UNIVERSIDADE
EDUARDO
MONDLANE

FACULTY OF ENGINEERING
MASTER'S THESIS

RISK ASSESSMENT AND SAFETY DURING MANAGEMENT OF INFECTIOUS HOSPITAL WASTE: IMPLICATIONS FOR THE ENVIRONMENT AND PUBLIC HEALTH AT BOANE HEALTH CARE CENTRE

A Dissertation by
LÚCIA TIAGO NAMPELE

Supervised by:

Prof. Doctor Clemêncio Nhantumbo, Eng.

Maputo 2024

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DECLARATION OF AUTHENTICIT

"I declare that this dissertation has never been submitted to obtain any degree or in any other context and is the result of my own individual work. This dissertation is presented in partial fulfillment of the requirements for the degree of Master of Science in Health, Safety and Environment, from the Eduardo Mondlane University".

Submitted by:

Lúcia Tiago Nampele

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ABSTRACT

Hospital waste is a special type of waste with a high potential for infection and injury. Additionally, infectious waste comprises one of the categories of hospital waste with great potential to cause damage to the environment and public health. Thus, qualitative research was carried out at the Boane Health Care Centre, with the aim of assessing the environmental, health and safety risks caused by the limited management of hospital waste. The data were collected from laboratory, and the entire process that includes handling, segregation and final disposal were evaluated. The risks throughout this process were identified and evaluated. In addition to the risks identified associated to the means, methods and treatment employed for the waste, there are other potentially high infectious risks in the laboratory sector that must be considered due to their implication for the environment and public health. However, they are considered low because they have a minimally adequate place for waste treatment, but with limited information that explains whether the process used is safe, despite few records on accidents such as perforation by contaminated needles and spillage of blood samples in this sector. It was also observed that, due to the improper use of plastic bags (black) in the segregation of infectious waste and common waste, mixing occurs, making it difficult to identify infectious waste, indicating the lack of adequate management, therefore endangering the lives of the employees.

KEY WORDS

Keywords: Risk management, Safety, infectious hospital waste, Occupational Health.

RESUMO

Os resíduos hospitalares são um tipo especial de resíduos, com alto potencial de causar infecção e lesões. Os resíduos infeciosos compreendem uma das categorias de resíduos hospitalares com grande potencial de causar danos ao meio ambiente e à saúde pública. Assim, foi realizada uma pesquisa qualitativa no Centro de Saúde de Boane, com o objetivo de avaliar os riscos ambientais, de saúde e segurança causados pela gestão limitada de resíduos hospitalares. Os dados foram colhidos no laboratório de saúde, o processo desde o manuseio, segregação até a disposição final. Os riscos identificados no processo, foram avaliados quanto ao seu potencial de perigosidade. Para além dos riscos identificados, associados aos meios, métodos e tratamentos utilizados, existem outros riscos potencialmente elevados no sector laboratorial que devem ser considerados devido as suas implicações para o ambiente e para a saúde pública. No entanto, alguns riscos foram considerados mínimos por possuir um local minimamente adequado para o tratamento de resíduos, mas com informação limitada que explica se o processo utilizado é seguro, pois existem alguns registros de acidentes por perfuração com agulhas contaminadas e derramamento de amostra de sangue neste sector. Observou-se também que devido ao uso inadequado de sacolas plásticas (Pretas) na segregação de resíduos infeciosos e resíduos comuns, ocorre mistura, sendo difícil a identificação do resíduo infeccioso. Isto indica uma gestão limitada, e que coloca em risco a vida dos trabalhadores.

PALAVRAS-CHAVE

Palavras-chave: Gestão de riscos, Segurança, resíduos infectantes hospitalares, Saúde Ocupacional.

DEDICATION

I dedicate this master thesis to all workers, who lost their jobs for claiming their rights, to those who don't know their rights at work and for those who saw their lives lost because of accidents at work.

I dedicate this work particularly to my parents, Tiago Alberto Nampele and Amina Chaumar for being my eyes and to whom I do everything to see well.

Finally, I dedicate this mater thesis to myself and everyone who fights for safety, understand, and realizes that dangers are everywhere.

ACKNOWLEDGMENT

Above all, I would like to thank God for protecting and guiding me.

I would like to express my gratitude to Fatima who gave me the opportunity to be at the Boane Health Care Centre and to the institution for accepting me and guiding me throughout this project. I would also like to thank my friends and family who supported me and provided insight into the study.

The gratification also extends to the professors of the course, who tirelessly tried to make the subjects understood in the best possible way, which was not easy. Finally, I would like to thank my colleagues for sharing and living together, as well as other people who directly and indirectly support me.

To all, thank you.

PREFACE

Healthcare waste contains potentially harmful microorganisms that can infect hospital patients, healthcare professionals and the Public. Previous records showed that in 2015, a joint WHO/UNICEF assessment found that just over half (58%) of sampled facilities from 24 countries had adequate systems for the safe disposal of healthcare waste. For example, a person who suffers an injury from a needle stick used on an infected patient has risks of 30%, 1.8% and 0.3%, respectively, of becoming infected with HBV, HCV, and HIV (WHO, 2014; 2018). This study also estimated that over two million healthcare workers are exposed to percutaneous injuries with infected harps each year.

Although it represents a small portion of the total solid waste generated, hospital waste can pose great risks. Nowadays it is easy to accept that for the success of organizations, the quality of working conditions must be considered (IGAS, 2018).

In Mozambique, there are few publications on the management and safety in handling hospital waste and, specifically, infectious waste that has a great potential to cause damage to the environment and public health while these impacts are not known. Infectious waste comprises 10-25% of all waste produced in the hospital, which cannot be disposed of with normal household waste, (Kumar, Shaikh, Somrongthong & Chapman, 2015). A particular case of a hospital in which environmental and health risks are imminent, while management and safety in the handling of hospital waste are limited, specifically infectious waste, is the health - Care Centre of Boane.

This research study proposes to develop an improved management of infectious hospital waste at the Health Care Centre of Boane, specifically in the laboratory sector. The study will include a description of the techniques and means used in the treatment of infectious waste, develop an assessment of the associated risks, and assess its work safety policies and the consequent relationship of the risks identified with compliance with the country's health legislation.

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LIST OF ABBREVIATIONS AND ACRONYMS

Abbreviation	*Description*
HIV	Human Immunodeficiency Virus
ILO	International Labour Organization
ISO	International Organization for Standardization
JC's	Joint Commission
JHPIEGO	Johns Hopkins Program for International Education in Gynecology and Obstetrics.
MISAU	Ministry of Health
NHS	National Health Service
PCI	Infection Fighting Program
PDCA	Plan, Do, Check and Act.
PRO	Pessimistic, Realistic and Optmistic
SDSSM	District Service for Women's Health and Social Action
SWOT	Strength, Weakness, Opportunity, and Threat
UNEP	United Nations Environment Programme
US	Sanitary Unit
WHO's	World Health Organization

CHAPTER I

1. General Introduction

1.1. Context

During all phases of development of human societies, the current phase is the one that produces the most waste. The large amount is usually associated with the immense variability in the composition of these wastes, which can include a huge diversity of toxic chemicals and pathogenic microorganisms, bringing serious consequences for the health of populations and the environment itself (Len, 2007).

Health units have the function of providing essential health care to human beings. However, it can generate dangerous products, including hospital waste that pose a risk to the health of workers, users, the community, and the surrounding environment and beyond (MISAU & JHPIEGO, 2014). Among the existing categories of hospital waste, infectious waste has a high potential to pose a risk to human health and the environment.

Infectious waste is waste that represents a danger to the environment due to its biological risk. It composes all material that has encounter fluids. Due to the complexity of some wastes in this category, they can be both infectious and dangerous, such as content containing both sharps and pharmaceuticals. Therefore, this waste requires special attention inside and outside the unit until its final disposal (Agency, 2015). Infectious waste comprises 10 to 25% of the waste produced in the hospital, which cannot be disposed of with normal household waste. (Kumar, Shaikh, Somrongthong, & & Chapman, 2015).

Health services as a whole work, most of the time, simply looking at the efficiency and provision of services, leaving aside the issue of safety at work, which is an important issue today. It becomes even more important to know, evaluate and disseminate the rights and duties of workers and the company/institution for the topic in question. In a specific case, it appears that in our country, problems related to sanitation and safety at work continue to be issues of poor management.

Certainly! Some examples of global legislation related to infection risks include; WHO's, ILO, ISO 13485, and JCI's. To reduce the risks of infections, accidents, and contamination by any agent in hospital units in Mozambique, policies, plans and programs to combat infections were created at national level.

Realizing the great importance of keeping the workplace suitable for the services provided. This is followed by an investigation carried out at the Boane Health Care Centre, to understand how the management of infectious waste has been at this health unit, considering the existence of limited resources in this management.

The present study aims to assess the environmental, health and safety risks caused by the limited management of hospital infection waste at the Boane Health Care Centre, specifically the laboratory, the sector indicated by the institution for this purpose.

1.2. Problem

The Boane Health Centre is one of the health units in the district, comprises category I in health services, and assists a considerable number of users. This unit is under the management of the District Service, so that all activities from planning and execution depend closely on that entity. It covers an approximate number of 150 employees; it also aids Health Centre and communities in the surrounding districts.

Infectious waste in this health unit is treated in a brick incinerator located in the unit's enclosure, next to the septic tanks and the open pit for burning common waste. The treatment of infectious waste occurs through the process of burning with fuel and phosphorus. This infectious waste management activity, practiced in this unit, is partly within one of the presumed national forms for the management of hospital waste, but it does not present the complete performance. Because some techniques and the lack of certain equipment, qualified staff endowed with technical and scientific knowledge about the area, may be at the origin of problems that compromise the health of the worker, the environment, and the surrounding residents. Hence, the following question arises: What are the environmental, health and safety risks generated by the limited management of hospital waste at the Boane Health Centre?

1.3. Motivation

Waste pollution is one of the major scourges in Mozambique, especially solid waste. The interest in the study of infectious waste, its management and safety, stems from the search for knowledge on the subject and from the student being inclined towards the area of environmental management. This interest is in line with a subsequent objective of evaluating the scenario according to public policies and laws that aim to safeguard the health and safety of workers in hazardous waste production sites in the country, to better understand and seek ways to increase the culture of safety. In the first place, in any activity that involves the presence and strength of man.

In this case, infectious waste ends up being highlighted in the waste that has the most impact on the environment and the health of populations, as it represents a major problem due to its negative impacts ranging from production, transport, and final disposal, which can be in the form of gas/ash. However, the negative aspects are visible when integrated and adequate management is not applied, following the established standards and by qualified personnel.

1.4. Objectives

1.4.1. General

The main objective of the study is to assess the environmental, health and safety risks caused by the limited management of hospital waste at the Boane Health Care Centre, focusing on its handling, segregation, and final disposal.

1.4.2. Specific Objectives

To achieve the macro-objective, it was intended to:

- Describe the techniques and means used for the treatment of infectious waste at the Boane Health Centre, including disposal sites.
- Develop an environmental, health and safety risk assessment the Boane Health Care Centre.
- Describe the functioning of the safety policies available to the workers responsible for managing infectious hospital waste at the Boane Health Centre.
- Compare the identified risks with the country's health legislation.

1.5. Contribution

The aim of this study is to encourage participatory and demanding adherence to worker safety, regardless of the area or sector, not only as a legal obligation but also as a need at various levels, intensifying its importance in organizations.

It is intended to communicate that the health of the worker is very important for the company/institution. That regardless of the training that this professional has, as well as in the institutional organization, adjustments of new knowledge of acting in practice are necessary, according to updates on the area.

It is intended to encourage the search for new research, involving health institutions with neighboring communities and on various matters of public interest, which aim to persuade and consider the common well-being and the environment, always guided by choices of less risk, less expenses and more productivity.

1.6. Problematization

Improper management of healthcare waste exposes healthcare professionals, waste handlers and the community to infections, toxic effects, injuries and more.

The choice of location for the practical realization of the study fell to the Health Centre of Boane, as it is one of the Health Units in the District, which provides its services to a considerable number of users, and because it is interested in understanding how it has been done. The management of hospital waste in national health units such as Health Centre's of the first level of health care provision in accordance with the hierarchy of the national health system, also due to the interest in understanding the safety policies of their workers.

The District of Boane, located in the southwest of Maputo Province, is based in Vila de Boane, **Figure 1**. It is bounded by the District of Moamba to the north and the District of Namaacha to the west and

Southwest, the District of Matutuine to the south and southwest, and the municipality of Matola to the east, it also has an area of 820km² and a population of 102,457 inhabitants/km² (State, 2005).

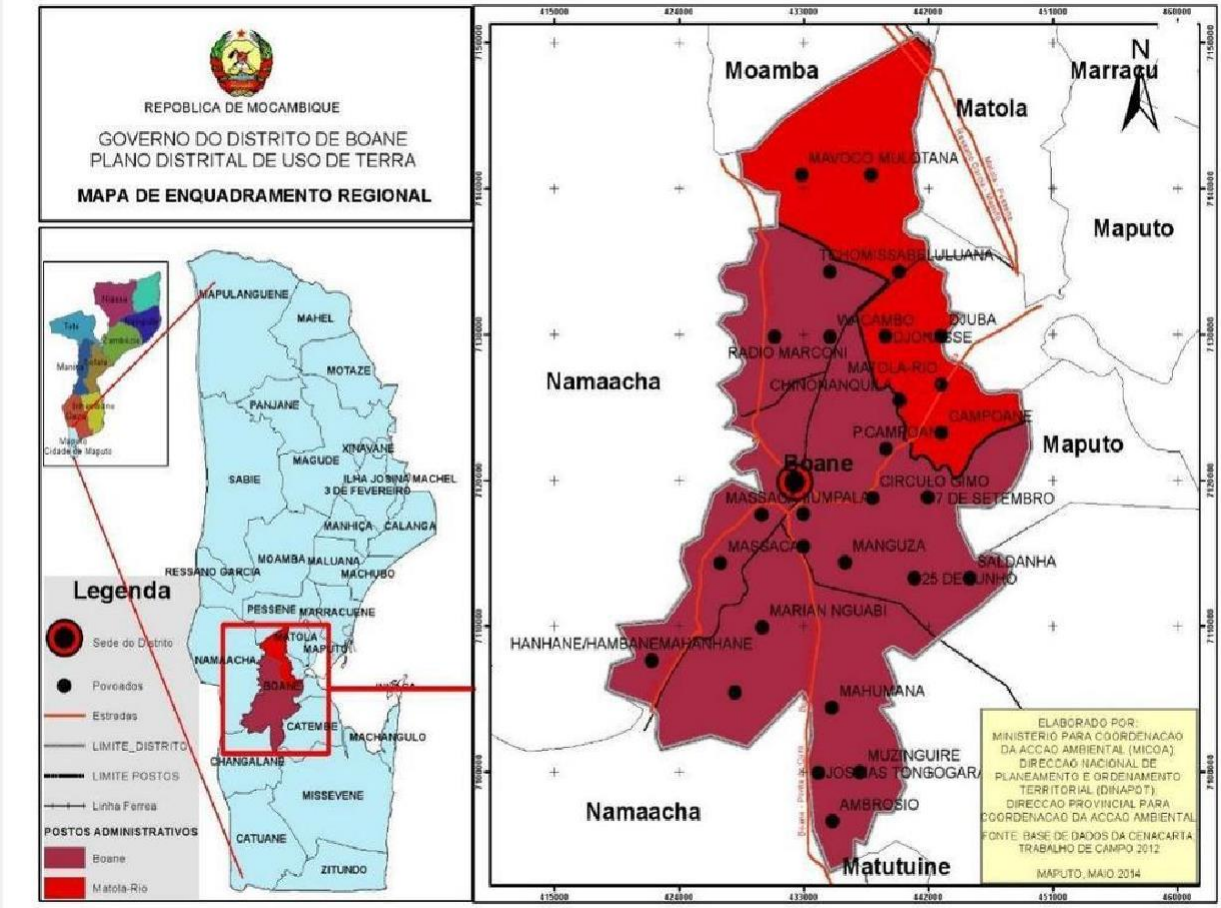


Figure 1: Boane District location map (Governo do Distrito de Boane, 2016).

The Boane Health Centre belongs to the Boane District Service for Women's Health and Social Action, the body responsible for planning, directing, and coordinating activities in the Health, Women and Social Action sector, approved by Decree n. º 6/ 2006 of April 12.

This Unit is under the management of the District Service, so that all activities, from planning and execution, depend closely on that entity, with about 150 active employees, the Unit provides various services efficiently.

CHAPTER II

2. Literature Review

2.1. Basic concepts and Definitions

2.1.1. Risk definition

Risk can be defined as danger, reward, or exposure. Risk is a random event that can occur. Comment accepted when defined in terms of hazard and exposure. With risk, there can be gains or losses when quantified, and it depends a lot on the context to be measured, as presented by the author (Robson & Toscano, 2007).

Hazard is something that has the potential to cause injury, illness, harm, loss, or harm**.**

For example, when there is a risk to public health, related to damage to human health or the environment, in the investment world, the risk is seen as a reward and in the industry as a loss.

In detail, we present that risk is the possibility of injury, loss or environmental damage created by a hazard. This thinking leads to the idea that there is danger before exposure is known, that the significance of the risk is measured according to the probability of occurrence of the unwanted incident and the severity of its consequence (Sinha, 2019).

All hazards or risk events need to be detected. And the corresponding probabilities and consequences need to be analyzed. Therefore, a decision must be made about whether the risk is acceptable or unacceptable. So, if the risk is acceptable, risk mitigation needs to be conducted and if unacceptable activities should not be carried out.

Risk Assessment

Risk assessment is a fundamental tool for effective risk management, both in the context of health and safety management. Thus, risk assessment and management are key segments of people's daily lives (NHS Foundation Trust, 2015), (Sinha, 2019).

Risk assessment can be defined as a systematic process of identifying hazards and assessing any associated hazards in a workplace, implementing reasonable control measures to remove or reduce them. Effective risk assessment is based on a series of steps, involving risk identification, assessing the extent of the risk, determining the need for action to reduce the risk, then acting and evaluating the results of the action (NHS Foundation Trust, 2015).

Defining each step, we will have

Identification of risks.

1. Extent of risks.
2. Actions to be taken.
3. Act.
4. Evaluation of the action's results.

In risk identification, we seek to identify hazards. Here it is essential to understand what, how and why this can end badly. It is also important to think of the movement within the context of the physical environment and culture of the association and the employees enacting the action.

In Extent of Risk, here we decide who can be harmed. It depends on your study context, e.g., individual working in the warehouse, people in general.

About the actions to be taken, here we assess the risk and decide on precautions. After you've done the two visualization steps, you need to protect people from harm, which can happen by completely removing the hazards or controlling the risk.

Taking measurements, here we record the discovery and put them in place. Your findings should be written down, the record should include details of any hazards noted in the risk assessment and action to reduce or eliminate.

Evaluate the result of the action, revise your risk assessment and update if necessary (Sinha, 2019).

As explained, when we identify the risk, it is important to evaluate it. Therefore, a risk management identified through the risk assessment process will be determined by the risk classification, **Figure 3**. In this way a risk ranking matrix, **Figure 2** is used to assess the likelihood and severity or consequences of each hazard and to provide a 'risk ranking' (NHS Foundation Trust, 2015).

		Hazard severity				
		No effect (1)	Minor (2)	Major (3)	Hazardous (4)	Catastrophic (5)
Likelihood of occurrence	*Very Unlikely (A)*	Low	Low	Low	Low	Medium
	Unlikely (B)	Low	Low	Low	Medium	Medium
	Possible (C)	Low	Low	Medium	Medium	High
	Likely (D)	Low	Medium	Medium	High	High
	Very Likely (E)	Low	Medium	High	High	High

Figure 2: Risk analysis matrix (Sefauhi, Kalla, Bahsmed, & Aourogh, 2013, p. 444)

Consequences (C)	How Severely Could Someone be Hurt?
Catastrophic	Death or permanent disability
Major	Serious injury, hospital treatment required
Moderate	Injury requiring medical treatment and some lost time
Minor	Minor injury, first aid only required
Insignificant	Injuries requiring no treatment or first aid
Likelihood (L)	**How Likely are the Consequences?**
Certain to Occur	Expected to occur in most circumstances
Very Likely	Will probably occur in most circumstances
Possible	Might occur occasionally
Unlikely	Could ha[illegible]pen some time
Rare	May happen only in exceptional circumstances

Figure 3: Risk classification matrix, (Western Sydney University, 2015)

Additionally, the risk score, **Figure 4**, determines the number of effort/resources that must be committed to an identified risk we have, as illustrated.

Risk level	Risk score	Escalation level
Extreme Red	15-25	Board of Directors
High Orange	9-12	Management committee (reporting to Board)
Moderate Yellow	6-8	Directorate/Team
Low Green (tolerated risks)	1-5	Team but monitored at Directorate level

Figure 4: Scale level (NHS Foudation Trust, 2015) p. 10

Risk scored from 1 to 5, considered low risk.

Risk score 6-8 considered moderate risks and should be managed/addressed so that they are reduced as reasonably as possible.

Risks with a score of 9 to 12, considered high risks. These risks must be addressed.

Risks with a score of 15 to 25, considered extreme/catastrophic risks. These risks must be addressed and will be added to the risk register.

When it is said that the risk score is what determines the amount of effort that must be committed to a certain classification, it shows that the most relevant ones must be considered immediately

because they are likely to cause more damage in relation to the low-risk ones, but not taking away the importance of others being considered.

Safety

Safety is a state in which hazards and conditions leading to physical, psychological, or material harm are controlled in order to preserve the health and well-being of individuals and the community. It is considered an essential resource for everyday life, necessary for individuals and communities to realize their aspirations.

However, for the same definition previously presented, safety and health at work (occupational) the concept is similar, but in this one, it is specifically turned to the worker presented as their social, mental, and physical well-being. Where this well-being, social, mental, and physical workers are very important and crucial factors in the work area. This is:

- Occupational health and safety involve promoting and maintaining high levels of all activity sectors.
- It involves preventing workers from adverse health effects resulting from their working conditions.
- It involves the protection of workers in their employment against the risks resulting from conditions harmful to health.
- It also involves placing and maintaining workers in a work environment adjusted to their physical and mental needs, adapting work to man (ILO, 2009).

Therefore, for success along these lines, the collaboration and participation of both employers and workers in health and safety programs are required.

2.2. Ocuppational Health

Its object concerns known risk factors whose presence in work environments is associated with a greater probability that a given disease will develop. Through a set of knowledge and models for identifying the risks mentioned, in the field of occupational health, risk surveillance and exposure control strategies are implemented, and more widely, mechanisms are implemented aimed at the safety of workers in companies and institutions. Currently, the concept of occupational health has been expanded to include devices and notions related to the "global" promotion of health and the experience of each worker in their activities (Asunção, 2010).

Usually, the term health outside of safety is simply not studied, because health by itself has been the subject of less attention in relation to issues related to safety at work. But it is also important to combine them both, as a healthy environment is a safe workplace, while the opposite cannot be considered true. However, the important point in all this context is the idea that health and safety issues must be identified in all workplaces. For example:

A particular study carried out in 2011 in the USA, **Figure 5** showed that the Hospital is one of the most dangerous places to work. It was reported in this study that over 58,860 comprised the

Workers who suffered from losses and illnesses that caused permanent job loss. Compared to other areas, hospitals/health facilities offer more dangers in terms of construction and manufacturing. That is:

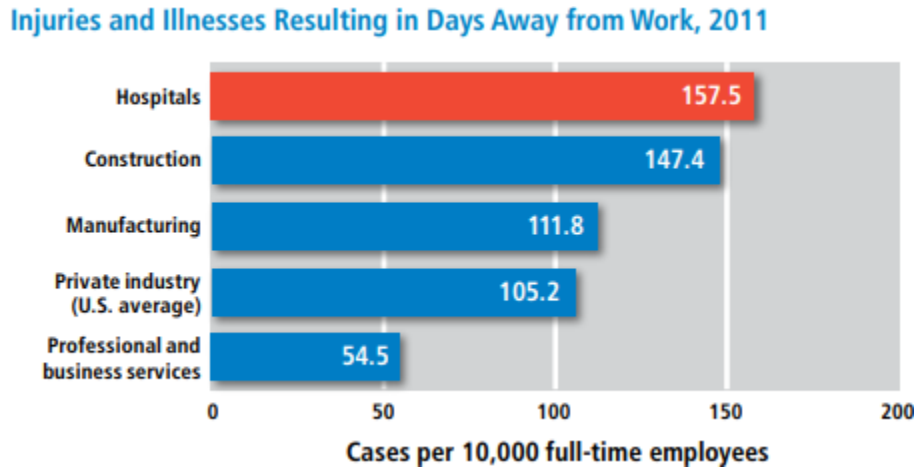


Figure 5: www.osha.gov/dsg/hospitals[Occupational Safety and Health Administration, 09/2013]

2.3. Waste

Wastes are broadly classified into three main types according to their physical states, namely liquid, solid, and gaseous waste. Regarding their environmental impact, they can be hazardous waste and non-hazardous waste (Amusuomo & Baird, 2016). Thus, due to the limited scope of the research, we studied only one type of solid waste that comprises the category of hazardous waste.

Solid waste is considered the most visible expression of environmental risks, playing an important role in the structure and sanitation of an urban community and, consequently, in aspects related to public health.

2.3.1. Hospital Waste

Medical waste is a special type of waste, which carries a high potential for infection and injury. It is generated in the diagnosis, treatment, or immunization of human beings or in research in a hospital and can have serious health effects from a public health point of view if not handled properly (Amin, Gul, & Mehrab, 2013).

Unlike developed countries that have a properly organized hospital waste disposal infrastructure, in developing countries the situation is the opposite, that is, the management of medical waste does not receive much attention, workers have little awareness of the associated dangers and disposal techniques are precarious. On the other hand, there is a lack of awareness at the levels of health policies and laws. Some of these examples can be mentioned, a case study in Bangladesh that reviewed the lack of awareness and knowledge among employees about medical waste, its management and consequences for human health and the environment. Another study in Dhaka city reported that there is also a lack of awareness and willingness at the level of health policies

and laws regarding the proper management of medical waste (Amin, Gul, & Mehrab, 2013, p. 991).

Likewise, according to the results of the Infection Prevention and Control Program (PCI) and the rapid assessment carried out by the Department of Environmental Hygiene/MISAU in Mozambique, the management of hospital waste remains a major challenge at all levels and waste management is generally deficient in almost all public systems in the country where PCI is implemented (MISAU & JHPIEGO, 2014).

The following weaknesses are highlighted:

- Bad segregation of waste;
- Transportation on inappropriate means;
- Lack of use of personal protective equipment by workers handling waste.
- Lack of adequate means and equipment for the treatment and final disposal of waste.

For the Biomedical Waste Management Regulation, the term hospital waste is like biomedical waste, and we can find it in **Art. 5**, that all Health Units, Research Institutes and Companies covered by it must develop a Biomedical Waste Management Plan. Produced by them and featuring the following points:

- Risk management processes;
- The hierarchy processes in waste management.
- Procedures for storage and transport, from the point of generation to its final disposal.

In hospital waste, five major groups can be identified, namely:

- Common *garbage*
- Infectious waste.
- Perforating garbage.
- Anatomical residues.
- Chemical/Radioactive Hazardous Waste

2.3.2. Infectious waste management

Infectious waste represents a potential risk to public health and the environment due to the presence of biological agents. It is a material suspected of containing pathogens (bacteria, viruses, parasites, or fungi) in sufficient concentration or quantity to cause disease in susceptible hosts (**Table 1**).

Initially, one of the first actions to be taken in the segregation of waste is the immediate separation and disposal in a bucket lined with plastic identified according to the category of waste produced, i.e.

> 'The bucket must be in the place where the procedure that generated it took place. This responsibility is closely linked to the health professional who performed the procedure. Therefore,

It is important that the health worker is aware of the importance of segregation, personal protection, financial and environmental implications" (MISAU & JHPIEGO, 2014) p. 7.

Table 1: Types of Hospital Waste

Category	Definition	Resources
Common Garbage	✚ This garbage is like that produced in homes; it does not represent a direct danger. ✚ However, since it is produced in the Health Unit, it requires special attention.	Leftover food, waste from administrative services such as: paper, cardboard, plastic material, among others.
Infectious Waste	✚ It's all that material that met blood and body fluids. ✚ They are waste produced during the provision of health care and represent a potential risk to human health and the environment, as they contain pathogenic microorganisms. ✚ It requires special attention inside and outside the unit until its final disposal.	Laboratory specimens, cultures, expired vaccines, cotton balls, gauze, or any residue that contains or has been in contact with blood or body fluids. Outdated blood or blood products, transfusion bags or with Post-transfusion residual volume.
Anatomical Residues	✚ This type of waste includes pieces or fragments of tissue resulting from amputations and other surgeries, autopsies, or deliveries.	Human tissue, placenta, fetuses, teeth, large amounts of fluids, organs or parts of organs, and other waste contaminated by these materials.
Perforating garbage	✚ Sharp piercing garbage. ✚ Used or discarded objects or devices with sharp edges, spikes or hard protrusions that can sting or cut.	Needles, syringes, lancets, glass ampoules, scalpel, intravenous catheters, blades, pipettes, etc.
Chemical Waste	✚ Waste that poses a potential risk to human and environmental health due to the presence of chemical components;	Medications, laboratory and pharmacy reagents out of date, residues containing heavy metals, hormonal products, antibiotics, cytostatic, antineoplastics, immunosuppressants, digitalis, antiretrovirals, flammable liquids, compressed gases, formaldehyde, among others.
	✚ Radioactive: All solid, liquid, or anatomical waste contaminated with isotopes of any nature.	Waste resulting from nuclear medicine care, radiotherapy, image-processing effluents, among others.

Source: (MISAU & JHPIEGO, 2014)

Infectious waste needs to be stored in a way that prevents the release of waste and avoids uncomfortable conditions, and is properly colored, coded and marked.

The storage of hospital waste can be done inside the procedure rooms (internal) and outside them (external). It is mandatory that the containers are duly labelled/identified. In the absence of colorful plastic buckets and bags, the label is more essential than ever. Segregation opens up the possibility of recycling: paper, glass, plastic and other recyclable and non-contaminated materials. The safe collection of infectious waste is a concern for everyone involved in the process, including health agents, laboratory technicians, nurses, environmental health technicians, interested health workers and others (Reinhardt & Gordon, 1991).

2.3.3. Infectious Waste Containers and Packaging

Segregation is one of the priority actions for the separation and collection of any type of waste. Specifically for infectious waste, this attitude is not only important but also essential and constitutes one of the most important ways to minimize the risk in handling this waste, including the use of suitable containers to pack the waste (Reinhardt & Gordon, 1991). Several factors should be considered when selecting containers for infectious waste:

- Type of waste;
- Waste collection procedures;
- Waste handling practices;
- Garbage storage;
- Sewage treatment;
- Transport of waste off-site.

Containers and packaging depend more on the type of infectious waste, and from your perspective, Infectious Waste is three general types: Sharps, solid and liquid waste, as we can see in the **Table 1**. So at least three different types of containers should be used. It corresponds to containment of sharp perforations, containment of solid waste and containment of liquids (**Annexes I and II**).

These retainers have specificities. *E.g.: there must be containment of sharps (perforation resistance, impermeability, and rigidity, resistance to tampering and adequate marking). Containment of solid waste – usually discarded in plastic bags, they need to be (impermeability, resistance, adequate marking); liquid containment, using bottles or similar rigid containers with secure closures such as screw caps or stoppers and a box to hold the bottles provide an extra degree of security and containment of spills* (Reinhardt & Gordon, 1991).

Waste must be collected regularly, at least once a day. It is recommended to never allow to accumulate where produced and a daily round collection program should be planned.

2.3.4. Transport and treatment of infectious waste

Infectious waste must be treated as soon as possible after its generation. Storage prior to treatment is acceptable only when the waste cannot be treated immediately (Reinhardt & Gordon, 1991). Different from the Boane Health Centre, they segregate and treat out of hours on a day-to-day basis.

Several options are available for treating infectious waste and these options need to be evaluated during the policy formulation and decision-making process for the infectious waste management system, **Table 2**, (Reinhardt & Gordon, 1991). This decision-making includes:

- **Selection of treatment site and;**
- **Selection of the type(s) of treatment technology that best meet your needs.**

Regarding the selection of the treatment site, the first important decision is where to treat the infectious waste. There are two basic options for this:

Table 2: Decision-making process for the infectious waste management system

On-site option	**External option**
	Treatment elsewhere. Untreated waste transported away from the facility where the waste was generated
On-site treatment. The available equipment must be able to treat the Infectious Waste. The capacity must be sufficient to treat the amounts of waste generated	
Advantages	Advantages
Total control over waste; Better cost control; **The use of incineration offers the opportunity for heat** recovery. Reduces the regulatory burden	The hospital focuses its efforts on its own primary functions. low concern for infectious waste management.
	Outdoor facilities must have modern and effective treatment equipment.
Disadvantages	Disadvantages
Dealing on site means that you engage in an activity that is not the core function of your organization. **Funds should be spent on treatment and operation** equipment. **The responsibility to meet all regulatory requirements (stay current with all new and changing regulations).**	Cost of losing the destination of your waste. Subject to additional regulatory requirements as a generator (track all infectious waste leaving the facility untreated).

Source: Adapted by author, from (Reinhardt & Gordon, 1991)

In this research, the focus is on the on-site treatment of infectious waste, as this is the location chosen by the health unit. Thus, different means of transport can be used within the facility, such as wheelbarrows, wheeled containers, and carts (International Committee of Red Cross, 2011). Therefore, when choosing this process, some precautions are necessary, such as:

- Collection and transport must be done when they reach two-thirds of their capacity.
- It is essential to maintain the integrity of the packaging throughout the waste collection process.
- Garbage removal must be done by a trained health technician and protected with personal protective equipment.
- Whatever the type of cart used, it needs to be easy to move, clean and disinfect and, if possible, carts dedicated only to the transport of infectious waste with a color coding or labelling system (MISAU & JHPIEGO, 2014).

The most common methods used to treat infectious waste are incineration, steam sterilization, autoclaving and shredding. Its treatment includes a cost, which involves capital costs, operating costs (labour, materials, and utilities). Each type of treatment technology has some impact on the environment. The incinerator is much more expensive than any of the types of equipment used to treat infectious waste and having pollution control equipment usually doubles the capital cost.

2.4. Implications for the environment and public health

Environmental and human health constitutes the initial phase of the environmental management system. All persons who are in contact with hazardous medical waste are potentially exposed to the various risks that this entails:

- People within the establishment who generate the waste, who treats it.
- Persons outside the facility who may be in contact with hazardous waste or its by-products if medical waste is not managed or is managed improperly.

These two groups of potentially exposed people can be divided among themselves, within the hospital; care staff, technical and logistical staff (cleaning, laundry staff, waste managers, patient carriers and others) and outside the hospital; external transport personnel, the general population (adults and children attacking wild objects found around the hospital or in dumps) (International Committee of the Red Cross, 2011).

For example, incinerators can pose a danger to people and the environment, **Figure 6**, emitting flue gases, ash, dioxin synthesis and furans (these are potential human carcinogens and have been linked to several adverse health effects), and health facilities have become sources of mercury in the environment.

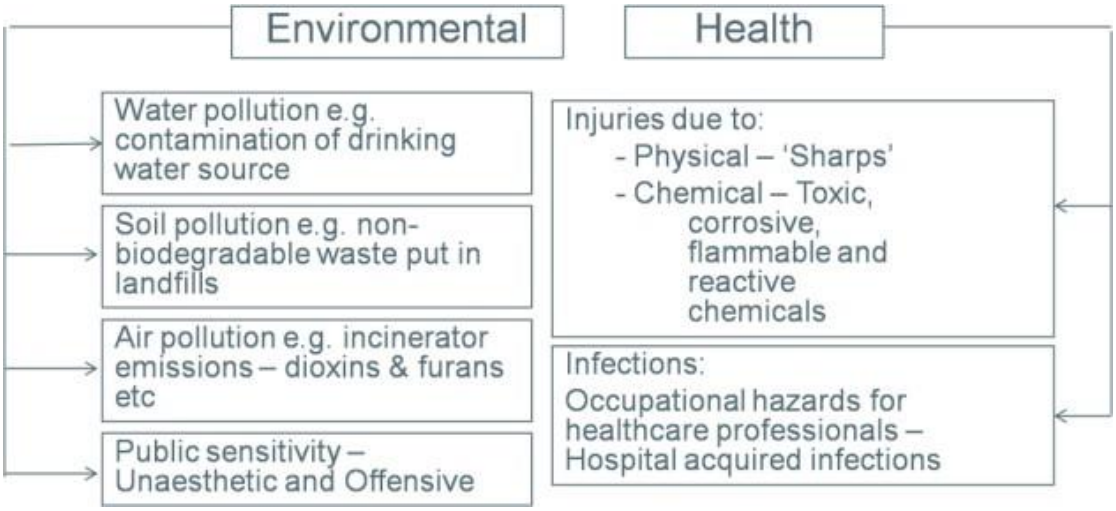


Figure 6: Unknown Author. (n.d) Effects of improper disposal of health care waste.

2.5. Mozambican regulation on the management of hospital waste

The current health system in Mozambique is quite like that in most sub-Saharan African countries. It is characterized by a primary level with a very poor infrastructure, poorly qualified health personnel and, unfortunately, it is much more common than one imagines that basic requirements are unavailable, such as running water, reliable energy supply, medicines, oxygen, safe transport or diagnostics and equipment. Therapeutic. For example, national representative data for Mozambique show that only 34% of facilities had the three basic infrastructure equipment: drinking water, sanitation, and energy. In addition, a limited number of 42.7% of health facilities had priority drugs available (World Bank, 2015a).

The Health System in Mozambique (HSM) encompasses public, private, non-profit, and traditional services. The public sector is the largest provider of conventional healthcare, followed by an emerging and growing private service. In all of them, the treatment of waste produced remains inadequate, inefficient, mainly in terms of segregation, and final disposal, generating a negative impact on the population's health and environmental pollution. Therefore, it is urgent to determine and establish safe methods for the management of hospital waste (MISAU & JHPIEGO, 2014).

The validity and compliance with the laws and regulations governing work safety, waste management, in general, have been carried out by the health and environment surveillance sector.

In Mozambique, we have the Ministry of Land and Environment that regulates

- Environmental Law No. 20/97 of October 1st.
- Regulation on the management of urban solid waste (decree n.° 94/2014, of 3 December).
- Regulation on the management of hazardous waste (decree n.° 83/2014, of 31 December).
- Regulation on the management of Biomedical Waste (decree no.° 8/2003, of February 18)

In addition, we have the Ministry of Health responsible for monitoring hospital waste and ensuring its implementation. Thus, in this study, the following documents were used as reference:

- National Strategy for Hospital Waste Management and the
- Reference manual for infection prevention and control in healthcare facilities.

2.6. Environmental Health

Environmental health comprises a very broad approach, which ranges from physical, chemical, and biological factors external to the individual, and all those related to these that affect behaviour. However, it also covers the assessment and control of environmental factors that can affect health, in general, environmental health is intended to prevent diseases and create environments favorable to health (INS, 2022).

Because of this, the National Institute of Health in Mozambique created a program that were divided into two major areas related to environmental health and worker health, and commonly when talking about public health, it refers to the provision of health services. for a particular community/area.

2.7. Labor Law

Work can be defined as a significant part of human life. Starting from the consideration that most workers spend at least eight hours in the workplace and every day exposed to the various factors that interfere with well-being and condition their performance, as well as individual and collective results (IGAS, 2018).

Regarding worker health and safety, the country has the Labour Law, 2007, of August and Health and Safety Regulation in Public Administration: Decree No. 14/2018 of 28 March.

According to ***Article 54.5*** of the Labour Law, the responsibilities of employers towards workers are many, but the most appropriate ones to highlight here are the responsibility to create and develop adequate means to protect the physical and mental integrity of workers and continuous improvement working conditions, due to previously identified risks.

Thus, for this work we will focus on the ***Articles 216*** on free protection and training, and the ***Article 209-268*** on the labour inspection system, to guide and support the arguments to be produced on the subject in question. .

It should be noted that this law does not distinguish between sectors but emphasizes its applicability to national and foreign employers and workers from all branches of activity, who carry out their activity in the country.

Therefore, it refers to Labor Law in this study, as it is important to evaluate the worker safety management policies present in the law, in comparison with the techniques implemented in the field of study, to allow for greater understanding and better forms of intervention.

CHAPTER III

3. METHODOLOGY

The research on nature is basic, because from it is intended to develop knowledge that can eventually be used to solve problems like the one being studied. It is based on a qualitative approach to assess the environmental, health and safety risks in the management of infectious waste at the Boane Health Centre.

Therefore, to achieve the objectives described, the research will be conducted following the following methods:

1. A literature review based on documentary and bibliographic research (books, journal articles, reports, national and international legislation), with content related to the research topic in order to describe the technologies and means used in the treatment and disposal of infectious hospital waste, as well as describing the risk assessment processes, as well as the characteristics of hospital and infectious waste. Therefore, this method will help to obtain a general knowledge about the topic that triggers the development of the research.

2. Function analysis, Fault tree, PRO analysis, and SWOT analysis, which will be used to achieve objective 2 regarding risk assessment, followed by data collection through structured interviews that will generate information for the development of possible future safety strategies and hospital waste management plans to be designed and implemented in the Boane Health Centre, as well as in other Health Units in the Country.

3. The field visit aimed to describe the study area, including the quality and quantity of waste generated, as well as the methods used for their treatment and disposal, specifically infectious waste. The data collection instruments used are field observations and interviews with laboratory technicians and assistants responsible for waste management in the sector and in the institution. With the field visit it is also expected that it will be possible to know and evaluate the health and safety policies made available to the workers of this institution.

4. Presentation, analysis, and discussion of the results will be generated from the information collected directly in the field through interviews, observations, and evaluation of safety policies available to workers.

3.1. Material and Methods

3.1.1. Material

For the execution of this research, it was not necessary to use an experimental method. It was only necessary to travel to the chosen area, and print the questionnaires prepared for the laboratory technicians and cleaning assistants, and it was not possible to expand the study in another sector due to the calamity situation that the country was going through.

Before starting to specify the tools, it is necessary to understand the techniques and means used for treatment, including the disposal of infectious waste at the Boane Health Centre.

Therefore, to identify the techniques and means, observation and interviews with laboratory technicians and cleaning assistants were used.

3.1.2. Description of infectious waste management processes in Boane Segregation, packaging, and identification.

Infectious and common waste produced in this sector is segregated in the same place where it is produced and by those who produce it.

The technician is present using personal protective equipment such as (gloves, gown, and mask).

- Gloves are replaced as soon as they meet another patient and are disposed of in the infectious waste bucket.
- The patient is assisted inside the laboratory (performing analysis, drawing blood and receiving samples) **Figure 7**.
- Infectious waste is separated from common waste through previously identified buckets (with written paper and plastic inside them) **Annex II**.
- Each technician is responsible for segregating the waste produced at the indicated location (inside the laboratory).
- The bucket that receives the infectious waste is always open.
- Sharps waste is placed inside an incinerator box (**Annex I**).
- The type of waste most produced in this sector is infectious and can reach up to 5-6 kg per day depending on the blood tubes used.

Segregation corresponds to one of the most crucial stages for good waste management, as it dictates the subsequent stages and their performance. For this sector, about the packaging of CSB waste, according to the conditions presented, it can be considered minimally adequate as the same occurs with plastics, although not necessarily established and sharps that go in suitable boxes complying with the regulation.

Its identification is only possible through the buckets that are labelled, but not the plastic ones inside. This factor goes against what is set out in the regulation and provides for the occurrence of an accident because the plastics are identical and are removed at the same time.

Figure 7: Example of producing infectious waste - lab technician assisting a patient, Source the author.

3.1.3. Storage

During the observation, it was found that the most used procedures have been collection at the production sites and subsequently transport to the treatment site, which has been in the enclosure of the Sanitary Unit.

3.1.4. Treatment and disposal of infectious waste at the Boane Health Centre Boane

According to MISAU, each health unit at the national level has a great responsibility to correctly manage the waste produced, even if this issue is deficient in almost all Health Units. Understanding this responsibility, the Boane Health Centre has a final disposal site within its facilities. In this place, there are two biological pits, an incinerator and an open space for the deposit and burning of common waste.

Infectious waste (perforating-cutting) undergoes a pre-treatment that has been carried out starting with decontamination using 0.5% hypochlorite by the nurse, as soon as this waste is produced, a process by which it can occur unnoticed by those who do not know it.

3.1.5. Incinerator

As soon as the buckets are full, the service agent for this sector takes the bags to the incinerator at the end of the day, between 2:30 pm and 3:00 pm. This incineration takes place in a brick incinerator, so that all production sectors take their waste to the same point. Quantities not estimated, but which may be smaller or exceed what is stipulated in the laboratory. The incinerator works once a day. Infectious waste comprises, bloody cotton, used blood tubes, gloves and incinerator box with used needles.

There are few Public Health Units in the country with incinerators. For example, the previous list published by (MISAU & JHPIEGO, 2014) did not include the Boane Health Centre Incinerator.

For transport to the site, the cleaning assistant is presented by the work uniform, gloves, mask, and headdress. She carries it by hand, unsupported by a face or bucket with wheels.

Most of the discarded garbage remains temporarily in the respective (open) buckets to allow better visualization at the procedure site, until it is removed to the treatment site and final disposal. The temporary waste storage site has been coupled with an incinerator facility.

The burning of infectious waste is done by oil that is thrown as soon as the waste is inside the incinerator and the fire is lit using a match.

3.1.6. Incineration

Incineration is a process suitable for waste that cannot be recycled, reused, or disposed of in landfills. During this process, oxidation occurs at high temperatures, where it is possible to significantly reduce the volume and weight of the organic matter subjected to this treatment. Therefore, for the process to occur efficiently, it is necessary to control some parameters such as: equipment conformation, adequate residence time, temperature, turbulence, feeding and oxygenation – to facilitate complete oxidation (Lyra da Fonseca & Rodrigues De Marchi, 2009).

For best results, it is recommended that materials submitted to incineration be pre-treated using an adequate process to minimize the risk of exposure. Modern incinerators work with two chambers: in the first, the temperature must be at least 800ºC; in the second, at least 1000ºC.

Note: the existing incinerator in Boane, presents itself with a not pleasant appearance and not able to meet the demand for the garbage it receives daily and with the specifications presented above.

Figure 8: Hospital waste treatment site – Boane, source the author.

The collection and transport of infectious waste in the CSB is briefly concluded as inadequate because it puts the health of those transporting it at risk when they are poorly segregated and mainly because they are being transported incorrectly, which violates the regulation on biomedical waste when portrays the transport of waste inside the health units and in unidentified bags.

More risks were identified, not related to infectious waste, but to working conditions and some techniques used in sample analysis. Presents:

Physical risk: Lack of equipment, makes the worker opt for dangerous procedures.

Chemical: Exposure to chemical agents.

Biological: Handling and contact with biological materials (bacteria).

Ergonomic: closed and cramped laboratory for the number of jobs and patient care, inappropriate postures, repetitive movements, unsuitable chairs for workers.

3.2. Safety policies available to Infectious waste workers - Centre Boane

During the field visit, it was possible to have access to the protection manual and good work practices created by MISAU in 2014, for health units in the country, called PCI. The manual has 2 main objectives, namely:

- Prevent serious infectious procedures from occurring during the provision of any type of safety care other than serious infectious procedures.
- Minimize the risk of transmission of serious people such as hepatitis C and HIV not only to users, but also to health workers.

The first objective has great applicability in the provision of any type of health care. In addition, the second with great applicability for users, but also for health professionals (including hygiene and cleaning staff) as well as for the community.

Therefore, their priorities are to teach health workers ways of personal protection as well as users, because if workers know how to guarantee their protection and use protective measures consistently, they will be helping to protect users and the community as well.

The requirement for the application of the PCI's practical guidelines should be at all levels of health service delivery (health units - HU) in Mozambique, from large urban hospitals to rural health Centres.

Through this manual, posters were produced at an institutional level, danger alerts to make the place and work safer, as well as techniques implemented due to the lack of equipment to protect the worker, such as the use of a lamp to prevent the bacteria present in the samples from infecting the health professional during the analysis. As you can see in **Figure 9** below.

Figure 9: Sample analysis using the lamp as protection. Source the Author

As well as the reading of samples in the washing sink due to the lack of adequate equipment, exposing professionals, patients and cleaning assistants to bacterial agents that may be present in this place, due to its regular and permanent use to carry out other activities, following images.

Figure 10: Preparation of samples/washing of containers for reuse, Source the Autor

In this manual we find the procedures, the safety policies for the cleaning worker and the management of hospital waste, as well as other important points, with generalized specifications for health units with limited resources, thus requiring more specific policies and updates for natures of specific jobs. In this manual, issues related to worker safety, management of hospital waste do not have a very specific and very plausible treatment. Thus, emphasizing the greatest effort in the use of personal protective equipment such as caps, goggles, surgical and facial masks, aprons, gowns, gloves, surgical pyjamas and boots or closed shoes in almost all activities.

Making a relationship between the risks found with the hospital and infectious waste management policies specifically existing in the country, it becomes acceptable to admit that such risks are experienced in most health units in the country, due to the lack of laws, comprehensive policies, and resources. Limited in the treatment of hospital waste, involving legal and recent procedures, in compliance with the WHO.

This relationship arises from the appreciation of the hazardous waste management law and the national strategy for the management of hospital waste, which are one of the few policies created to assist in the management of waste generated in hospitals, containing in them suggestions that have not yet been reviewed, nor updated.

It is also acceptable since there are no standards for emissions from incinerators; policies are still weak, treating hospital waste superficially.

Therefore, regulatory bodies responsible for the sanitation and health of workers and the public must, in addition to supervising, enforce the availability and use of personal protective equipment.

Emphasize the recovery / recycling of hospital waste such as (cardboard, plastics), create various options for treatment and final disposal.

According to the methods, means and place of disposal found in the treatment of infectious waste in Boane. The following must be considered in our Risk Assessment at **Table 3**.

Table 3: Risk assessment (methods, means and final disposal of infectious waste)

Activity	Significant Dangers	People at risk	Probable damage	Existing Control measures	Additional control measures	Risk factor		Escalation level
						L	S	
Collection of blood samples	Seringe prick	Laboratory technician	Contamination by contaminated blood (HIV, viral hepatitis, B, etc.)	Use of PPE	Enforce PPE use and develop written work and emergency procedures	**D**	**5**	**Environ. Services department**
Transport of infectious waste (sharp objects)	Needle stick	Cleaning assistant	Damage Infection	Use of PPE	Cut resistant gloves. Use of hand faces or buckets with wheels for transport. use of apron Segregation in appropriate garbage bags. Develop written work and emergency procedures	**C**	**5**	**Environ. Services Department**
Infectious waste treatment	Burn and Explosion	Responsible for the incinerator	Burn Damage Fracture Injuries State of shock	Use of PPE	Implementation of better forms of treatment, enforcing the use of PPE.	**B**	**4**	**Hospital Administration**
Garbage incineration	Emission of polluting gases	Public around Environment	Bad smell Scattered Smoke Air pollution	Incinerator working once a day.	Restructuring of the incinerator. Replacement/placement of chimneys. Consider the load capacity of the incinerator	**D**	**4**	**Hospital Administration**

From the above, it can be said that the risks identified for the handling and treatment of infectious waste in the Health Centre of Boane are not as serious as expected and in terms of the other risks identified. Therefore, the previously analyzed risks find their justification based on the limitation of their resources and the lack of regulatory bases to make the process clearer and simpler.

To complement the risk assessment process, the phase of determining the functions under the management of hospital infectious waste was followed, using the analysis of functions, **Figure 11**. This tool is used to study behavioral effects; it may involve the survey of antecedents, causes and their consequences. It is possible to see everything around the subject, his behaviour, and its consequences, but in this aspect, it was simply used as a means to show the functions that govern the return of infectious waste management at the Boane Health Centre.

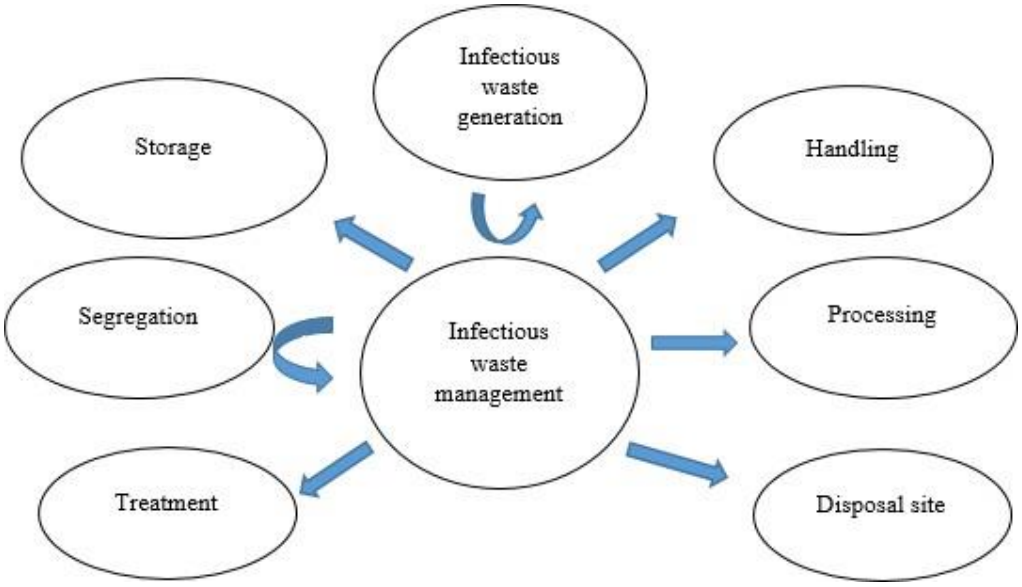


Figure 11: Function analysis of Waste management, Source the Autor

In addition to the governing factors, it is important to understand what the input, output products are, and what their effect has been, **Flowchart 1**. This is for infectious waste to exist, it must be produced using raw materials, which now do not make up the system, but which will soon end up being part of it, where its great risk lies in the production generated and in its treatment that it can bring. Consequences for the professional, the people around him and the environment. While carrying out the analysis of values / function of values, one must first consider that the system that composes it must have an interaction with its external environment, because without it one of the parts fails or does not work, commonly the life cycle depending very much on the context to be studied. But for the specific case of this work, we started from the use because it is waste.

For this diagram, the external environmental components end up being, the raw material (generating the infectious waste) and the segregation.

Below is the PRO anslysis**, Table 4**, wich serves as an aid in decision-making to understand the

though processes of employees and make best decision. We also present the SWOT analysis, **Flowchart 2** used to identify and analyze the internal and external factors.

***Flowchart 1**: Fault tree Analysis*

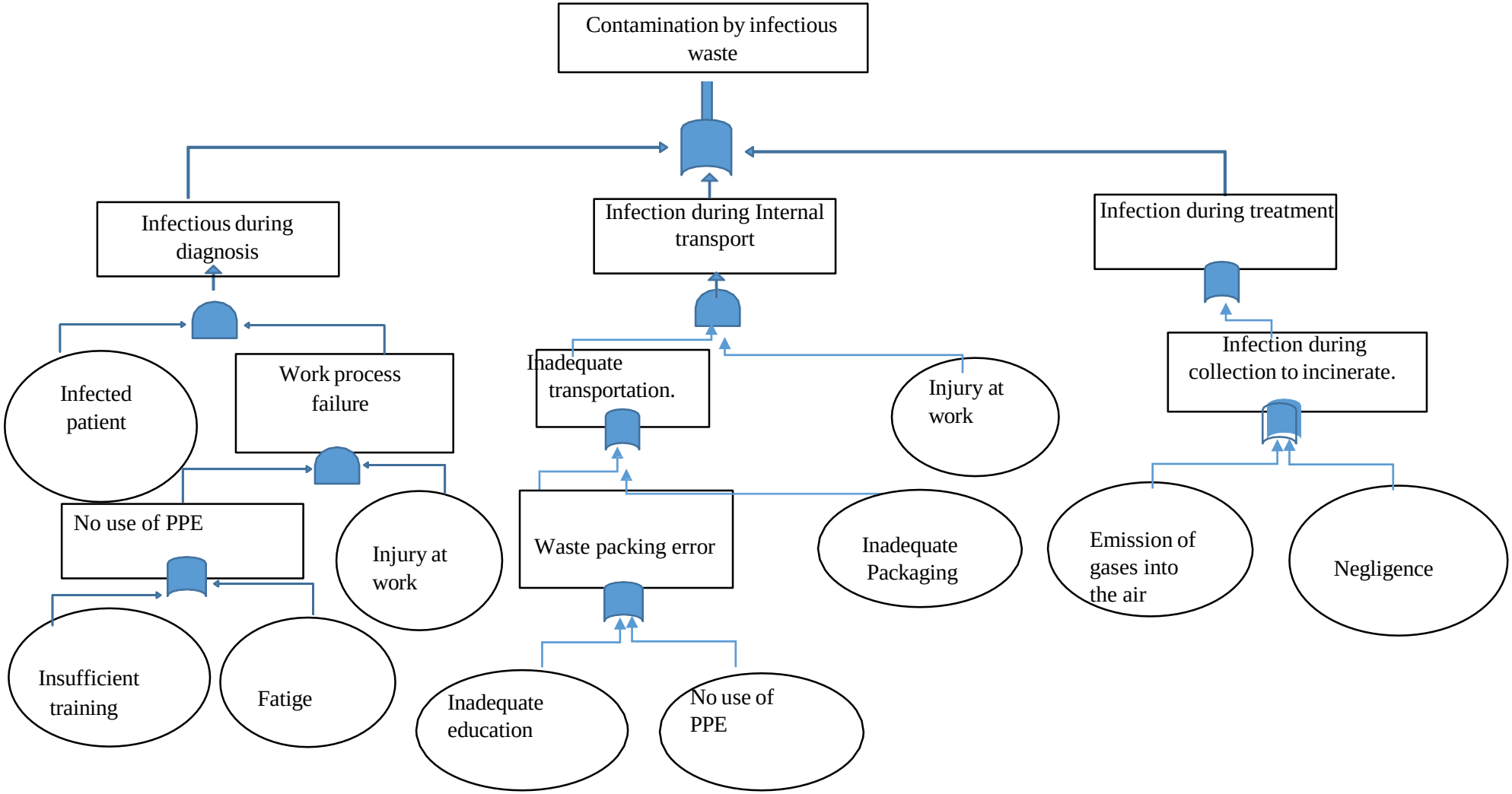
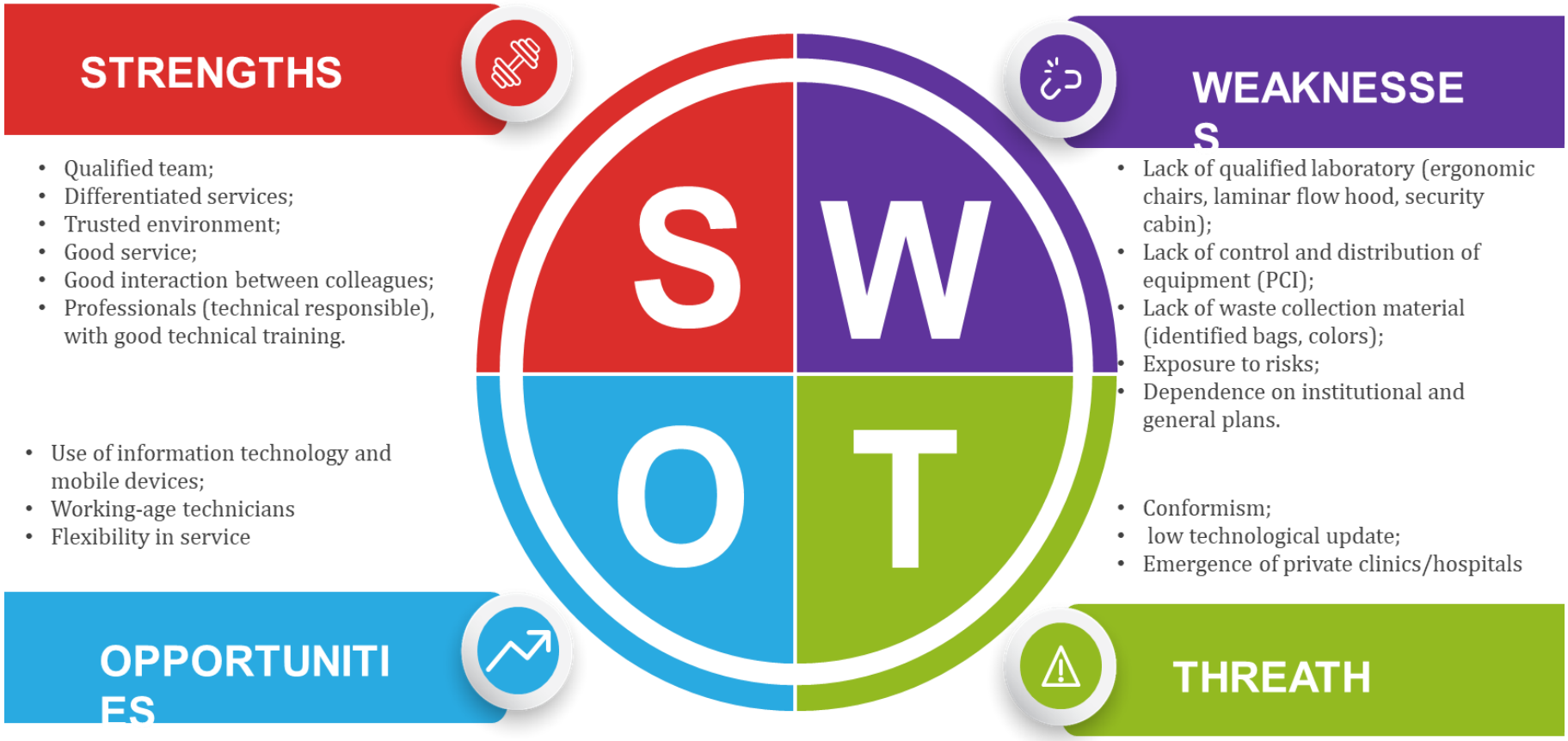


Table 4: PRO Analysis

Objective/ Question	**(Thought) Pessimistic**	**(Thought) Realist**	**(Thought) Optimistic**
Workplace safety	We cannot change, these are the conditions we have.	You can perform the functions in the conditions in which we find ourselves.	With more security things would be better and we would be safer
Accessibility	We are used to	Things tend to get better over time, slowly but it's going.	With more security things would be better and we would be safer
PPE	We don't always receive the complete equipment	We all have a duty to take care of what is ours in the best way. To ensure the long-lasting use of this material.	Routine consultations would help to improve material allocation when needed.
Waste treatment techniques and means	The lack of correct identification leads us to this usage, and it's been a long time, we can't change.	We manage to manage the situation, but sometimes we fail.	Separation helps us understand the risks, and over time, conditions improve
Waste description area	We do not have adequate conditions to manage waste.	Resources are scarce but manageable.	Set up incinerator to recommended standards / transfer to designated treatment site.
Acess to worker's policies	We do not receive training; doesn't help us to notice much.	Things can be better. we must better understand our rights and duties as workers	With everyone involved we will be and do better
Security strategy	The registered accidents are due to lack of material, it's always like that.	We use PPE and believe it is the best way to prevent accidents.	Correct use of PPEs.

***Flowchart 2**: Swot Analysis*



CAPITULO IV

4. Discussion and Results

4.1. Data Survey

From the point of view of presentation, analysis and interpretation of data, the sample was determined using a simple random probabilistic sample, where any element found in the laboratory was interviewed. The unit selected was the Level I Boane Health Centre in the hospital network of health services. The study was not carried out in the entire health unit, but only in the Laboratory sector, a place authorized by the institution for 1 month.

Before the development of the research, one of the main stages was the survey of the health units inside and outside the Municipality of Matola, which have carried out the management of waste internally, having fallen to the health centre of Boane with a positive response for the execution. from work.

4.2. Study Population

Tthe total number of respondents, **Table 5**, in this study is seven which include a cleaning agent, an incinerator manager and the remaining 5 laboratory technicians.

The number of respondents did not exceed what was expected, as the technicians work alternately and in different weeks, it is estimated that there are around 10 technicians working in this laboratory.

Table 5: Employees Intrerviewed

	ID
Sex	**year of work**
Male	1 month
Female	11 years
Female	5 months
Male	6 months
Female	5 months
Male	11 years
Female	6years

Of these, 65.5% represent the number of women working in the laboratory, with the oldest having 11 years of work. In this number of respondents, two of whom represent the cleaning department, the oldest being responsible for the incinerator, also with 11 years of work.

In general, for laboratory technicians, the activities they perform do not differ much from each other, as there are similarities and joint needs.

4.3. Data Collection

This research was qualitative, using primary and secondary data on infectious waste management from the Boane Health Centre in the laboratory sector. Questionnaires were designed in this study as a research tool to collect data on workers' knowledge regarding risk assessment, waste management attitudes, safety and practices regarding infectious waste management and protection.

The duration of the field visits and research was 2 months (April to June). The application of the questionnaires was a face-to-face interview with health professionals.

Below, we present some joint questions and answers on the points most considered in the study.

Question 1: Have you ever had any kind of accident?

Answer: 85% answered no, but two of them answered yes. They are aware of some first aid techniques for the most common accidents in their work area, such as (prophylaxis, washing of the infected area and communication to the superior entity).

Question 2: Perception of the level of exposure in relation to the work performed.

Ans: 95% responded that they realized how much level, and most know that they perform a dangerous activity due to the high risk of exposure.

Question 3: Does the sector have safe working conditions?

Ans: 100% of respondents said no, that the conditions were minimal and that did not help much in their work and performance.

Question 4: Do you have all the PPE?

Ans: 95% said yes, and the others said no, claiming a constant non-distribution of personal protective equipment.

Waste management (questions)

For this section, the questions were restricted to production, separation, and disposal.

Question 1: What kind of garbage is produced?

Ans: Infectious, penetrating, chemical and biological.

Question 2: How was the separation done?

Ans: In identified containers (bucket labelling).

Question 3: What precautions should be taken when transporting infectious waste?

Ans: Please use all PPE and use it correctly.

Question 4: Where is medical waste incinerated?

Ans: Inside the health facility facilities to avoid contamination.

4.4. Results

The study revealed that most respondents were female (65.5%), aged between 20 and 40 years. It also revealed that the time of professional experience starts with more than 1 month and more than 10 years, and the largest occupation group is composed of those who had experience in handling infectious waste.

According to the results, it was found that the amount of infectious waste is estimated at 5 kg/day depending on the daily patient flow. But on not very busy days production has not been more than 2 kg per day. The main categories of infectious waste generated in Boane in the Laboratory sector include infectious needles (70%) and infectious cotton (30%).

Based on the observation of the responses obtained in relation to worker safety in the laboratory sector of this unit, gaps are visible that must be filled. The search for this filling would promote good and better safety practices, such as ensuring that workers have and properly use their protective equipment.

Another example that can be mentioned is related to the matter of registering the occurrence of accidents at work, where two of the interviewees had already suffered an accident, but not as serious as mentioned: (non-contaminated needle stick and spillage of a sample of blood in the body).

Therefore, the pinprick occurred due to the lack of suitable plastics to identify the waste and the spill due to the lack of efficient processing equipment for this purpose, demonstrating a weak concern for the safety of workers.

As already mentioned, the management of hospital waste is an area that is gaining more and more importance, due to the environmental and economic issues associated with it, but also in terms of public health.

However, the path seems to be long, as there are lines to be covered and improved, so it is essential that more studies are carried out to allow knowledge of the reality of each health service, as this will allow improvements to be made.

In addition to the laboratory technicians, a cleaning agent, and a person in charge of the incinerator were involved, which also allowed us to gather their perceptions on the risks that hospital waste poses to their health. In general terms, it is expected to understand the extent to which health units are committed to ensuring the health of workers, the environment and what factors can contribute to improving the identified gaps, so it can be said that they were unable to achieve.

Regarding the management of infectious waste, these data showed that almost all respondents had corrected knowledge in handling infectious waste. But an observation can still be made that, for the same problems identified by MISAU in 2014, they are still being faced today.

The initial objective of this research was to establish the relationship between the risk assessment of infectious waste and the health of workers, the environment, and the public. But this relationship could not be taken to heart without comparisons of similar studies in other national units and due to the lack of regulations that address the issue in the country.

Therefore, it was only possible to obtain superficial and not very detailed information about the handling, segregation, and final treatment of infectious waste, and evaluated based on the methods initially chosen.

Then, the techniques mentioned by them in case of an accident are not as relevant as expected from a health unit that provides health services, due to the complexity of its activities that, before investing in providing services to communities, it should invest mainly in safety of these health professionals.

PPE is personal protective equipment, and this equipment must be mandatory in all activities involving exposure to risk, regardless of the level of exposure. As enshrined in the 2007 labour law, "all employers are responsible for the creation and development of adequate means to protect the physical and mental integrity of workers and the continuous improvement of working conditions", there is no justification for the absence of such equipment at the health level, as it is necessary for them to feel safe to deal adequately with unsafe procedures.

With regard to waste management, the practice they develop, which consists of separating waste by each generator, with the spirit of segregation that is incumbent on each one of them, is a very commendable practice, despite the fact that there are often failures in the separation because the plastic that collects the various residues is the same colour and the work is being carried out by the flow of patients, making one and another inadequate process to be carried out by the cleaning assistant.

Although the laboratory is not a very spacious place for the work and the number of workers, it is a clean and ventilated place (windows and open door), but these should not be the characteristics of this environment due to the importance that this place has within a unit. of health.

Unfortunately, paper, gloves, boxes, recipes are not recycled, all of which are incinerated in a specific open pit for common waste.

The incineration takes place on the institution's premises, in an incinerator made of bricks, which is not very sustainable and reliable (according to what it presents).

Regarding the selection of the treatment site, the first important decision is where to treat the infectious waste. There are two basic options: on-site option and off-site option.

4.5. List of objectives and methods employed.

The type and amount of infectious waste at the Boane Health Centre are not institutionally identified and quantified. There is only one estimate. In general, it can be said that the collection and disposal system practiced is not adequate and safe.

Individual accidents and subsequent infections caused by infectious waste are not well documented and do not have an HSE department.

About techniques, means and place of disposal, we consider 4 potential risks. But it is believed that there are many potential hazards for workers such as Chemical, Physical, Biological and Ergonomic due to the type of work and its conditions.

In the laboratory sector, waste is segregated according to its characteristics, but they do not use a certain colour code, so they use a black plastic bag as an alternative to place the infectious waste in an identified bucket.

A risk assessment is presented in table 3, this identifies the hazards, analysis and risk assessment related to exposure to some means, methods, and final disposal of infectious waste in Boane. The result of the risk assessment matrix, as a preliminary assessment shows sampling, transport of infectious waste and incineration of infectious waste are in the high-risk area in this sector. Sharps are items that represent the most acute potential health hazards. It can not only cause cuts and punctures, but also infect these wounds if they are contaminated with pathogens.

The previous case of an accident caused by a contaminated needlestick can be considered as highly dangerous infectious waste. To prevent similar or adversarial situations from happening again, initiatives such as monthly training and recycling of training for all employees who deal with HW as well as technicians can be considered, to deal with injuries and exposure, develop programs that predispose how acceptance in case of exposure or injury by hazardous substances. As well as the person who is directly involved in the handling of potentially dangerous health care waste, he must be provided with adequate protection associated with him. For example, in other health units, or rather in most hospitals worldwide, workers who deal with hospital waste management in general receive periodic training specific to this process (Valadares, 2009) and in our case this process shows if it is still partial and sometimes not very fluent, it can only be performed when it is convenient and not for the people who really need this training.

The risk matrix shows that all identified infectious waste risks to date start with moderate to high potential to cause harm to workers specifically. Environmental and public health conditions can be separated from disposals from the final disposal site due specifically to the incinerator, observation and information provided. But it was not possible due to the lack of information about its functioning. But it can be considered that the incinerator is unable to meet the demand for garbage per day, due to the conditions it presents, in need of remodeling.

About the worker policy, we found a policy, very detailed, but not very specific, and the policy for cleaning and infectious waste workers does not exist. In this context, for the existing policy there

Is a lack of implementation and control, as well as a lack of consideration of the existence of more risks.

The fault tree analysis allowed analyzing and identifying areas for mitigation and hazard prevention. Of the areas previously analyzed, they end up being the same ones that our fault tree presents.

The PRO analysis helped by evaluating the action (thoughts, feelings, goals, and actions), responding to the controllable and uncontrollable situation around the risk assessment. From this analysis, it was obtained that opinions differ greatly among technicians, where self-indulgence is present in almost all minds in relation to complaints, working conditions, availability of equipment, but that there is a great interest in seeing improvements, because they realize that danger is present in everything that is done in this workplace. In addition, the SWOT analysis worked to define the health unit, showing some strengths, weaknesses, opportunities, and threats. And it found that this sector has a large qualified team, professionals with good technical training on their specific work, but who end up losing to conformism, the low technologies used, the lack of equipment and macro institutional dependence to solve any problem.

CHAPTER V

5. Conclusions and Recommendations

5.1. Conclusion

Therefore, it was concluded that the techniques used for the management of infectious hospital waste comprise segregation in plastic bins, decontamination using chlorine solution for some utensils, and the segregation took place in situ. The removal of waste has been at the end of the activities and the burning of waste is done in brick incinerator. It was also observed that there are almost no records of accidents involving infectious objects.

A risk assessment was conducted using the data collected from production, segregation, transport and final disposal.

Additionally, it was observed that it is important to enforce the implementation of the policy to fight infectious diseases at the health units. Posters were produced at an institutional level, including danger alerts aiming to make the workplace safer. Techniques that include the use of UV lamp to protect the workers from bacterial infection during the analysis were suggested.

Looking at the few existing laws in the country and the little abridgement of these laws in relation to health and safety of workers the Health Centre of Boane performs minimally according to what is set out in the laws. However, the working conditions and equipment as well as the access to training need to be improved. The absence of an occupational health representative was also a concern.

Finally, among the various difficulties encountered in the laboratory sector and waste treatment sites, the lack of an incinerator capable of meeting current demand constitutes a major challenge. All identified risks; all can be controlled depending on the resources available and the priorities.

The study revealed that the knowledge of the interviewees on handling infectious waste that includes identification, precaution and waste classification is acceptable. However, it is necessary to consider the risks that can pose serious danger to the health care workers. According to the bibliography and observation to the management of infectious waste established at the Boane Health Care Centre, it is possible to conclude that better management can be achieved with significant improvements of some aspects such as, the availability of personal protective equipment, availability of adequate working tools (e.g. safety cabin).The equipment should be adjusted to the workers and not the opposite as it was observed during this study, considering different aspects, such as the work place, the risks and the need to reduce or eliminate them.

5.2. Recommendations

The greatest effort for today and for the Management System acceptable today, is to consider the health and safety of the worker in any area.

- Infectious waste management guidelines should be provided and enforced by the health facility as whole.
- Capacity, Distribution and Control of PPE.
- PPE control.
- Development of safety strategies, an appropriate and specific waste management plan for infectious waste due to its potential to bring risks to the environment and public health.
- Designing policies for workers handling dangerous objects, sharp objects and more.
- Knowledge of its strengths and weaknesses (conducting self-assessment studies such as the SWOT ANALISYS) twice a year.
- Defenders of workers' rights and duties
- Carrying out more similar studies for deeper conclusions in other points or health units.

Key words

- Risk management;
- Safety;
- Infectious hospital waste;
- Occupational Health.

CHAPTER VII

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***APPENDIX 0-A**: Questionnaire*

HEALTH, SAFETY AND ENVIRONMENT ENGINEERING MASTER'S PROGRAM

Description

Student: Lúcia Tiago Nampele

CIEP-UTT Professor: Raed Kouta

Compagny: Centro de Saúde de Boane Sede - Maputo province

Questionario para o trabalhador do laboratorio / questionnaire for the laboratory worker

CONTEXT:

"Garbage, depending on where it comes from, constitutes a danger to the environment in which it finds itself. Mozambique is a country with poor sanitation systems, since the separation, collection, treatment and disposal of waste generated by the population on a daily basis. In waste management, there are who suffer directly from the consequences of poor management and who suffer indirectly. Nowadays, a search for better working conditions generates competition in the work sectors; more than producing it is creating good working conditions for its workers and especially for high-risk sectors"

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Perguntas /Questions

1. Sexo: Masculino ☐ Feminino ☐
2. Há quantos anos trabalha neste sector?

4.2. Para além do procedimento anterior o que é feito para evitar outras contaminaçõoes da doença?

4.3. Existe algum relatório médico que no final fica arquivado sobre o ocorrido?

5. Considera o teu trabalho perigoso? Porquê?

6. Que tipo de Lixo é produzido no seu sector?

a. Lixo Infeccioso_____ b. Perfuro Cortante_____ c. Lixo Quimico_____ d. Lixo Comum _____

e. Lixo f. Biologico _____, Outro(s)_____

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7. Como tem sido feita a separação do lixo?

8. Na tua opinião, o sector no qual trabalha possui condições e gabinete de segurança adequada à sua segurança? Se NÃO, o que falta?

9. Possui todo EPI para a realização das suas tarefas laborais? Se NÃO, o que falta?

10. Na tua instituição o EPI é obrigatório ou não? Se não, porque? Se sim, em que circunstâncias?

APPENDIX 0-B: *HSE POLICY EXAMPLE PROPOSED*

HSE policy proposed

Laboratory worker

Implementation of Health and Safety educational and Training

This sample of a new policy in this Unite, can be revised and adapted to others sector, in this case we made following the gaps identified and in order to avoid the risks, probability and their consequences about work place.

This policy will aim to:

- Prevent accidents and cases of work –related ill health;
- Educate a technicians about good practices at work;
- Implement a supplementary programs;
- Enforce on use and provide personal protective equipment;
- The technicians can participate on an consult with what matters affects their health and safety;
- Ensure safe handling use of substances;
- Ensure to implement emergency procedures;
- Adjust and revise their policy regularly.

APPENDIX 0-C: *WASTE MANAGEMENT PROPOSED EXAMPLE*

Waste management policy

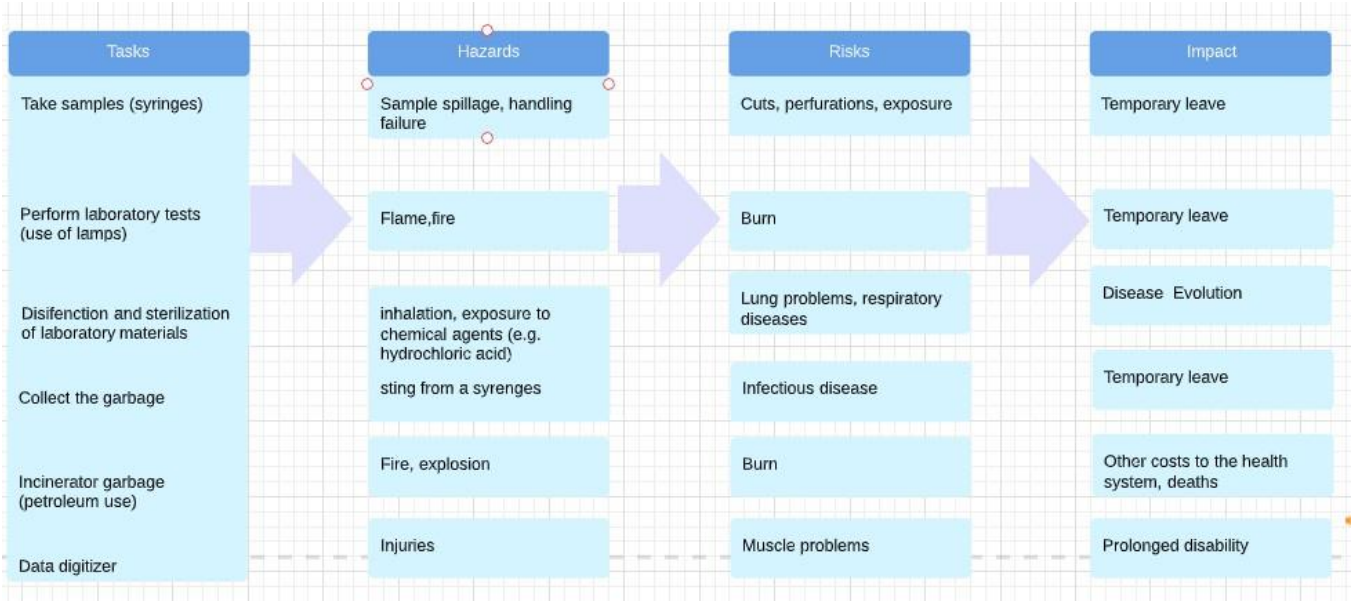
First is important to understand that the general idea about infectious waste is to know that waste is a medical waste that may contain microorganisms that have potential to cause disease, and there are many factors which facilities the progression of an infectious exposure to an infectious disease.

Protocols, regulations, policy regulations must be in place and must be updated in accordance with current law on waste management. Should be in place to ensure compliance with optimal waste handling.

About this topic:

- Need to change practice of waste management procedure;
- Follow the guidelines in the law on non-hazardous waste management (doing the recycling);
- All staff should be trained to deal with the waste they will encounter;
- training can be organized internally or externally;
- Oversee the local landfill;
- carry out studies on effluent emission (surrounding and internally);
- Restructure the incinerator;
- Create mechanisms to have labels on the garbage when going to the incinerator.

***APPENDIX 0-D**:EXAMPLE OF EVALUATION RISK ANALYSIS*



Annex

ANNEX 1: *Box of sharps*

Figure 12: Containment of sharps

Figure 13: Containment of solid waste

ANNEX 2: *Type of waste, color coding and type of container*

Type of waste	Colour coding - symbol	Type of container
0. Household refuse	Black	Plastic bag
1. Sharps	Yellow and 	Sharps container
2a. Waste entailing a risk of contamination **2b. Anatomical waste**	Yellow and 	Plastic bag or container
2c. Infectious waste	Yellow marked "highly infectious" and 	Plastic bag or container which can be autoclaved
3. Chemical and pharmaceutical waste	Brown, marked with a suitable symbol (see Annex 4, chapter 4: Labelling of chemicals). E.g.: 	Plastic bag, container

Figure 14: Coding recommendations (WHO-UNEP/SBC 2005) cited by (International Comite of Red Cross, 2011) p. 47.

ANNEX 3: *Infectious waste segregation- Boane Health Centre*

Figure 15: Infectious waste segregation- Boane Health Centre, source the author.