. National infection prevention and control reference manual for health care service providers and managers. 3rd edition.

Momeni H, Farad, SF, & Arefinejad, A. 2018. Composition, production rate and management of dental solid waste in 2017 in Birjand, Iran. *International Journal of Occupational and Environmental Medicine 9:52-60.*

MOH Ethiopia. 2021. National infection prevention and control policy. January 2021.

Naresh, K, Narsi RB, Subhash CK & Ashok, C. 2018. Assessment of domestic solid waste (DSW) management practices in rural areas and scope for attaining and sustaining the scientific solid waste management mechanism.*Annals of Biology* 34(1):35–39.

Neuman, L. 2014. *Social research methods: Qualitative and quantitative approaches*. Seventh edition, Pearson Education Limited.

Ngwa, CH, Ngoh, EA & Samuel, NS. 2018. Assessment of the knowledge, attitude and practice of health care workers in Fako division on post exposure prophylaxis to blood borne viruses: A hospital-based cross-sectional study. *Pan African Medical Journal 31(108):*1-8.

Nguyen, PT. 2016. Health-care solid waste management in vietnam: Current status and strategic actions. *Environmental Research Journal*7(4):342–365.

Olaniyi, FC, Ogola, JS, & Tshitangano, TG. 2019. Efficiency of health care risk waste management in rural healthcare facilities of South Africa: An assessment of selected facilities in Vhembe district, Limpopo Province. *International Journal of Environmental Research & Public Health,*16(2199).

Onoh, L. 2018. Comparison of hospital waste management by health care workers in two selected (private and public) hospitals in enugu, south east nigeria. *NJIRM* 9(4):55–61.

Olaifaac, A, Govenderb, RD & Rossc, AJ. 2018. Knowledge, attitudes and practices of healthcare workers about healthcare waste management at a district hospital in KwaZulu-Natal. *South African Family Practice 60 (5):*137-146.

Oykale, AS & Oykale, TO. 2017. HCW management practices and safety indicators in Nigeria. *BMC Public Health*7(740):1-14.

Orhorhoro, EK & Oghoghorie, O. 2019. Review on solid waste generation and management in Sub-Saharan Africa: A case study of Nigeria. *Journal of Applied Science &Environmental Management* 23 (9) 1729-1737.

Paez, A, Higgins, CD, Vivona, SF. 2019. Demand and level of service inflation in Floating Catchment Area (FCA) methods. *PLoS ONE* 14(6).

Patricia, L. 2017. *Research design: Quantitative, qualitative, mixed methods, arts-based, and community-based participatory research approaches*. 2nd edition. Edited by Sharlene, NH & Patricia, L. New York: The Guilford press

Patton, MQ. 2015. *Qualitative research and evaluation method. Integrating theory and practice* 4th edition.

Pooja, S, Bikash, M, Vipin, K, Vikrant, K, Yogesh, G & Anil, KG. 2016. Health care professional training in biomedical waste management at a tertiary care hospital in India', *Biomedical Waste Management*, 30 (2):168–170.

Polit, DF, & Beck, CT. 2017. *Nursing research: Generating and assessing evidence for nursing practice.* 10th edition. Editor, Christina B.

Popoola, A, Ayangbile, OA & Adeleye, BM. 2016. Assessment of solid waste management systems in Ibadan north, Oyo state using geo-spatial techniques *Ethiopian Journal of Environmental Studies &Management* 9 (6) : 666 – 679.

Prabhat, P &Meenu, MP. 2015. *Research methodology: Tools and techniques*. Bridge centre.

Pullishery, F, Panchmal, GS, Siddique, S & Abraham, A. 2016. Awareness, knowledge and practices on bio-medical waste management among health care professionals in Mangalore - A cross sectional study. *International Archives of Integrated Medicine 3* (1) :29-35.

Qadir, M, Murad, R, Faraz, N. 2016. Hospital waste management; tertiary care. *The Professional Medical Journal.* 23 (7) :802-806.

Rada, EC. 2016. *Biological treatment of solid waste, enhancing sustainability*. CRC Press Taylor & Francis Group.

Rafiee, A, Yaghmaeian, K, Hoseini, M, Parmy, S, Mahvi, A, Yunesian, M, Khaefi, M & Nabizadeh, R. 2016. Assessment and selection of the best treatment alternative for infectious waste by modified sustainability assessment of technologies methodology. *Journal of Environmental Health Science & Engineering 14 (10).*

Raila, EM & Anderson, DO. 2017. Black carbon emission reduction strategies in healthcare industry for effective global climate change management. *Waste Management &Recycling*35 (4) :416-425.

Ravishekar, NH, Shailaja, P, Sumeena, B, Sandhya, G, Tarana, SE, & Vijayalaxmi, VM. 2016. Knowledge, attitude and practices of healthcare workers regarding biomedical waste management: A Multispeciality hospital based cross- sectional study in eastern india. *Journal of Krishna Institute of Medical Sciences University* 5 (4) :64-72.

Ream, PS, Tipplea, AF, Salgadoa, AS & Souza, AC. 2016. Hospital housekeepers: Victims of ineffective hospital waste management. *Archives of Environmental & Occupational Health* 71 (5) :273-280.

Reddy, LK & Shammari, FA. 2017. Evaluation of biomedical waste management in primary health care centres in Saudi Arabia: A knowledge, attitudes and practices study. *Eastern Mediterranean Health Journal* 23 (9): 640.

Rida, A, Sadiq, A, Hussain, T, & Rehman, A. 2019. Knowledge and practices regarding biomedical waste management among healthcare personnel in a tertiary care hospital, Rawalpindi. *Journal of Rawalpindi Medical College.23 (2) :72-75.*

Reinhardt, PA & Gordon, JG. 2018. *Infectious and medical waste management*. CRC Press Taylor & Francis group.

Rishav, B, Nilanjana, G, Risheen, M, & Sumanta, C. 2018. Assessment of knowledge and practice of biomedical waste management among health care personnel in a rural tertiary care hospital of Darjeeling District, West Bengal, India. *Journal of Comprehensive Health* 6 (1) :14–18.

Sampson, JP. 2017.*A guide to quantitative and qualitative dissertation research*. 2nd edition. Dissertation research guide.

Serge, K. 2020.The role of community participation in solid waste management in Sub-Saharan Africa: a study of Orlando East, Johannesburg, South Africa. 103 (1):1-14.

Sudhir, CJ. Vishal, D, Ashok, JT, Rita, J, Harshada, S, Megha, S, Ashish, P, Ragini, M, Cecilia, SL. 2015. Staff perception on biomedical or health care waste management: A Qualitative study in a rural tertiary care hospital in India. *PLOS One* 10 (5):1–15.

Saha A, Bhattacharjya H. 2019. Health-care waste management in public sector of Tripura, North-East India: An observational study. *Indian Journal of Community Medicine*.44 (4) :368-72.

Sahiledingel B. 2019. Self-reported healthcare waste segregation practice and its correlate among healthcare workers in hospitals of Southeast Ethiopia*. BMC Health Services Research 19591:1-11.*

Samuel, DS & Mathew, MG. 2019. Knowledge and practice of waste disposal management in dental clinics in Chennai. *Drug Invention Today 12 (1) 41-44.*

Selvamuthu, D, & Das, D. 2018. *Introduction to statistical methods, design of experiments and statistical quality control*. Springer.

Sekaran, U, & Bougie, R. 2016. Research methods for business. A skill-building approach, seventh edition, John Wiley & Sons.

Sharlene, HB. 2018. *Toward an understanding of a qualitatively driven mixed methods data collection and analysis: Moving toward theoretically centred mixed methods praxis. The SAGE handbook of qualitative data collection in UWEF*. SAGE Publications Ltd.

Shinee, E, Gombojav, Nishimura, A, Hamajima, N, Ito, K. (2008). Healthcare waste management in the capital city of Mongolia. *Waste Management* 28 435–441.

Siah, A. 2014. *Research design for business & management: Data collection methods*. SAGE Publications Ltd.

Singhal, L, Tuli, AK & Gautam, V. 2017. Biomedical waste management guidelines. What's done and what needs to be done. *Indian Journal of Medical Microbiology* 35(2):194–198.

Tabash, MI, Rim, AH, Mahmoud, AH, ElBorgy, MD & Abu-Hamad, BA. 2018. Impact of an educational program on knowledge and practice of health care staff toward pharmaceutical

waste management in Gaza Palestine. *Journal of the Air & Waste Management Association* 66 (4):429-438.

Tadesse, ML, Kumie, A. 2014. Healthcare waste generation and management practice in government health centres of Addis Ababa, Ethiopia. *BMC Public Health* 14 (1221) 1-18.

Teshiwal, DY, Mekonnen, GT &Kasaw, AC. 2019. Healthcare waste management current status and potential challenges in Ethiopia*:* a systematic review. *Biomed Central Research Notes 12 (285)*:1-7.

Tiruneh, YA & Adisse, A. 2017. Hand hygiene compliance and associated factors among health workers in Wachemo university Nigist Eleni Mohamed Memorial hospital. *International Journal of Innovative Research* 6(10).

Thomas, Delphine & Patricia. 2019. *Sample size for pre-tests of questionnaires*. Springer International Publishing Switzerland.

Tolley, EE, Ulin, PR, Mack, N, Robinson, ET, Succop, SM. 2016. *Qualitative methods in public health a field guide for applied research*. 2nd edition. John Wiley & Son.

Trochim, WM. *Research methods knowledge base*. Edited by Shomoita Alam Lopa.

Tulu, FD. 2014. Hazardous waste management by healthcare institutions, Addis Ababa: Implementation of laws and regulation. *Ethiopian Journal of Environmental Studies & Management* 7 (2):134–141.

Wilson, DC, Velis, CA. 2015. Waste management – still a global challenge in the 21st century: An evidence-based call for action. *Waste Management & Research*33(12) 1049–1051

Win, EM, Saw, YM, Oo, KL, Than, TM, Cho, SM, Kariya, T, Yamamoto, E & Hamajima, N. 2019. Healthcare waste management at primary health centres in Mon State, Myanmar: The comparisons between hospital and non-hospital type primary health centres. *Nagoya Journal Medical Sciences*. 81 81–91.

Ulysses, PA, Patricia, MM, Washington, SF, Taline, CS, Rafael, RV, Thiago, GS. 2019. Social-ecological theory of maximization*:* Basic concepts and two initial models*. Biological Theory* 14:73-85.

Vanberkel, PT & Moayed, SY. 2017. A general model to compute activity-based waste disposal costs for health care products. *The Engineering Economist 62 (2):132.*

Vikas, T & Ramesh, A. 2015. Selection of waste disposal firms using grey theory based multi-criteria decision making technique. *Procedia - Social and Behavioral Sciences*189: 81–91.

Plano, C & Nataliya, VI. 2017. *Mixed methods research: A guide to the Field: Why use mixed methods research: Identifying rationales for mixing methods*. Thousand Oaks SAGE Publications, Inc.

Wafik, H, Mariam, M, Mahd, K, Habib, C. 2014. Routing system for infectious healthcare-waste transportation in Tunisia: a case study. *Environmental Engineering and Management Journal* 13 (1) :21–28.

Wafula, ST, Musiime, J, & Oporia. F. 2019. HCW management among health workers and associated factors in primary health care facilities in Kampala City, Uganda: Across-sectional study. *Biomed Central Public Health* 2019 (19) :1-10.

WHO. 2012. Handbook for guideline development.

WHO.2014. *Safe management of waste from health-care activities*. Geneva: Switzerland.

WHO. 2014. Handbook for guideline development. 2nd edition

WHO. 2014. World Health Organisation (WHO) *Safe management of wastes from health-care activities* 2nd Edition. Edited by Chartier Y, Emmanuel J, Pieper U, Prüss A, Rushbrook P, Stringer R.

WHO.2015. *Status of health-care waste management in selected countries of the Western Pacific region*. Geneva: Switzerland.

WHO. 2015. *Status of health-care waste management in selected countries of the Western Pacific Region*. WHO library cataloguing in publication data.

WHO. 2017. *Safe management of wastes from health care activities, A summary. Geneva.* (WHO/FWC/WSH/17.05). License: CC BY-NC-SA 3.0 IGO.

WHO. 2017. Safe management of wastes from health care activities*. A summary. 2nd Edition.Geneva: Switzerland.*

WHO. 2019. *Overview of technologies for the treatment of infectious and sharp waste from health care facilities*.

Yallew, WW, Kumie, A, & Yehuala, FM. 2017. Risk factors for hospital-acquired infections in teaching hospitals of Amhara regional state, Ethiopia: A matched-case control study. *PLoS ONE* 12 (7): 1-11.

Yazie, TD, Tebeje, MG & Chufa, KA. 2019. Healthcare waste management current status and potential challenges in Ethiopia. A systematic review. *Biomed Central Notes* 12 (285) :1-7.

Yordanova, D, Angelova, S, Kyoseva, V, & Dombalov, I. 2014. Household medical waste threat to the environment and human health. *Journal of Chemical Technology and Metallurgy* 49 (2):185.

Zaman, A & Ahsan,T 2020. *Zero- waste, reconsidering waste management for the future*. CRC press Taylor & Francis group.

Zelda, J, Michael, GR, Phoebe, F, & Brian, YM. Going green: Decreasing medical waste in a paediatric intensive care unit in the United States. *Cummings The New Bioethics* 26 (2) :98–110)

APPENDICES

Appendix 1: Ethics review certificate from UNISA higher degree ethics review committee

UNISA university of south africa

UNISA HEALTH STUDIES HIGHER DEGREES ETHICS REVIEW COMMITTEE

Date 8 July 2020

Dear Yeshanew Ayele Tiruneh

NHREC Registration # : REC-012714-039
ERC Reference # : **HSHDC/1002/2020**
Name : Yeshanew Ayele Tiruneh
Student #: 67125166
Staff #:

Decision: Ethics Approval from
8 July 2020 to 8 July 2025

Researcher(s): Name Yeshanew Ayele Tiruneh
Address
E-mail address 67125166@mylife.unisa.ac.za, telephone # 251- 0911786219

Supervisor (s): Name Prof LM Modiba, Dr SM Zuma
E-mail address modiblm@unisa.ac.za, telephone # 0823319629

Working title of research:

Development of practice guidelines for solid health care waste management in Ethiopia

Qualification: PhD

Thank you for the application for research ethics clearance by the Unisa Health Studies Higher Degrees Ethics Review Committee for the above mentioned research. Ethics approval is granted for five (5) years.

*The **low risk application** was **reviewed** by a Sub-committee of URERC on 7 July 2020 in compliance with the Unisa Policy on Research Ethics and the Standard Operating Procedure on Research Ethics Risk Assessment. The decision was approved on 7 July 2020.*

The proposed research may now commence with the provisions that:

1. The researcher will ensure that the research project adheres to the relevant guidelines set out in the Unisa Covid-19 position statement on research ethics attached.

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
www.unisa.ac.za

2. The researcher(s) will ensure that the research project adheres to the values and principles expressed in the UNISA Policy on Research Ethics.
3. Any adverse circumstance arising in the undertaking of the research project that is relevant to the ethicality of the study should be communicated in writing to the Health Studies Research Ethics Committee HSREC@unisa.ac.za.
4. The researcher(s) will conduct the study according to the methods and procedures set out in the approved application.
5. Any changes that can affect the study-related risks for the research participants, particularly in terms of assurances made with regards to the protection of participants' privacy and the confidentiality of the data, should be reported to the Committee in writing, accompanied by a progress report.
6. The researcher will ensure that the research project adheres to any applicable national legislation, professional codes of conduct, institutional guidelines and scientific standards relevant to the specific field of study. Adherence to the following South African legislation is important, if applicable: Protection of Personal Information Act, no 4 of 2013; Children's act no 38 of 2005 and the National Health Act, no 61 of 2003.
7. Only de-identified research data may be used for secondary research purposes in future on condition that the research objectives are similar to those of the original research. Secondary use of identifiable human research data require additional ethics clearance.
8. No field work activities may continue after the expiry date (8 July 2025). Submission of a completed research ethics progress report will constitute an application for renewal of Ethics Research Committee approval.

Note:

*The reference number **HSHDC/1002/2020** should be clearly indicated on all forms of communication with the intended research participants, as well as with the Committee.*

Yours sincerely,

Signatures :

Chair of HSREC : Prof JM Mathibe-Neke

E-mail: mathijm@unisa.ac.za

Tel: (012) 429-6443

pp

Executive Dean : Prof K Masemola

E-mail: masemk@unisa.ac.za

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Appendix 2: Authorisation letter from zonal health department to collect data from health facilities found in Hossaena Town

Southern Nations, Nationalities & People Regional Government
Hadiya Zone Health Department
HOSSANA

ቀጥር ሀ/ዞ/ጤ/35/699
ቀን 13/12/13

To: - **Mr Yeshanew Ayele, the researcher**

Subject: - **Research authorization**

Following your application for Hadiya zone health department to conduct research on DEVELOPMENT OF PRACTICE GUIDELINES FOR SOLID HEALTH CARE WASTE MANAGEMENT IN ETHIOPIA, this is to inform you that you have been authorized to conduct the research in government and private health facilities found in hossaena town.

You are advised to report to each health facilities to which this letter has been copied before embarking on your research.

Misrak Wamolo Wole

SNNPRG Hadiya Zone Administration Health Office

Appendix 3:Participant information sheet English version

Hello. My name is Yeshanew Ayele Tiruneh, a doctoral student from University of South Africa (UNISA). I would like to invite you to participate in a study on DEVELOPMENT OF A GUIDELINE TO IMPROVE MANAGEMENT PRACTICES OF SOLID HEALTH CARE WASTE MANAGEMENT IN ETHIOPIA at Hossaena Town.

Purpose of the study is to assess waste management practices towards developing guidelines to improve SHCWM practices.

You are one out of ----------respondents that have been selected to fill this questionnaire.

Confidentiality: to establish secured safeguards of the confidentiality of research data, the principal investigator will use codes during the data collection period instead of using names. The original data will be locked in cabinets until the data analysis carryout and no person shall access except the principal investigator. The use of information for any purpose other than that to which participants consented is unethical to the participants. The information you provide is not disclosed in the way it identified your personal characteristics and privacy. After the research defence and final work is approved by the college of health studies academic commission and university senate, the original data questionnaire will be incinerated in a secure manner.

Procedure and Participation: The method of this research is a descriptive mixed methods longitudinal study. The expected duration of the participant's contact with the interviewer will be not more than fifty minutes. You asked to participate in this research because the trustful information which you will provide is important for the understanding of the proposed subject matter.

Risk: The proposed research does not have any inhumane treatment of research participants and any physical harm, social discrimination, psychological trauma and economic loss. This study process has no any form of inducement, coercion and the study does not bring any risks that incur compensation.

Results Dissemination: The researcher is responsible for dissemination of findings moreover fully accountable to provide feedback to the health facilities administration and to the policy makers. Maximum effort will be done to publish the finding in the scientific reputable journal.

Freedom to withdraw: If you want to participant in the study, you have full right to withdraw from the study any time you wish. This would have no effect at all on your health benefit or other administrative effect that you get from the hospital as routine moreover; nobody will enforce you to explain the reason of withdrawal.

Person to Contact: The participant has the right to ask information that is not clear about the research context and content before and or during the research work. You can contact the principal investigator. Tel 0911786219 or yeshaayele@yahoo.com

Appendix 4: Turnitin Report

ORIGINALITY REPORT

24%	21%	11%	13%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	uir.unisa.ac.za Internet Source	3%
2	docshare.tips Internet Source	1%
3	etd.aau.edu.et Internet Source	1%
4	hdl.handle.net Internet Source	1%
5	dokumen.pub Internet Source	1%
6	journals.plos.org Internet Source	1%
7	www.science.gov Internet Source	<1%
8	ebin.pub Internet Source	<1%
9	link.springer.com Internet Source	<1%

Appendix 5:Data collection tools

Data collection tools

Questionnaire

HEALTH WORKER QUESTIONAIRE

1. Sex ---------- Reference Number ……

2. Age ----------

3. What is your highest academic qualification?

Diploma	First degree	2nd degree/masters	General practitioner	Specialist doctor	Specify if others
					---------

4. Current working department ----------

5. How long have you worked in this health facilities ---------?

Please answer the following questions with either yes or no answer

	ASSESSMENT OF KNOWLEDGE AND PRACTICES IN SOLID WASTE MANAGEMENT		yes	No	I don't know
	Is there a color-coded waste bin system in this department?				
	Is the waste container foot operated?				
	is there an elbow controlled or foot operated water tap for hand washing in each of the waste storage and treatment areas?				
	Protective material is available for personnel who work with waste?				
	If the answer is yes availability of personal protective equipment in the facility?	Duty glove?			
		Plastic apron?			
		Boot>			
		Mask?			
	Before you start work do you receive any training regarding solid waste management?				
	Do you know there is a policy regarding solid health care waste management in your health facilities?				
	Is there clear roles and responsibilities with regards to health care waste management?				

	Satisfactory procedures are present in cases of accidents and spillages (focal assigned for post exposure prophylaxis)?			
	Have you been exposed to needle stick injury?			
	Have you been pricked by a needle(s) in the last 12 months?			
	Do you think current practices need improvement?			
	Is there an incinerator at your healthcare facility?			
	Would you say health care waste management practices in this facility are environmentally friendly?			
	Satisfactory procedures are present in cases of accidents and spillages?			
	Is there an immunization program for health care waste workers?			
	Procedures are clear as to what to do in cases of accidental needle stick injury?			
	Do you recap needles			
	Does your healthcare facility (HCF) provide training for staff with regards to health care waste management?			
	Have you ever been injured while using sharp objects such as needles, blades and knives?			
	If yes, what action do you take? ----------			
	Are you provided with protective clothing when handing clinical waste?			
	Have you ever received any training in clinical waste management?			
	Did you receive any protective vaccination for contamination?			
	If yes please specify?			
	Does the infection prevention committee or equivalent have minute book?			
	Do you have guideline on health care waste management?			
	Do you have instructive poster on HCW segregation?			
	On-site treatment of HCW practiced?			
	If yes, please state? ----------			

	-			

Thank You for completing this questionnaire

HEALTH FACILITY MANAGERS QUESTIONNAIRE POLICY AND ASSESSMENT OF HEALTH CARE WASTE MANAGEMENT ASPECTS

Health facility Code .

Participant Code ___

Instructions

Please answer the following questions with a numerical value or yes or no answer

1	ASSESSING HEALTHCARE WASTE MANAGEMENT PRACTICES?		
2	How many employees are available in this institution ----------?		
3	How many of them are direct contact with waste generation -------?		
4	For how many patients in this organisation give service last month?		
5	How many beds? ----------		
6	Is HCW generation rate assessment done last year? If yes, how much the total HCW generated per day?		
7	Does the organisation reuse waste?		
8	If yes how much waste is reused?		
9	If yes which type of waste is reused?		
10	Are there a waste segregation practices?		
11	Does the facility have on-site sterilisation/ disinfection equipment?		
12	Do you have a written solid waste reduction strategy?		
13	Does the facility have a mercury (Hg) elimination policy/program?		
14	Do you have a waste management policy that includes: - Hierarchy of waste management? - Goals of waste management program. - Handling and disposal procedures for all waste streams. - Pollution privation?		
15	Does the facility have a program for purchasing Hg alternative materials?		
16	Does the facility have a recycling program?		
18	Are waste volumes tracked?		
19	Has the facility performed a waste audit in the last 1 years?		

20	Has a committee been formed to investigate waste management?		
21	Does the committee have plan and performance monitoring mechanism?		
22	Does the committee meet at least monthly?		
23	Does the facility have a written operational standard of the waste management?		
24	Is there HCW trainer in this institution?		
25	How many of the staff trained on waste management?		
26	How often is training provided?		
27	Does your hospital provide waste management education or training?		
28	Do you have an environmental preferable purchasing policy to encourage waste reduction?		
29	Do you have a procedure for the safe handling and disposal of Cytotoxic drugs? (ART drugs □Ethambutol, tamoxifun□ peridensulon)?		
30	Is there an operating budget for labour?		
31	Is there an operating budget for consumables e.g. purchase of plastic bags?		
32	Is there an adequate immunisation program for health care waste workers (Hep B, Hep C)?		
33	Does this facility have an environmental management office or facility?		
34	Is there a written training plan and schedule for refresher Trainings?		
35	Are you aware of any legislation/s applicable to HCW Management?		
36	Are you aware of any manual, policy or document on HCW management?		
37	Are waste management responsibilities included in the job description of the person in charge of the health care facility?		
38	The health facilities have a record of occurrences where waste-related injuries to staff, patients and visitors are recorded?		
39	Do you incinerate health care waste in your facility?		

40	If you incinerate your solid waste, is there a plan to try to eliminate incineration as a disposal method?		
41	Does the facility give imaging service? If yes?		
42	Has the facility investigated using non-toxic x-ray developing solutions or digital imaging system?	----------	
43	Do you think current practices need improvement?		
44	All staff working with waste are provided with detailed operating manuals or instructions?		
45	Do you have the policy that personal protective equipment is to be used by workers routinely when handling medical waste?		`
46	How many injuries related to clinical waste have been reported by healthcare workers and waste handlers in the past 12 months?		
	Health professionals ----------		
	Supportive staffs ----------		
47	Is there a job description for health facility waste management workers?		

HEALTH MANAGER INTERVIEW GUIDE

BIOGRAPHICAL DATA

1. Gender ----------
2. Age ----------
3. What is your highest educational qualification? ……..

How long have you managed this health facility? ……

Research Question

Please describe how solid health care waste is managed in your health facility?

……

……

……

……

Probing Questions

What are the different types of solid health care wastes generated in your health care facility?

……

……

What qualification and experience is the minimum requirement for staff responsible for waste management in this health facility?

……

……

Do you have a national or local policy for solid healthcare waste management?

……

……

What are the gaps in the existing Ethiopian national health care waste management policies?

……

……

What are the interventions that can improve management practices of solid health care waste management in Ethiopia?

……

……

How often are the policies reviewed and/or updated?

……

……

Do you have any recommendation on what should be included in the guideline for solid health care waste management?

……

……

Thank You for your participation?

INTERVIEW GUIDE FOR HEALTH FACILITIES WORKERS

BIOGRAPHICAL DATA

1. Gender ----------

2. Age ----------

3. What is your highest educational qualification?……

4 How long have you worked in this health facility ?…….

Please describe your involvement with health care waste management?

……..……

……

……

……

…….

PART A POLICY ASPECTS RELATED TO SOLID HEALTH CARE WASTE MANAGEMENT

Please explain what the national and local policy prescribes for management of solid healthcare waste?

National

policy?……

……

Provincial Policy?

……

……

PART B SOLID HEALTH CARE WASTE MANAGEMENT PRACTICES

What are the types of wastes generated at your healthcare facility?----------
---

Describe how waste is segregated?----------

How do you manage risks associated with solid health care waste?

……

……

Please describe how solid health care waste is segregated in your facility?

……
……

How often do you hold meetings in your health facilities in an attempt to address problems related to the management of waste?

……

In your facility how do you dispose of infectious wastes including blood, body fluids and items saturated with blood or body fluids?

……

What are the initiatives taken to ensure effective management of solid health care waste in your facility?

……
……

What are the problems you encounter in managing solid health care waste in your healthcare facility?

……
……

What is the mode of transportation of clinical waste within the healthcare facility (onsite)?

……
……

What do you think should be included in the guideline for management of solid healthcare waste?

……
……

Do you have any recommendation on management of solid healthcare waste?

……
……

Thank You for your time and participation

Tools for observational checklist for assessing health care waste management practice

Name of health facility _____

Name of data collector_____

1.1 Observational checklist for waste segregation and waste storage?

s/n	Activities	Room 1		Room 2 ...	
		Yes	No	Yes	No
	Is the waste segregated at the point of generation?				
	Is the colour for general health care waste bin black?				
	Is the bin for infectious (containing blood and other body fluid) health care wastes yellow?				
	Is there a container for used sharp, including broken glass yellow containers leak and puncture resistant?				
	Is there a disposable sharp container?				
	Are the waste containers labelled non-infectious / infectious)?				
	Is the temporary waste storage bin having cover?				
	Is the temporary waste storage bin easily cleanable?				
	Is the temporary waste storage bin pedal operated?				
	Is temporary waste storage bin at an arm reach distance?				

Other observation

1.2. Observational checklist for waste collection and transportation:

s/n	Activities	Yes	No
1	Does the facility have temporary waste collection point?		
2	Does the waste collection point clean and free from dirt?		
3	Does the waste collection comply with timetable of the frequency of collection?		
4	Is Infectious waste collected at least daily?		
5	Does the waste collection worker have utility glove?		
6	Does the waste collection worker have boots?		
7	Does the waste collection worker have face mask?		
8	Does the waste collection workers have apron?		
9	Does hazardous / infectious health care waste and non-risk waste are collected on a separate container?		
10	Does waste transportation containers are appropriate cover?		
11	Does waste removed and replaced immediately when they are no more than three-fourth full?		
12	Are there dedicated trolleys for collection and transportation of hazardous waste?		
13	The disinfection and cleaning of trolleys is sufficient?		

Other observation?

1.3. Observational checklist for onsite health care waste storage

s/n	Activities	Yes	No
1	Does the facility have dedicated place for onsite temporary storage of waste?		
	If there is answer the question below?		
2	Is it clean and free from dirt?		
3	Is it fenced and restricted for unauthorized access?		
4	Is the health care waste stored for more than 24 hours before disposal?		
5	Temporary storage areas are located away from patient areas?		

Other observation?

1.4 Observational checklist for waste treatment and disposal:

s/n	Activities	Yes	No
1	Does the facility have onsite solid waste treatment facility?		
2	Do existing treatment facilities have adequate capacity?		
3	Does the treatment facility restrict unauthorized?		
4	Is the treatment and disposal facilities constructed in accordance with waste management standards?		
5	If yes, is it constructed in accordance with waste management standards?		
6	Is there an incinerator in the facility?		
7	If no, where is clinical waste incinerated? ----------		
8	If there is an incinerator, is it constructed in accordance with waste management standards?		
9	Does the facilities have ash pit for incinerated wastes?		
10	Is the Infectious medical waste disinfected before disposal incineration?		

Other observation?

Observational checklist for patient care

s/n	Activities	Yes	No
1	Does the room have a black and yellow container with a plastic bag?		
2	Are visual aid instructions present near the waste receptacles to help in proper segregation?		
3	If yes, what aids are used?		
4	Is sharps containers non reusable?		
5	Does the non-infectious waste container contain infectious waste?		
6	Does the infectious waste containers contain non-infectious waste?		
7	Are non-PVC IV bags used?		
8	Are non-PVC blood bags used?		
9	Is scattered solid waste picked before moping the room		

Other observation?

--

Other observations

10. Are the medical care waste containers sealed while in transport? ----------

---

---

11. Is the medical wastes segregated at the source? ----------

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-

12. Is the infectious waste containers labelled with biohazard symbol? ----------

---

Policy for health service managers

	Activities	yes	No
1	Does your hospital have a specific waste management policy/plan?		
2	Do you consider your waste management policy as reliable and updated?		
3	Do you have the policy that personal protective equipment is to be used by workers routinely when handling medical waste?		
4	Do you have the regulation that placing medical waste in wrong bin is a high risk?		
5	Do you have the policy documents regarding adequate disposal procedures of human tissue remains?		
6	Do you have the policy document that it is necessary to sort medical waste at point of generation?		

In-depth interview for health facility workers

1. Sex ----------
2. Age ----------
3. What is your educational background? ----------

How often do you hold meetings in your health facilities in an attempt to address problems related to the management of waste?

How do you manage risks associated with clinical waste?

Are you aware of national or local policies governing the management of biomedical wastes?

Yes------ no-----

If yes please explain----------

In your facility how do you dispose of infectious wastes including blood, body fluids and items saturated with blood or body fluids? ----------

What policies and procedures are in place to support the Health Care Waste Management (HCWM) system? ----------

6.How often are policies reviewed and/or updated? ----------

7.Describe how waste is segregated----------

8. What are the initiatives taken for effective management of clinical waste? ----------

9.What are the problems you encounter in managing clinical waste in your health care facility?

10, What is the mode of transportation of clinical waste within the healthcare facility (onsite)?

Is there anything you would like to emphasise on HCWM?

Thank you for your time and participation

FOCUS GROUP INTERVIEW GUIDE

What are the problems you encounter in managing health care waste?

……

……

……

What are the problems that you encounter in collection and disposal of health care waste?

……..

……

……

How can the management of solid health care waste be improved in our health facilities?

……

……

……

Do you have any recommendations for improving health care waste management?

……

……

……

Thank you for participation

	Types of waste generated			Day 1	Day 2	Day 4	day 5	day 6	day 7	Total kg
		Description	Department	kg	kg	kg	kg	kg		
Health facility name	Infectious	Wastes suspected to contain pathogens eg laboratory cultures wastes from isolation wards, equipment that have been in contact with infected patients, contaminated gloves	OPD							
			emergency							
			laboratory							
			delivery							
			obstetric ang gyny ward							
			ICU							
			surgery							
			orthopaedic ward							
			administrative							
			kitchen							
			MDR TB							
			MCH							
			peadi							
			operation room							
			medical							
	Pathological waste	Human tissues or fluids e.g., body parts; blood and other body fluids; foetuses	OPD							
			emergency							
			laboratory							
			delivery							
			obstetric and gyny ward							
			ICU							
			surgery							
			orthopedic ward							
			administrative							
			kitchen							
			MDR TB							
			MCH							
			operation room							
			peadi							
	Pharmaceutical waste	Waste containing pharmaceuticals e.g.	OPD							
			emergency							
			laboratory							
			delivery							

		pharmaceuticals that are expired or no longer needed; items contaminated by or containing pharmaceuticals (bottles, boxes)	obstetric ang gyny ward							
			ICU							
			surgery							
			Orthopedic ward							
			administrative							
			kitchen							
			MDR TB							
			MCH							
			peadi							
			operation room							
			pharmacy							
	Pressurized container	aerosol cans								
	Radioactive waste	batteries; broken thermometers; blood-pressure gauges; heavy metals								
	Total mixed waste	wastes containing infectious and non-infectious	opd							
			emergency							
			laboratory							
			delivery							
			obstetric ang gyny ward							
			icu							
			surgery							
			orthopedic ward							
			administrative							
			kitchen							
			mdr tb							
			mch							
			peadi							

	General waste (Non-hazardous/non-pathological waste is waste that does not contain pathogens)								
		Paper and card board							
		Plastic and rubber							
		Organic or vegetables							
		Glass and ceramic							
		Ferrous metal							
		Aluminium							
		Wood							
		Textile							
		Garden waste							
		plastic bottle							
		Left-over food							
		Others							

Appendix 6: Language editing certificate

EDITING AND PROOFREADING CERTIFICATE

7542 Galangal Street

Lotus Gardens

Pretoria

0008

13 August 2022

TO WHOM IT MAY CONCERN

This certificate serves to confirm that I have language edited Tiruneh Yeshanew Ayele's thesis entitled, **"DEVELOPMENT OF PRACTICE GUIDELINES FOR SOLID HEALTH CARE WASTE MANAGEMENT IN ETHIOPIA."**

I found the work easy and intriguing to read. Much of my editing basically dealt with obstructionist technical aspects of language, which could have otherwise compromised smooth reading as well as the sense of the information being conveyed. I hope that the work will be found to be of an acceptable standard. I am a member of Professional Editors' Guild.

Hereunder are my contact details:

Dr Jack Chokwe (PhD)

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Professional EDITORS Guild

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