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ROOT CAUSE ANALYSIS ON DELAYED DISPOSAL OF EXPIRED MEDICINES AT MASVINGO PROVINCIAL HOSPITAL, MASVINGO PROVINCE ZIMBABWE 2019-2020

BY

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A DESSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF PUBLIC HEALTH IN THE COLLEGE OF HEALTH, AGRICULTURE AND NATURAL SCIENCES

2022

Abstract

The disposal of expired medicines is an important subject gripping attention in the world. It has been comprehended that inappropriate disposal of expired medicines in hospitals leads to the contamination of the surrounding areas and pose a hazard to air, water, food chain, animals/livestock and even agricultural products. Human life is also threatened through inhalation and ingestion of the expired medicines. This study was a root cause analysis leading to the delay of disposing expired medicines by Masvingo Provincial Hospital. Root cause analysis (RCA) is the process of discovering the root cause of problems in order to identify appropriate solutions. The research design used in this study was quantitative research design with non-experimental correlational design data was analyzed using SPSS software. Primary data was obtained through structured questionnaires administered to Masvingo Provincial Hospital staff and responses were evaluated on a likert scale. The researcher investigated the causal effect relationship between the independent variables namely; work environment, incineration equipment, administration, staff and donation against the dependent variable effect, the variable effect meant 'delay the disposal of expired medicines'. Results showed that work environment has a positive effect on the delay of disposal of expired medicines ($F_{(1, 98)}$ =1.7; Beta=2,1; p-value= 0.028). The researcher also developed a regression equation for work environment; $Delay = 3.7 + 2.1 * work(1)$uunavailability of incineration equipment has a negative effect on the delay of disposal of expired medicines ($F_{(1, 98)}$ =1.1; p-value= 0.01: p-value = 0.00; Beta=-3.1, p-value =0.01). The negative effect implies that 1% increase in the provision of equipment to use, the delay of disposal of expired medicine drops by a certain percentage of time. The regression equation is as follows; delay=4.4-3.1*equipment (2) administration has a positive effect on the delay of disposal of expired medicines ($F_{(1, 98)}$ =0.0; p-value 0.029, p-value0.00; Beta=3.0 p-value=0.029).The regression equation is as follows ;delay=4.1+3.0*administration (3) staff has negative effect on the delay of disposal of expired medicines ($F_{(1, 98)}$ =1.1; p-value=0.02; P-value=0.00; Beta=-2.1 p-value 0.02).The regression is as follows; Delay =4.5-2.1*staff(4)donations have a negative effect on the delay of the disposal of expired medicines $F_{(1, 98)}$=0.216; p-value 0.03;p-value0.00;Beta=-3.0 p-value0.03).The regression equation is as follows;$delay = 4.3 - 3.0 * donation(5)$.Work environment, unavailability of equipment at the hospital to dispose expired medicines, lack of a monitoring technique of expired medicines by the administration, low pharmacy staff compliment at the hospital and donations of medicines by outsiders are the root cause of the delay to dispose expired medicines at Masvingo Provincial Hospital. Recommendations are that: revive the hospital therapeutic committees on disposal of expired medicines procure a high temperature incinerator which can dispose expired medicines; address the issue staff pharmacy to avoid fatigue lastly there is need for a computerized system to monitor the follow of drugs.

Keyword: Delay; Disposal; Environment; Expired medicines;Incinerator;

Declaration Page

I declare that this dissertation is my original work except where sources have been cited and acknowledged. The work has never been submitted nor will it ever be submitted to another university for the award of a degree.

Sithabile Matava

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31/08/2022

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Acknowledgements

I would like to acknowledge my academic supervisor Dr. Mugomeri for his guidance through this work and Mr. Chikaka for assisting with data analysis. My Field supervisor, Dr. Masinire has been helpful too in guiding me away from the institution. I acknowledge Masvingo Provincial Medical Director's office for the support through allowing me to collect data in the province.

Thank you to, my husband and children, for the undying love, emotional and moral support you have given me throughout the work.

Above all I would like to acknowledge God for making all this possible.

List of Acronyms and Abbreviations

APIs	Pharmaceutically ingredient
HCI	Health care associated infections
HCWM	Health care waste management
HIV	Human Immunodeficiency Virus
EMA	Environmental Management Agency
MRSA	Methicillin-resistant Staphylococcus aureus
MPH	Masvingo Provincial Hospital
MSW	Municipal Solid Waste
PPE	Personal protective clothing
WHO	World health organization
ZRP	Zimbabwe republic police

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CHAPTER 1 INTRODUCTION

1.1 Introduction

Expired medicines are medicines which are no longer suitable for use due to the elapsed shelf life or expiration date set by the manufacturer for the correct intended use (World Health Organisation, 2015). Increasing disease incidence and prevalence necessitate healthcare practitioners at tertiary institutions to prescribe and dispense different medications as presented by Seehusen & Edwards (2020). The disposal of these medicines at hospital in time if they expire remains a challenge in most hospitals with Masvingo Provincial Hospital included.

Presently, expired medicines are a threat to humans, environment and wildlife if not properly discarded as noted by Shamim (2018). Expired medication disposal is an important subject gripping attention in the world. It has been comprehended that inappropriate disposal leads to the contamination of the surrounding areas and pose a hazard to air, water, food chain, animals/livestock and even agricultural products (Kusturica et al., 2018). To my knowledge, no research has been carried out in Zimbabwe to establish why expired medicines are kept long before they are disposed to mitigate on the likelihood of environmental contamination and human life threats that may be caused by expired medicines.

This study was conducted through a root cause analysis to which the delay of disposing expired medicines by hospitals had been noted to be detrimental. Root cause analysis

(RCA) is the process of discovering the root cause of problems in order to identify appropriate solutions. The root cause analysis was in two fold using quantitative correlational research design. The first process aimed in determining the contributing factors, with focus on the latent hazards in the system that contributed to the occurrence of the event. The second aimed to develop solutions or proposed changes that once implemented, they will eliminate the hazards and reduce the chances that a similar event could occur in the future as noted by Maeng et al. (2016). In this study expired medicines also included unused medicines.

1.2 Background of the study

The current handling of unused medication, including expired ones has become a global canker. The use of prescription and over the counter medicine is increasing globally and is expected to reach over 6.5 trillion doses in 2022, a 24% increase from 2018 (Kristina, 2018). All the prescribed medicines may not be consumed by the patient, and large quantities of the medications will remain unused or expired in the hospitals (Kozak et al. 2016). There are many reasons for medication accumulation in hospitals such as drug adverse effects, change in dosage/regimen, expiration of the medicine, promotional influence by manufacturers, physician prescribing practice and dispensing practices (Kusturica et al., 2018).

The accumulation of leftover, unused, or expired medicines at hospitals is a threat to environmental contamination due to lack of awareness on appropriate medicine disposal methods (Shamim et al., 2018). The improper disposal of unused medicines is a worldwide concern because of its impact on the environment, economy and health. The

management of these medicines in the environment is both challenging and potentially costly (Braund et al., 2009).

Masvingo Provincial Hospital (MPH) is a health institution characterized by few specialists and medical doctors with the majority being nurses and nurse aids. The hospital services Masvingo Province population. Recently, there has been brain drain of skilled personnel into neighbouring countries and overseas. Health personnel have not been spared; best doctors and nurses with vast experience have gone to greener pastures. Consequently, very few experienced staff is left at the hospital and the majority is not experienced and has little knowledge about monitoring of medicines and their effects when there are expired.

The hospital has a pharmacy and pharmacists specializing on medicines distributions and the receiving of donated medicines. The checking of expiring dates involves adequate staff compliment when being done manually to avoid errors and fatigue (Persson et al., 2009). In this regard, hospital staff complements at Masvingo Provincial Hospital is very low thus they are kept busy most of the time to the fact that execution of their duties is compromised due to fatigue.

Indian press reports cases in which hospitals are shut down for not following regulations on proper disposal of expired medicines. Manocha et al. (2020) states that, the common method of biomedical waste and expired medicines disposal is unlike other wastes like domestic wastes. However the timeous disposal of expired medicines in African countries remains a challenge due to unavailability of governed legislation as noted by (Ngole, 2007).

The population of Masvingo is ever growing but infrastructure at the hospital is not being upgraded to match the growing demand for health services. Therefore, the rooms to keep hospital equipment and medicines are becoming smaller by each passing day. This result in the mixing of equipment and medicines or medicines to be abandoned left for obsolete.

Medicines may be delivered at the hospital having already expired or nearing their expiration date or in large quantities more than the populations can consumers (WHO, 2016). Some of the donated medicines at the hospital come from foreign countries with labels or names difficulty to comprehend. Donated medicines with a long shelf-life may be mismanaged and forgotten, due to inadequacies in stock management, distribution, lack of a routine system of disposal. Unsafe disposal of these unwanted or expired medicines create a major problem to the environment and animals (Berckmans & Vangenechten, 2006).

According to WHO (2019) most of the African health institutions depend on aid from European countries. Masvingo Provincial Hospital strongly relies on medicines donations from other health institutions and independent donors from abroad due to melting down of economic situation in Zimbabwe. Usually the budget allocated to health system by the Ministry of Finance cannot adequately address challenges in the health sector.

The disposal of expired medicines at dumpsite, low temperature incinerators and sewer drains is still the most common method of disposing expired medicines in developing countries. World Health Organization guidelines have since been shifted focus to the

context of "environmental issue'' by regulating human actions that may cause direct or indirect damage to the environment. In 2016 the World health organization published guidelines regarding the safe disposal of unused pharmaceuticals. These guidelines can be summarized as follows: (I) return to donor or manufacturer; (II) high temperature incineration (greater than 1200 °C); (III) immobilization by waste encapsulation; (IV) chemical decomposition, if chemical expertise and materials are available (WHO, 2016). The use of high temperature incinerator is still a challenge with only 8 hospitals in Zimbabwe having the correct ones at their institutions.

Zimbabwe is one of the African countries that have no proper regulations or systems specifically designed to manage expired medicines within a time frame. MOHCC in Zimbabwe has set guidelines for the disposal of expired medicines which are striving to work due to the absence of regulations (Alvim- Ferraz & Afonso, 2003). Although the Environmental Management Agency Act has a section on disposal of solid waste, there is not much emphasis on expired medicines. Guidelines for evaluating environmental impact of the existing and new medications are also lacking in developing countries like Zimbabwe.

1.3 Statement of the Problem

Masvingo Provincial Hospital has no prescribed disposal method and time frame to dispose expired medicines. This poses risk to the patients and the public while hospital storage space is also committed to expired medicines. There is a concern of unused and expired medication storage that requires clear guidance about its disposal time frame and methods. The presence of unused and expired medications in hospital storerooms

and is potential threat and can be harmful to humans, environment and wildlife (Halling et al., 2009). Specifically, the presence of discarded medicines in waterways and drinking water is a serious and multifaceted issue that has gained national and international attention with the public, lawmakers and regulators.

According to the hospital records at Masvingo Provincial Hospital expired dangerous medicines which expired between the years 1995 and 2019 were disposed in 2021. The said medicines occupied two sore rooms out of the four available. Studies have reported that, over half of the world's population was already at risk of patients ending up being exposed to expired medicines of through inhalation or ingestion (Pachauri et al., 2019). Additionally, Wu et al. (2019) describes the likelihood of expired medicines mixing up in storerooms as a cause to patient's deaths and complicated illnesses.

Hence, the study sought to find out the delay in disposing expired medicines, general practices, and awareness concerning the correct disposal of unused and expired drugs at Masvingo Provincial Hospital.

1.4 Aims and Objectives

1.4.1 Aim

To conduct a root cause analysis to determine factors associated with delayed disposal of expired medicines at Masvingo Provincial Hospital

1.4.2 Research objectives

I. To identify factors that causes delay in the disposal of expired medicines at Masvingo Provincial Hospital.

II. To assess the impact of the factors leading the delay of disposal of expired medicine at Masvingo Provincial Hospital.

III. To evaluate the impact associated with delay and method of disposal of expired medicines on the environment, wildlife and humans.

IV. To find strategies that can be used to speed up the delay of expired medicines at Masvingo Provincial Hospital

1.5 Research questions

I. To what extent do delayed disposal expired medicines at Masvingo Provincial Hospital affect the environmental, wildlife and humans?

II. Does the impact of delay of disposal of expired medicine at Masvingo Provincial Hospital vary with the method of disposal?

III. How effective are the strategies used to reduce the delay disposal of expired medicines at Masvingo Provincial Hospital?

1.6 Significance of the study

Pharmaceutical products are essential in maintaining human health, but many pharmaceuticals contain hazardous chemicals that can contaminate the environment if they are not properly managed or discarded. Many households frequently store unwanted, unused, or expired medications in their homes indefinitely or discard them through general municipal waste bins, sinks, or flush them down their toilets. It is necessary to know that disposing of unused or expired medications through these unauthorized channels predispose the environment and the inhabitants to serious health risks.

When expired medicines are delayed or improperly disposed leading to contamination and a wide range of toxicities in man and animals. People can be exposed or accumulate traces or residues of pharmaceuticals from the environment by drinking contaminated water. Proper disposal handling and management of expired medicines prevent avoidable toxicities and promote the safe and friendly environment (Chartier, 2014).

Community pharmacies are meant to collect sort and dispose of expired drugs rationally more than anyone else could. They are meant to serve as collection points for expired drugs in the communities where they are located because they have been trained on the act of proper drugs disposal. It underscores the need for proper medicine disposal in the good interest of our environment and population health. This study determined the causes of delaying the disposal of expired medicines and recommends the correct disposal methods to safe guide man and his environment.

1.7 Delimitations of the Study

The records from the hospital administration on expired medicines and disposal were available as the administrator keeps a file on the drugs which will have been disposed and the dates. The success of the medical/healthcare waste management will certainly accelerate the progress toward meeting the above-mentioned goals by 2030. Good health and wellbeing are essential for sustainable development, and these are, directly and indirectly, related to the unsafe disposal of medical waste, which is responsible for about 5.2 million lives, including 4 million children annually, and millions of workers involved in handling medical waste are being infected with many infectious diseases such as HIV, Hepatitis B, and Hepatitis C (WHO, 2018).

1.8 Limitations of the Study

District health centers and private health facilities were not included in the study and thus the results may be slightly different if those facilities were included. Disposal options vary considerably between situations, and the ideal solution may not be feasible. The aim of these guidelines is to propose the simplest, safest and most practical alternatives.

Inefficient and insecure sorting and disposal may allow drugs beyond their expiry date to be diverted for resale to the general public. Sorting should be done as close as possible to the stockpile in an orderly way, with all sorted material clearly labeled and separated at all times.

1.9 Chapter Summary

This highlighted the research that there is an urgent need for countries to adopt a safe medical waste disposal system to prevent the stockpile and to prevent communities from being contaminated with potentially infectious medical waste. The researcher conducted a root cause analysis to determine factors associated with delayed disposal of expired medicines. This chapter also focused the background to the study, the statement of the problem, key objectives to be achieved and the research questions thereto. It also outlined the delimitations of the study. The next part is the review of the related literature.

CHAPTER 2 REVIEW OF RELATED LITERATURE

2.1 Introduction

This chapter explores a review of the literature that is related to the topic. The review describes summaries, evaluates and clarifies the literature that is related to the topic under study to establish any knowledge gaps in the area of interest (Boote & Belie, 2005). This part is structured in such a way that it reviews the literature that is related to each of the specific objectives that go with the study as summarized below.

2.2 Theoretical Framework

Nesbit & Gick (2008) are of the affirmation that even though there are parallels that can be drawn between health and environmental behaviors, these aforementioned aspects which are also inclusive of health promotion and health-behavior change are in most cases referenced to when it comes to the recognition of environmental issues. For the successful conduction of the research study, the researcher came up with the position that makes use of two models that can clearly articulate on the issues and concerns that are to be addressed by the research study.

The theories that were used are the Health Belief Model (HBM) and the Theory of Planned behavior (TPB) as illustrated by the diagram below.

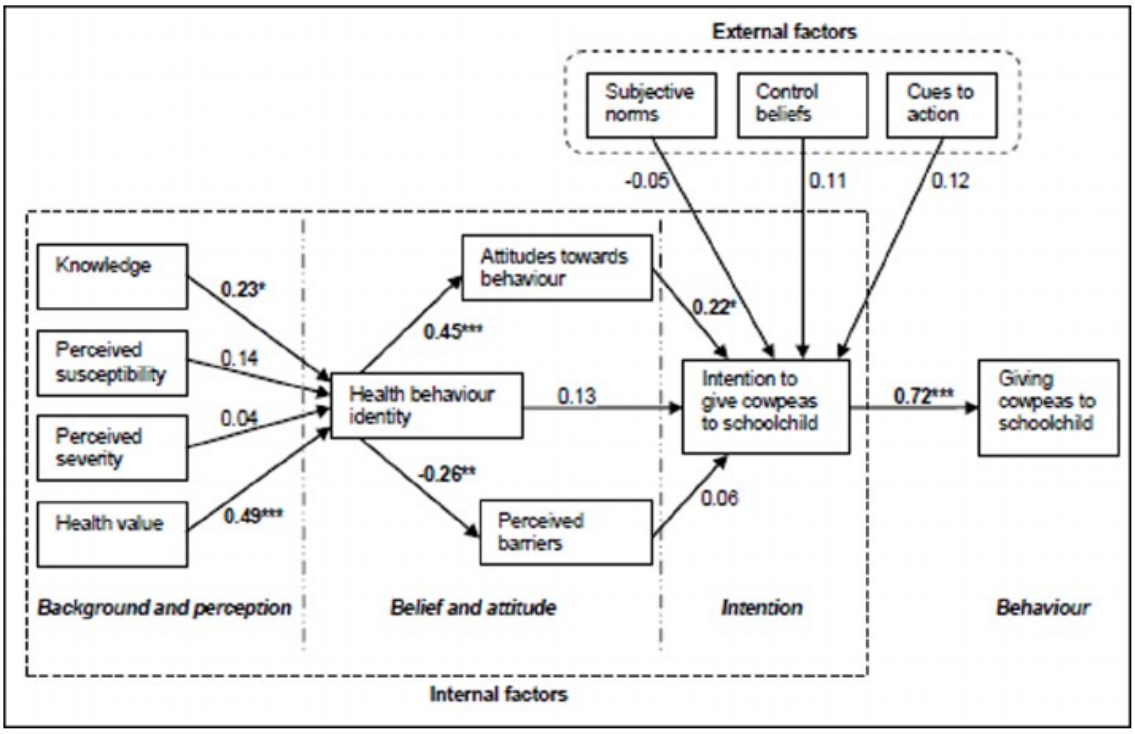

Figure 1: Theory of planned behavior

The background for choosing TPB is that it places a special emphasis on planned behavior on the delay of pharmaceutical disposal. In the case of HBM, it aligns the research study, by means of looking at the aspects of recycling and environmental fortification.

2.2.1 Theory of Planned Behavior (TPB)

Theory of Planned Behavior (TPB) is an extension of Ajzen and Fishbein's Theory of Reasoned Action- TRA These two models accentuate that a person's intention determines that their willingness to do it (Conner & Sparks, 2005). prevailing in that individual's social scene.

The theory delves into the main components of individual and social factors. Behavioural philosophies are noted as precursors and or influencer of one's behavioural attitude. These are further reputed to encourage attitudes toward the behavior, while normative beliefs strengthen subjective norms. An important aspect was not included in the original model, according to Conner & Sparks (2005) it was the matter of behavioural regulation, and the magnitude to which an individual has the control to achieve the behavioural goal.

Since many factors can interfere with the actual control over which a person has performed a certain behavior, behavioural control has been conceptualized as perceived control, "the person's belief as to how easy or difficult performance of the behavior is likely to be" (Conner & Sparks, 2005). The stronger people's perceived control over completing the goal activity is the more internal and external resources and possibilities

they perceive, and the fewer obstacles they anticipate. Attitudes, subjective norms, and perceived behavioural control all have varied effects on behavior. Attitudes, subjective standards, and perceived behavioural control all influence behavior in different ways.

Two versions tested in the TPB in two experiments by Conner & Sparks (2005) both revealed that the TPB outperformed its predecessor. The inclusion of perceived behavioural control considerably improved the theory's ability to predict intentions and subsequent attainment of behavioural goals, as expected.

Since its inception, researchers have used the TPB extensively in examining health-related behaviors such as smoking cessation, health screening, dental flossing and as well as the behavior of health care professionals (Nesbit & Gick, 2008). It was also recognized that future research would likely uncover additional factors that influence intention and outcomes.

Social norms may not be a unified construct but a descriptive norm that designate perceptions of others' behavior and rigid norms that designate perceived expectations about how individuals will act can have independent effects on intentions (Fernandes et al., 2020). TPB study explored the respective influences of descriptive and injunctive norms on recycling behavior, as well as aspects of social identity.

Researcher also used the TPB to examine behavior in organizations (Fernandes et al., 2020) applied the TPB to the study of environmental measures taken by managers of small and midsized firms. Waste disposal was one of the aspects studied. For health care

facilities, proper pharmaceutical disposal must be managed at the organizational as well as the individual level.

Most studies in this line of research focused on recycling behavior (Nisbet & Gick, 2008). In their review of this research, (Nisbet & Gick, 2008) found that intentions to recycle arose from positive attitudes toward recycling and perceived behavioural control, provided that ‚people feel their own contribution is important". The influence of subjective norms on recycling was less consistent. Fernandes et al. (2020) deliberately chose to focus on the influence of subjective norms on recycling.

In summary, the behaviors that trigger the disposal of unused or expired pharmaceutical products are multifactorial and can therefore be best explained by using two theoretical frameworks: the TPB and the HBM. Conner & Sparks (2005) hinges on the concept of intention to perform an action, given that the individual has the perception of having behavioural control. In the context of this study the TPB has provided clues on the need for individuals to have feasible and available disposal options. Sanchez-Medina et al. (2014) used the TPB to investigate behaviors related to environmental protection, whereas (Nisbet & Gick, 2008) used the TPB to explore behaviors related to recycling.

2.2.3 Health Belief-Model

Hochbaum developed the HBM in the 1950s in reaction to the unfortunate attainment of public health campaigns to encourage disease screening (Champion & Skinner, 2008). Grounded on intensive assessment of probability models of grown-ups in urban areas that offered tuberculosis screening, Hochbaum distinguished the convictions that

structure the premise of the model: saw weakness and saw advantages of activity. Hochbaum likewise perceived the job of inborn and outward signals or triggers in persuading individuals to make a move, albeit never observationally researching that element of the model (Champion & Skinner, 2008).

Decades later, Champion & Skinner (2008) expanded the HBM model and has a strong empirical foundation. The model has several essential components. Perceived susceptibility denotes the person's subjective perception of experiencing a health or medical condition. This dimension encompasses susceptibility to illness in general, as well as vulnerability to a specific condition. A related factor is perceived severity, referencing the seriousness of experiencing the condition or allowing it to remain untreated. This component includes medical consequences ,pain, disability, death and social consequences for example, the impact of the condition on work and social relationships. Taken together, perceived susceptibility and perceived severity produce perceived threat.

Although acceptance of a perceived personal threat is a prerequisite for taking action, the specific course of action the person chooses to take depends on the perceived benefits of the available options (Armitage & Christian, 2003). Bringing unused and expired medications to a take-back event or disposal center neutralizes the potential threat those drugs might present to people and pets, and does not contribute to environmental pollution. The action might carry the intrinsic reward of feeling one has done the right thing. A drug take-back event might offer an opportunity for socializing.

For young people in particular, peer pressure to engage in environmentally friendly actions might influence drug disposal behavior.

Signals to activity are perceived as significant variables in wellbeing ways of behaving, yet have not been efficiently inspected (Armitage & Christian, 2003). As a matter of fact, it is challenging to measure signs since they are in many cases inconspicuous and exceptionally personal. For instance, individuals who love nature or know about the poisonous effect of inappropriately discarding meds in the climate may be bound to change conduct and carry out a legitimate disposal practice. The HBM has been applied to a wide assortment of wellbeing ways of behaving. A short rundown incorporates disease screening, wearing sunscreen, dental cleanliness, medicine adherence, and HIV risk conduct (Nisbet and Gick, 2008). Until now, the HBM has been utilized in just a single distributed concentrate on connected with the climate: reusing conduct. In a recent report by Lindsay & Strathman (2020) people who saw the outcomes of not reusing as to a greater extent a genuine danger were more disposed to consent.

Self-viability and more prominent view of advantages or lower apparent expenses likewise lined up with reusing. Self-efficacy has been applied to a horde of wellbeing ways of behaving. The more certain individuals feel in executing a game-plan and achieving the ideal outcomes, the more probable they are to embrace the way of behaving and persevere through difficulties to accomplish their objectives (Waheedi & Koshy, 2012).

Most purchasers are so used to discarding prescriptions in the sink or latrine that theymay not really think about their way of behaving, notwithstanding wellbeing and

ecological worries. Indeed, even medical attendants, drug specialists, and other medical services staff who know about appropriate and ill-advised removal rehearses discard unused drugs in the channel or latrine (Abahussain et al., 2012).

Another explanation that hinders conduct change is the conviction that the gamble to the climate or to one's wellbeing is low (Nisbet & Gick, 2008). The utilization of professionally prescribed medicines in the US has been marked a scourge (Lyon & Maxwell, 2011). Exposure for prescription reclaim programs stresses the risks of keeping unused and lapsed meds in the home. Assuming the discernment is that it is more perilous to keep drug at home than to dispose of it to sewage a more quick versus a more far off risk without even a trace of a helpfully gotten to removal program, the messages may incidentally build up the proceeded with utilization of inappropriate removal rehearses. Dangers to individual wellbeing from unpretentious changes to the climate might be seen as not occurring in the course of one's life. Individuals with small kids might be generally open to messages about the human-wellbeing danger of disposing of medications to sewage.

Nisbet & Gick (2008) likewise called attention to that individuals are inclined to unreasonable idealism with respect to wellbeing and ecological dangers that poor person yet occurred and are believed to far-fetched be. Regardless of whether people are persuaded of the reality of a wellbeing or ecological danger, their confidence might persuade them to think they are less powerless than others, and hence would be more averse to make a move to change their way of behaving. Other individual ascribes, for

example, a feeling of obligation toward nature and the climate are probably going to impact conduct connected with ecological security and wellbeing.

Taking everything into account, the HBM relies upon solid areas for a foundation by which an individual's obvious shortcoming and saw reality of a risk are at the focal point of its determined framework. For instance, the aftereffects of the concentrate by Nisbet & Gick (2008) recommended that the more individuals were worried about the danger outcomes of missing a portion of their endorsed medicine, the almost certain they were to conform to their drug consumption. Certain ways of behaving, for example, that of discarding drug drugs in the channel or latrine, are profoundly settled in; in this way proposing that the apparent danger to one's wellbeing from a contaminated climate is either too low to be in any way worth considering, or non-existent..

2.3 Theoretical framework

A theory is a set of concepts, definitions, and propositions that explain or predict events or situations by illustrating the relationships between variables in that situation or event. They must be applicable to a broad variety of situations. According to Wondimu et al., (2015) theories are by nature, abstract, and do not have a specified content or topic area. Like empty coffee cups, theories have shapes and boundaries, but nothing inside. A theoretical framework may be defined as a structure that can hold or support a theory and assumptions upon which a research study is framed. The theoretical framework introduces and describes the theory that explains why and how the research problem under study exists and how issues involved in a study can be envisioned, understood and explained.

The theoretical framework is going to be explained using the Fish born diagram also known as Ishikawa, to find out the ways in the causes which lead to the delayed of disposing of expired medicines at Masvingo Provincial Hospital. Figure 2 below examines all the possible reasons why expired medicines take time in the hospitals before there are disposed.

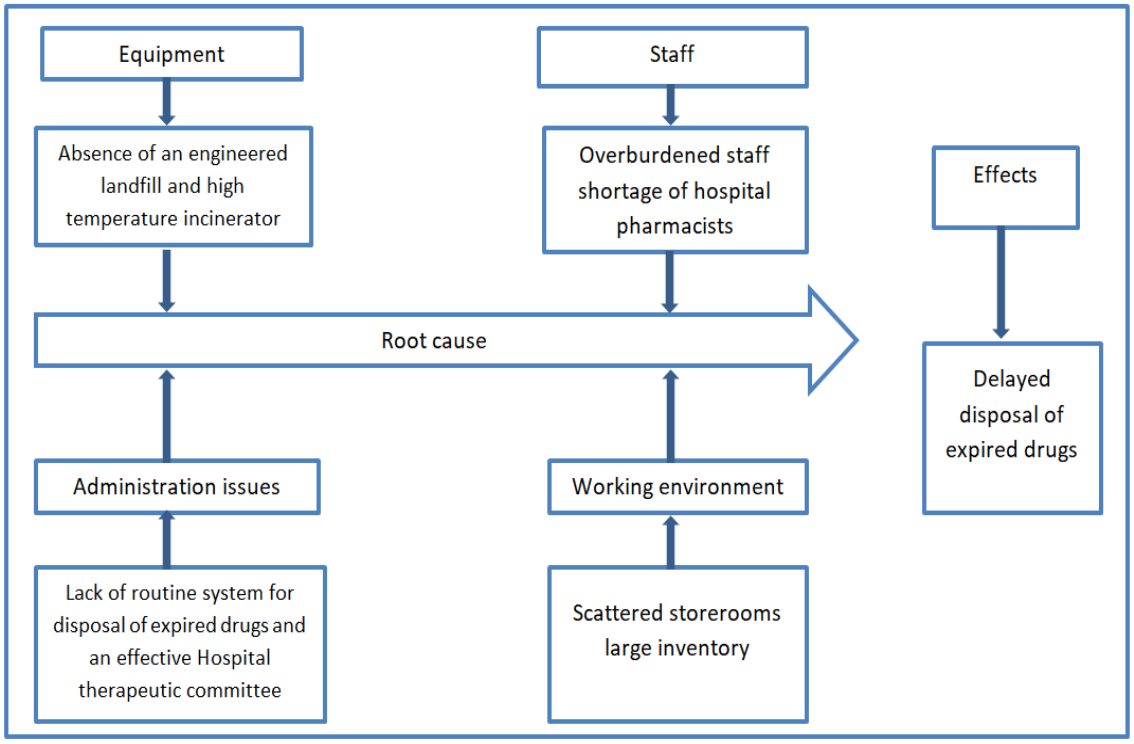

Figure 2: Fish born diagram

2.4 Environmental and human effects of expired medicines

The table below shows classes of medicines classified according to the medicines substance control Act (chapter 15:03) these have been linked to the likely risks that they can pose to humans and their environment.

Table 1: Classes of medicines and environmental risks

Description of medicines	Class of medicines	Risk to humans	Water pollution	Air pollution	Waste water pollution(Sewage)	Effect in the soil
D .D.A	1	✔	✔	✔	✔	✔
Prescription medicines	2	✔	✔		✔	✔
Over the counter	3		✔		✔	✔

Humans are unintentionally exposed to very low concentrations of expired medicines via daily intakes of drinking water, leaf crops, root crops, fishes, dairy products, and meat (Halling & Dahlberg, 2001).

2.4.1 Water Pollution

Early and correct disposal of unused or expired medications through unauthorized channels leads to serious health risks and poisoning in humans. In Pakistan the detection of antibiotics, antidepressants, and hormone replacement medications traces are found in water ways and in drinking water supplies (Stackelberg el al., 2007). The residues of expired medicines dumped in soil with time they will reach water supplies and their decomposition derivatives influence the natural life. For instance, the continuing exposure to specific estrogens such as ethinylestradiol found in contraceptive pills has directed the feminization of male rats (Chartier, 2009).

In Masvingo City there are incidences where shortages of water treatment chemicals have been reported and if such water pollution happens they will be serious adverse

results to wildlife and human. Figure 3 below show how drinking water can be contaminated expired medicines if not properly disposed. More water chemicals will thereby need to chlorinate the water and making it safe for drinking.

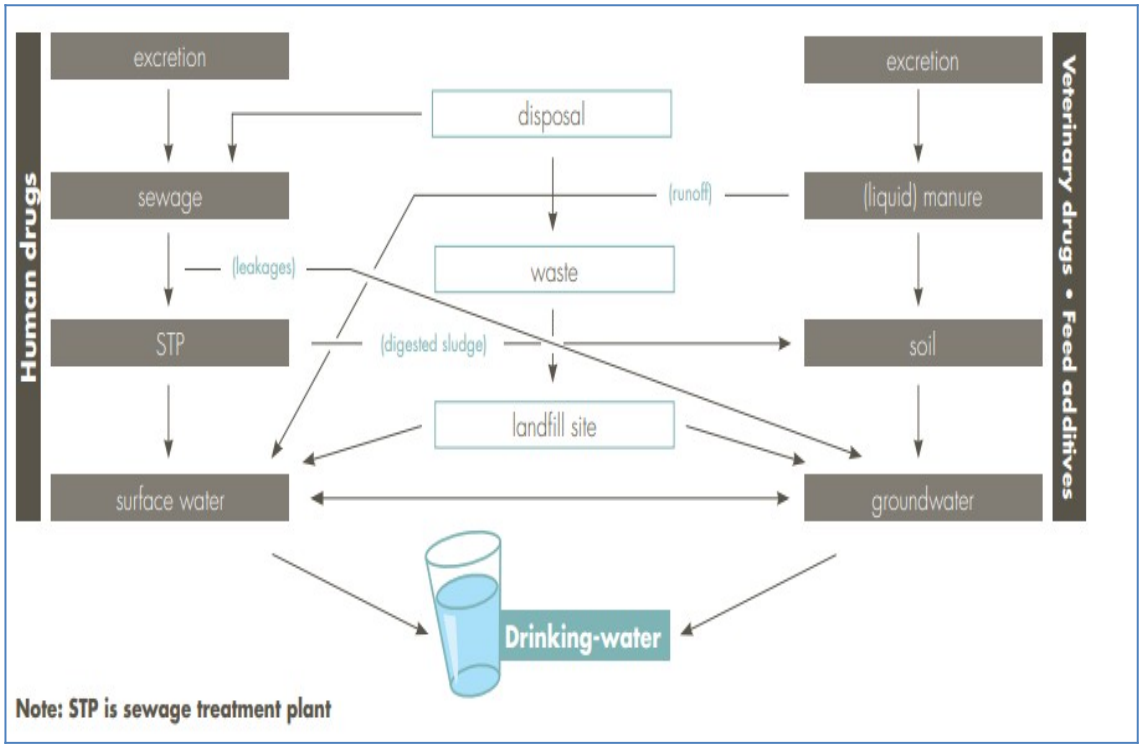

Figure 3: Fate of pharmaceuticals in the environment

2.4.2 How expired medicines enter the food chain.

Minute quantities of active expired medicines eventually enter the food chain, where they actually become enriched again, and subsequently return unintentionally to the human population which had previously disposed of them. In some cases, particularly when expired medicines are incinerated at low temperature (less than 800°C) dioxins, furans and various other toxic air-borne pollutants are formed. They are found in emissions but also in residual and other air-borne ash and in the effluent gases released through incinerator chimneys. These substances are persistent and molecules do not

break down in the environment and they accumulate in the food chain. The bulk of human exposure to dioxins, furans and coplanar polychlorinated biphenyls takes place through food intake (kristina, 2018).

2.4.3 Sewage system contamination

Environmental contamination is a fundamental issue of concern worldwide in regards to the inappropriate disposal of expired medicines from hospitals. Fluoxetine, Gemfibrozil, and ibuprofen, are some the medicines that have been detected in wastewater. The presence of expired medicines in the sewage has also led to increased antibiotic resistance due to the numerous strains of microorganisms found in sewage which mutate to deadly and resistant pathogens from harmless microbes. Karthikeyan & Meyer (2006) also noted that they destroy and alter the environment ecosystem. ARV medication is another of the medicines found on the expired medicines list at MPH.

Poor management of wastewater and sewage sludge also results in the contamination of water and soil with pathogens or toxic chemicals. Pouring expired medicines down the drain can impair the functioning of biological sewage treatment plants (Alvim-Ferraz & Afonso, 2020). At Masvingo Provincial Hospital there are syrups being discharged in the sewer system. Very few researches have looked at the effects of the municipal sewage treatment plant to which expired medicines are disposed into. Antibiotics and their metabolites are excreted in the urine and fecal matter of patients under treatment and end up in sewage.

Hospital sewage contains 2 to 10 times more antibiotic-resistant bacteria than domestic wastewater, a phenomenon which contributes to the emergence and propagation of pathogens such as MRSA (Methicillin-Resistant Staphylococcus Aureus) (Alvim-Ferraz & Afonso, 2020). The effects can also be detected if expired medicines find their way to the sewer system.

The medicines reach the environment in various ways such as inadequate disposal in the sink or toilet, household waste, excretion from the human body as metabolites or even the base compound, urination/defecation, and by washing them off the skin creams and ointments. Due to the fact that sewerage systems are not properly equipped to eliminate medicines and their compounds in an efficient way, they can be released in water courses and then get into the drinking water supply system (Karthikeyan & Meyer, 2006).

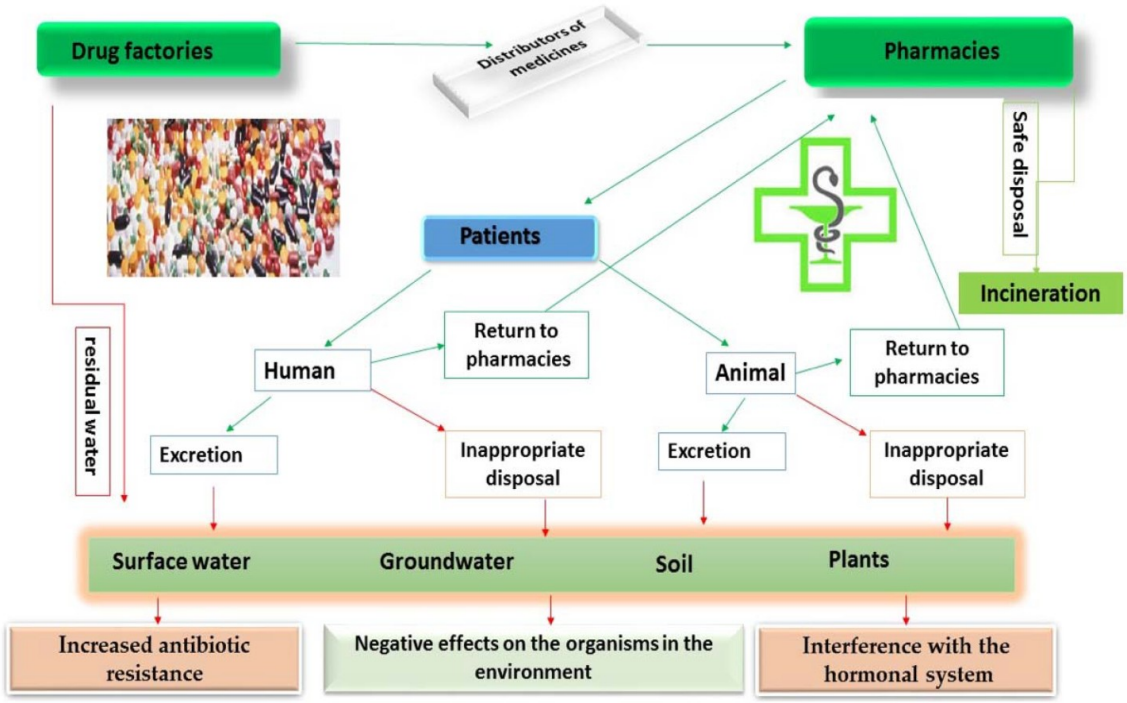

Figure 4: Expired medicines effects

2.4.4 Air pollution

Incineration, as a preferred choice disposing expired medicine, has similar merits and demerits as with the incineration of municipal waste (Stackelberg et al., 2006). Some of the merits include significant reduction in volume and size including little processing time for treatment of the waste while the demerits include air pollution risks. Sub-standard incineration results in the release of toxic chemicals into the environment capable of travelling long distances in the air before eventually depositing to earth (Sanchez-Medina et al., 2011). At MPH this method is being used of a low temperature incinerator that enhances air pollution.

The burning of waste materials which is adopted in many countries including Zimbabwe is not a completely environmentally friendly method. Most expired medicines are

organic substances requiring sufficient oxygen, time, and temperature for ultimate incineration. Thus, burning of expired medicines at low temperatures in open dumps is environmentally unfavourable and produces toxic air pollutants for example aromatic compounds because many expired medicines contains halogens in their respective structure. Dietary supplements for example, also contain heavy metals such as iron, zinc, manganese, selenium, and molybdenum which do not incinerate easily. According to the U.S. National Academy of Science (2000) the potential risks to human health that might result from the emission of pollutants during the incineration process.

2.5 Root causes for delaying to dispose expired medicines

2.5.1 Absence of a high temperature incineration

In Zimbabwe the main type of disposal of expired medicines is incineration with all district hospitals provided with an incinerator within its premises. According to Mangizvo & Chinamasa (2003) in a study on solid waste management in Kwekwe handling of expired medicines is presenting a number of environmental challenges in both Zimbabwe's urban and rural centers. At MPH an incinerator is such equipment needed for disposal of expired medicines, however there is a coal burner incinerator with low capacity of incineration. Currently the incinerator is not functioning and at times it runs out of coal. This then hinders the rapid disposal of expired medicines.

Medicines are ideally disposed of by high temperature (above 1,200ºC) incineration. Such incineration facilities should be equipped with adequate emission control. These are expensive to procure with Zimbabwe relying on at Hwange Colliery Company, Chipinge Saw mills, Bulawayo Nat pharm and Harare Bronte for the disposal of

dangerous medicines. The majority of districts and provincial hospitals have incinerators with very low temperatures not exceeding the required temperatures (Ahmed & Mushtaq, 2013).

In many African countries there are no high temperature incinerators at public institutions with Zimbabwe included using private institutions for the disposal of expired medicines. High temperature incinerators have two-chamber incinerators designed to handle more than 1% halogenated compounds. Such incinerators meet strict emission control standards, such as those published by World health organization. The unavailability of a high temperature incinerator in Masvingo Province impacts on untimely disposal of expired medicines.

2.5.2 Unavailability of an engineered landfill

Landfill means to place waste directly into a land disposal site without prior treatment. Landfill is the oldest and the most widely practiced method of disposing of solid waste. Properly constructed and operated engineered landfill sites offer a relatively safe disposal route for municipal solid wastes, including expired medicines. The top priority is protection of the aquifer. According to Bataduwaarachchi & Weeraratne (2016) an appropriate landfill consists of an evacuated pit isolated from watercourses and above the water table. Each day's solid waste is compacted and covered with soil to maintain sanitary conditions.

MPH is supposed to use the landfill in the council area however, Masvingo city council has an engineered landfill of which when expired medicines are dumped there in the open, uncontrolled dumps with insufficient isolation from the aquifer or other

watercourses can lead to pollution on both air and water pollution. This further delays the disposal of the expired medicines at any given time.

The use of landfills remains the most popular method for disposing clinical waste in both developed and developing countries. Al-Shareef et al.(2016) makes a distinction between controlled landfills and sanitary landfills. According to the authors, a controlled landfill is a restricted land disposal facility sited according to hydrological conditions. They should be basic record keeping of waste disposal and when the landfill is full, it is ultimately covered with vegetation. A sanitary landfill on the other hand is an engineered depression built within the ground with special attention given to geology, hydrology and social characteristics of the area.

2.5.3 Expired Medicines handing and management

In areas requiring waste storage before transportation, storage is done haphazardly exposing a threat to handlers and open trucks are used in transportation of waste. An example of type of waste normally ferried in open trucks is the pharmacy expired waste which in Matabeleland North Province is disposed of at Hwange Colliery incinerator at very high temperatures (Ngole, 2017). The World Health Organization has always argued that proper management of expired medicines is a problem in most developing countries, especially in those countries where municipal solid waste is not managed properly.

2.5.4 Shortage of pharmacy Staff

The acute shortage of pharmacists in our hospitals in Zimbabwe and the ever increasing inventory of medical stores due to introduction of newer medicines and their

variants/combinations, have resulted in a situation where it is extremely difficult to maintain medical stores manually. This leads to a large number of medicines which are unused which eventually expire before use (Mirelles, 2007). At MPH currently there is one pharmacist who serves the whole hospital instead of more than five recommended.

In addition, due to communication gaps between the pharmacy and clinicians, a large variety of medicines, both generic and branded, are prescribed with wide variations in consumption. This frequently leads to stock outs of some essential medicines with some other medicines becoming slow moving and then eventually expiring. The communication gap enhanced by the overburdened pharmacist takes away the time that pharmacist needs to prepare for drug disposal. Ahmed & Mushtaq (2013) also realized that this leads to a financial loss to the hospital and decreases both patient and clinician satisfaction.

2.5.5 Poor Inventory system

In any large hospitals most of the budgetary outlay excluding salaries of staff, is spent in the procurement of medicines. MPH is a tertiary care hospital with a large inventory of medicines and consumable items. Even in today's high technology world, such a large inventory is being managed manually at most similar hospitals in government sector including MPH. This makes it very difficult and time consuming to obtain reliable data about consumption patterns, submitting of timely demands for procurement, shelf life of medicines, slow moving, fast moving and overstocked medicines and other such data for medical stores inventory management.

In addition, there is lack of infrastructure for safe stocking of medicines and other consumables, these are usually seen by the way the store rooms are scattered across the hospital. (Abahussain et al., 2012) argues that it is unrealistic for an expert to keep watch on the medical stores infrastructure in the absence of a systems driven approach. This often leads to underutilization of other rooms which could be used for the same purpose

Thus, there is need to automate the inventory management system up to standard. Any such system must not be complicated; rather it should be user friendly, so that it is effectively used. As most government hospitals have a transferable staff population, these systems should have a common platform by utilizing ordinary computers. If the computerized system is complicated it will not be utilized properly.

2.5.6 Administration issues

Facilities ought to dispose at least twice per year but in 2021 the Herald newspaper noted that some institutions were keeping expired medicines for more than 2 decades despite having received permission to destroy the expired medicines. Section 90 of the Public Procurement and Disposal of Public assets of Zimbabwe requires all obsolete and expired medicines in Zimbabwe to be disposed as soon as they expiry. At MPH expired medicines can spend 20 years without being disposed because the hospital has no therapeutic committee to ensure that disposal is being done in time. Mwita et al. (2019) said most facilities fail to dispose unfit medicines because there are no standard protocols guiding the timing and frequency with which these activities should be done.

2.6 Related Studies

In South Africa, through its Department of Environmental Affairs (DEA) has been a frontrunner in coming up with waste management procedures that are inclusive of doing appropriate research studies on the subject matter on a national level. That being said by Mirelles (2017) attests that the issues raised in the policy documents are pointers to a much bigger problem that is affecting the country on a national and institutional level. The issues of medical waste management and poor waste management practices have been identified as an issue of concern. Ross-Durow el al. (2013) further points out the causes of poor waste management as being attributed to poor infrastructure, lack of training in the disposal of the medical waste and poor budget allocation to the matter.

Health Professional Council of South Africa (HPCSA) came up with a well detailed and informed healthcare risk waste (HCRW) management guideline document that provides a full description of HCRW and categorized the waste into the various classifications. The document further sheds lights on the downstream implications of the mismanagement of the waste and it clearly spells out the roles and responsibilities of the each health care worker in the management and disposal of medical waste (Ayele & Mamu, 2018).

Ferreira & Veiga (2003) have noted with interest that Ethiopia and Kenya do not have national policy guidelines that are targeted at the regulation of the safe disposal of unused medicines. Nonetheless Ghana has developed programs for the disposal of medicines, under the programme title disposal of unused medicine programme (DUMP). This programme has had a resounding success in the management of unused medicines

in its health institutions. Furthermore, this programme is cognisant of the adverse impacts of not doing a proper job to the disposal of unused medicines to the environment .

Most countries in Africa have very low budget allocations to invest in proper disposal methods and technologies (Bettington et al., 2018). The World Health Organization established international guidelines for the disposal of unused, unwanted and expired pharmaceutical waste and medicines during and after emergencies. This was due to taking note of the increase in natural disasters and conflicts between countries, humanitarian efforts meant that large quantities of unwanted pharmaceuticals arrived past or near their expiration. Moreover, the introduction of this documentation developed by the WHO meant that unused pharmaceutical waste could be sufficiently dealt with and allowed countries to dispose of their waste appropriately and efficiently.

In 1996 Botswana came up with a code of on how to deal with medical waste efficiently. However, research studies conducted amongst the users of the document indicated that the users of the code were unaware that this policy was already in force (Ross-Durow et al., 2013).

Currently in South Africa, there have policies and legal frameworks and statutory instruments that guide them in the disposal of medical waste. This medical waste has been put into various classifications that enable the institutions responsible to appropriately dispose the medical waste. All this is done taking into consideration the impacts of not properly disposing medical waste can affect the environment and the humans (Hodes, 2019).

The Department of Health in South Africa made an issuance on policy on medical waste management. In this policy it outlines the storage of medical waste before removal and how it is to be handled and removed by the responsible authorities (Hodes, 2019). More so the policy sheds more light on the staff composition of the disposal team, which is inclusive of a pharmacist who has knowledge of the waste that is being disposed.

The policy document emphasizes the use of green spec bins are ought to be provided by the waste company (Kato at el., 2019). The amount of medical waste to be disposed should be recorded by the pharmacist and to have a detailed knowledge of the contents of it thereof. In addition the procedures outlined in the policy only covers medical waste and are not inclusive of radioactive waste substances.

Ansari et al. (2019) noted that South Africa makes use of incinerators for various reasons. Namely the mining sector makes use of incinerators in the smelting and separation of metals. However, not all of these incinerators have the capability to handle and incinerate health care waste, which requires an incinerator which has about 600°C–1000°C.

What's more, an exploration concentrate on that took a gander at seven clinics in Lagos, Nigeria observed that the Lagos squander the executive's authority (LWMA) had acquainted mediation programs with guarantee congruity and safe waste administration through its cycles. This equivalent review presumed that there were no approaches or rules in any of the seven clinics surveyed for treating medical services squander, in spite of the fact that it found that each of the seven clinics for the most part isolated their

general and clinical waste, with medical services laborers approaching individual defensive gear (PPE).

Private emergency clinics and state clinics are not fundamentally unique with respect to squander the executives. Numerous medical services office laborers are inadequately prepared on arrangements for disposing of various groupings of waste. Various examinations have recommended change has been carried out in Nigeria, and more medical services laborers in the public area have gone to squander the board instructional courses on the most proficient method to accurately deal with medical services squander than have done in the private area, and they were more mindful of the waste administration plot. Moreover, a waste administration board of trustees was laid out however doesn't exist in the public area, and a couple have been built in private emergency clinics and medical care offices (Chartier, 2016).

In Egypt, the issue of unsafe clinical waste the executives has obtained a rising interest over the most recent twenty years, as the attention to their genuine wellbeing impacts has expanded on both public and administrative levels (Shouman et al., 2013). As indicated by WHO (2015) the typical measure of waste per bed each day is assessed to go from 0.7 to 1.7 kg bed−1 in Egypt. Information got from the Ministry of Health in Egypt shows that the extent of dangerous clinical waste is in the scope of 25%-30% (Bujak et al., 2019). This huge rate might be because of improper medical care squander isolation. In Egypt, the innovations applied for clinical waste treatment are cremation, steam cleansing and compound disinfection. Cremation addresses the most well-known technique applied in Egypt (Shouman et al., 2013).

Polluted conditions increment the gamble of transmission of medical care related diseases. One review showed the increment adherence to waste management policy at medical care office in Egypt (Mirelles, 2020). That concentrate on obviously shown the high gamble of hepatitis contamination among labourers dealing with, particularly clinical waste (El-Gilany et al., 2013). Thusly, security measures, including proper PPE, should be accessible for those labourers notwithstanding instructive and preparing programs to go about their business in a protected work space.

In Morocco, there is no data at present with respect to the amounts of a wide range of clinical waste really gathered and treated in the country. In addition, little data is accessible in regards to age taking care of and removal of waste (Mbarki et al., 2013). The yearly creation of clinical waste from the 142 public clinics is assessed at 21,000 tons year−1, including 6000 tons of irresistible clinical waste. Clinical waste handling actually requires improvement. Despite the fact that numerous clinics are furnished with an incinerator, a large portion of these don't work or are old. It is assessed that the vast majority of this waste is put away in open landfills, which is a not kidding issue, since it isn't just a wellspring of natural contamination yet in addition a possible hotspot for the spread of irresistible sicknesses (Mackridge & Marriott, 2017).

Nigeria at present doesn't have an organized medical services squander the board framework, particularly in the space of isolation, assortment, capacity, therapy and removal (Uchechukwu et al., 2017). The degree of mindfulness among medical services labourers in regards to medical services squander has not been sufficiently reported in Nigeria (Ruhoy& Daughton, 2008). Numerous wellbeing offices in Nigeria don't have a

particular strategy for their waste administration (Awodele et al., 2016). In Cameroon, clinical waste administration is a not kidding concern, and consequently there is need for an assessment of current administration practices to empower making arrangements for better waste administration (Aitken et al., 2017).

In Tunisia, the on-going amount of clinical waste is assessed at 18,000 tons year−1, including 8000 tons of dangerous waste. The partition of waste tends to not be rehearsed, and dangerous waste is blended in with general civil waste, winding up in open-field dumps. Sudden ignition and lacking cremation rehearses are answerable for 90% of the aggregate sum of dioxins and furans discharged in the country (Cinar et al., 2008). In Libya, little data is accessible in regards to age, taking care of and removal of clinical waste. This reality frustrates the turn of events and execution of clinic squander the executives plans. (Sawalem et al., 2009) observed that the normal waste age rate was viewed as 1.3 kg (patient-day) −1, included 72% general medical care squander non-risk and 28% dangerous waste. Besides, the medical clinics had neither rule for isolated assortment and order nor techniques for capacity and removal of produced squander.

This lack shows the requirement for a sufficient clinical waste administration methodology to improve and control what is going on. In Sudan, the assessed typical created pace of medical services waste went from 0.38 to 0.87 kg (bed-day). The investigation by Bettington et al. (2018) showed that the administration of medical care waste is wasteful, as all waste are blended in with home domestic waste and discarded inappropriately. The review ascribed this to many reasons, including absence of waste isolation at the source, absence of approaches, disappointment of arranging, insufficient

preparation, absence of attention to the risky idea of such sorts of waste, feeble framework and an absence of appropriate treatment advancements.

2.7 Chapter Summary

The major challenges on disposal practices of expired and unused medications revealed in the literature review of this research were poor education and low level of awareness on the standard protocols in the management of expired pharmaceuticals, limited documentation on this issue, inadequate law enforcement strategies. Therefore there is a need to enhance and strengthen the policies on disposal practices especially for developing countries. The researcher discovered strategies that can be used to speed up the delay of expired medicines at Masvingo Provincial Hospital. Lastly, the chapter delved on the related studies across the global and regional medical scenes, where the disposal of medical waste is either being instituted properly and or not.

CHAPTER 3: METHODOLOGY

3.1 Introduction

This section discusses the methodology employed in the study. The concept methodology reflects on issues related to the research design and the logic and rationale behind the use of particular data collection, analysis, and interpretation procedures in a research project (Mantri, 2008). This part is therefore about the research design and the various strategies and techniques used to collect data, present, analyses and interpret results.

3.2 The Research design

The research design used in this study was quantitative research design with non-experimental correlational design. Most importantly, primary data was obtained through the structured questionnaires administered to Masvingo Provincial Hospital staff (doctors, nurses and nurse aids and cleaners). Responses were evaluated on a Likert scale of 1-5, where 1- means Strongly disagree; 2 means Disagree; 3 means Neutral; 4 means Agree and 5 means Strongly agree. A survey was also conducted with the Environmental Management Agency (EMA) agency to obtain information about the disposal of expired medicine and other related effects of the disposal to the environment, human life and wildlife.

The cross-sectional design was used to investigate the causal effect between independent variables and the dependent variable. In particular, the Chi-square test and the regression analysis were used to investigate relationships. Information obtained from

the survey with EMA agency was used to ascertain the impact of disposed expired medicines on human life and the environment. Descriptive statistics were used to describe the characteristics of the real data such as the mean, mode, standard deviation and correlations.

3.3 Study area

This research was carried out in Masvingo Province, which is predominantly a rural province with an estimated population of 1,8million people. It is composed of 7 districts namely; Bikita, Chiredzi, Chivi, Gutu, Masvingo, Mwenezi and Zaka. Masvingo Provincial Hospital is a tertiary referral hospital that provides tertiary care. It has a full complement of services including pediatrics, obstetrics, general medicines, gynecology and branches of surgery. The medicines that these specialists require are different from the medicines in district hospitals. Some medicines expire or are unused due the level of care offered by these doctors which require special management.

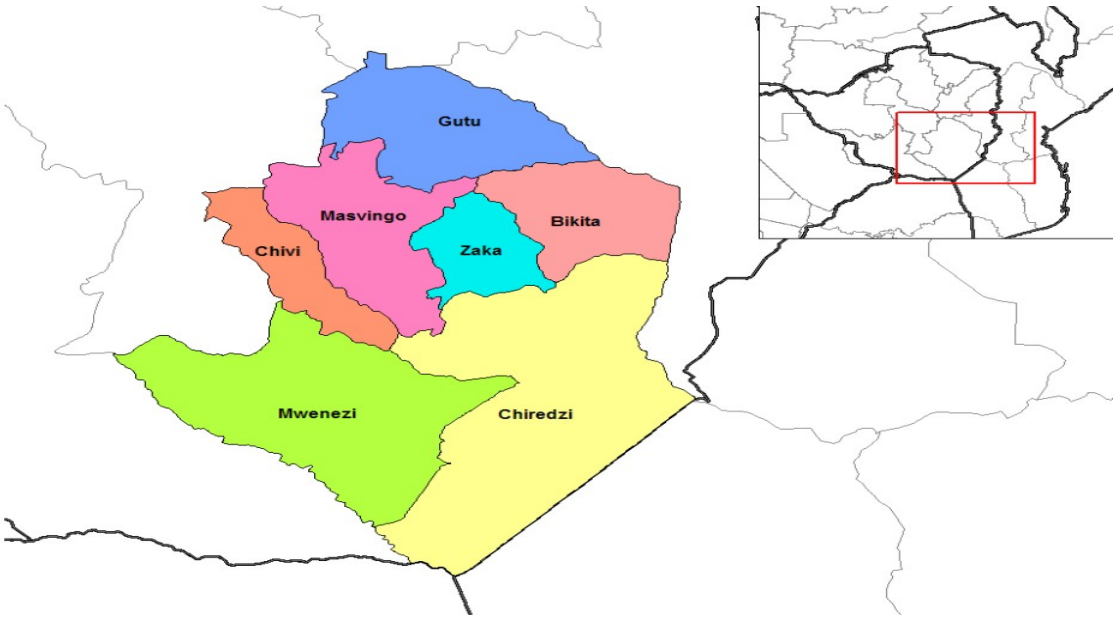

Figure 5: Masvingo District Map

3.4 Study Population

In this research the target population is the Masvingo Provincial Hospital staff which include,Pharmacist, Pharmacy technicians, clinicians and EMA staff in charge of solid waste disposal was also part of the study.

3.4.1 Sampling technique

Purposive sampling was used since the researcher knew the people who were directly involved in the disposal of expired medicines. Simple random sampling of nurses involved in ordering medicines at the hospitals was done. The nurses were allocated numbers and a simple number generator was used to select a random sample.

3.4.2 **Sample size**

The study sample was calculated using a single population proportion formula (Kothari, 2004). In the absence of previous prevalence data, it is advised to take 50% to get a

maximum sample size, and thus the proportion of health workers was assumed to be 50 % (Kothari, 2004).

Number of health workers to be sampled

(160÷4000) × 243 = 11 the sample size (n) was calculated using the formula : $n = [z^2 * p * (1 - p) / e^2] / [1 + (z^2 * p * (1 - p) / e^2 * N)]$

Where: z = 2.576 for a confidence level (α) of 99%,

p = proportion (expressed as a decimal), N = population size, e = margin of error.

z = 2.576, p = 0.5, N = 4000, e = 0.1

$n = [2.576^2 * 0.5 * (1 - 0.5) / 0.1^2] / [1 + (2.576^2 * 0.5 * (1 - 0.5) / 0.1^2 * 4000)]$

n = 98.8944 / 1.0415 = 99.8

n = 100

Considering the homogeneity of the health workers, taking a design effect of 1.2 and a 10% non-responsive rate, the final sample size was 100 health workers.

3.5 Data collection Instruments

Registers, minutes and documents from the pharmacist on the expired medicines that have been disposed were view to check on the dates, reasons for expiring, types of medicines expiring and disposal methods that were used. A questionnaire was used to collect and record data or information from the nurses, doctors and other hospital staff

about waste management practices and their potential effects on the environment and health of people.

Frequency of waste disposal and points of waste generation was addressed by this research tool. The questionnaire was used to address issues on type of expired medicines which are usually discarded, the effects that have been felt as a result of low incineration burning, and waste management of expired medicines practices at the hospital. A set of structured questionnaire (Appendix 3) for the health workers was constructed before the field visit. Both open ended and closed ended questions were included in the questionnaire.

3.6 Inclusion and Exclusion criteria

3.6.1 Inclusion criteria

The study included only clinicians' pharmacy staff and hospital administrators involved with disposal of expired medicines working for Masvingo Provincial Hospital and key informative directly involved with disposal of solid waste management from hospitals and EMA.

3.6.2 Exclusion criteria

The study excluded clinicians' pharmacy staff and hospital administrators involved with disposal of expired medicines for Masvingo Provincial Hospital and key informative not involved with disposal of solid waste management from hospitals from and EMA.

3.7 Data Collection Procedure

Quantitative data was collected using an in depth interview by trained data collectors. A checklist and questionnaire will be used for collecting data at the facility. The researcher assessed the layout and storage practice of medications at the store and additional information on number and types of medications expired, reasons for expiring, and related information was be collected. Interviews will be conducted with stores personal, pharmacist, pharmacy technician of Masvingo Provincial Hospital administration officers and clinicians.

3.8 Pretesting of tools

The data collection tools were pre-tested at Ndanga District Hospital which was not a site included in study. Issues were raised concerning the research instrument and the necessary adjustments were made before the actual interview took place.

3.9 Analysis and organization of data

For the research study the researcher made use of data analysis soft wares SPSS V20 and STATA V7. The combination of these soft wares ensured that the researcher captures all the relevant information pertain the research study that would have been presented in the questionnaires. For the presentation of the data, frequency tables, graphs and pictorial representations of the data were made into use, thereby the data was being presented in a clear and succinct manner.

In addition, descriptive statistics was used in the analysis of the data. For variables such as age and gender, the mean and Standard Deviation was computed and an analysis was made out from it. Confidence intervals were taken into consideration to determine the

delay cause in the different independent variables under study. The regression coefficients β show the effect of each variable on the delay to dispose expired medicines.

The Multivariate analysis was used in the analysis of the independent variables associated with the delay in the disposal of expired medicines. The researcher used the ordinary Cronbach's alpha indices. Fourthly, the researcher performed the Chi-square test to test for randomness in the variables as part of our assumption that variables in question should be a random variable.

3.10 Ethical Considerations

The research study was submitted to the ethics committee for Africa University known as the Africa University Research Ethics Committee (AUREC), for approval and ethical clearance. The study took consideration of the following research ethical guidelines

Voluntary and Informed Consent: According to Arminger & Christian (2003) voluntary and informed consent is whereby an individual, voluntarily and willingly takes part in a research with full knowledge of the scope of the research study and its intended objective, without any coercion of any sorts. The research study managed to attain this, as its participants were able to participate at their volition.

Beneficence: The concept of beneficence is hinged on the aspect of doing well (Ayele & Mamu, 2018). This means that the researcher has to ensure that the participant knows the purpose of the study and its intended benefits that will come out of it. The examination of the benefits ensure that the research participant is fully aware of the

research study thus they will be able to be part of it, knowing that there are contributing to the good of the research.

Non-Maleficence: This aspect looks at the potential harm that one can suffer during participation in the research study. It is the duty of the researcher to clearly outline the potential risks of harm to the participant before participating in the research (Oaks et al., 2004). That being said the types of harm should thus then be made contextual to the type of research being undertaken, in this research the harm might be in form of psychological harm. The researcher ensured that the no harm befell the participants in any way.

Deception: It is important to shed light to the ethos and objectives of the research study to the participants, by telling them what is expected of them in great detail where possible. No half-truths should be said, as they will be tantamount to deception. Deception usually comes across if the researcher is biased towards the research. In the case of this research the researcher was not biased in their research (De Vries et al., 2006).

III.11 Chapter Summary

The chapter looked at how the research study is to be conducted, which is by means of administering a detailed questionnaire. The questionnaire had several questions that were carefully designed for the benefit of its respondents who are inclusive of health care workers and pharmacists. Furthermore, the chapter looked at the research design which is a quantitative research study. The chapter also looked at the ethical

considerations that were used in the research; some of these are deception, voluntary and informed consent and lastly beneficence.

CHAPTER 4 DATA PRESENTATION, ANALYSIS AND INTERPRETATION

4.1 Introduction

In this chapter, the researcher presents the results of the study. Data was collected in chapter 3 and statistical analysis was done using STATA version 7 and SPSS. The researcher presents the results of the study. Descriptive statistics on socio-demographic characteristics of the study participants will be presented. The researcher also presents the results of analytical statistics done in form of tables and graphs. Results will also be interpreted to give meaning to the outcomes of the statistical analyses.

Firstly descriptive statistics were the original data described by computing the mean, standard deviation, skewness and kurtosis was performed. Secondly, the researcher performed correlation analysis to explore the existence of relationships between variables. At the end a reliability analysis on variables to find out whether the items constructing a variable were consistent and reliable. Regression analysis was performed on pairs of variables independent and dependent variables. The idea was to investigate the kind and depth of effect/impact an independent variable has on the dependent variable. Ideally, the researcher discovered seven variables of interest (see Figure 1). Recall from our adopted framework in literature review, the illustrated interrelationship in figure before the researcher carried out the descriptive statistics of variable.

4.2 Data Presentation and Analysis

The researcher presented findings in form of graphs, figures and tables. Specific investigations into the root cause of the delay of disposal of expired medicines. The researcher found also contributing control variables which come from background information (gender, age and occupation).

4.3 Discussion and Interpretation

4.3.1 Demographic Data

A total of 100 respondents were recruited into this study and majority was (66%) females. The majority of the respondents were in the age group above 48 years. Most of the respondents were RGN 85(85%) and only 2(2%) were medical doctors and (2%) pharmacists. The most mentioned expired medicine by 97% respondents indicated prescription medicines and only 1(1%) mentioned DDA. The majority of the respondents indicated that the expired medicine delayed disposal for more than one year 89(89%) and only 19(19%) indicated more than 5 years on delay of expired medicine. Eighty six (86%) concurred that there is delay on the disposal of expired medicine at Masvingo Provincial Hospital.

Table 1: Gender of Participants

Gender	Frequency	Percent
Female	68	68%
Male	32	32%

Table 2: Distribution of age and occupation of respondents

N=100

		Frequency	Percent%
Age			
	18-25 years	19	19
	26-33 years	5	5
	34-41 years	14	14
	42-49	19	19
	50 years +	42	43
Occupation			
	Pharmacist	2	3
	Pharmacy technician	2	2
	Doctor	4	4
	Nurse	87	87
	Nurse aid	5	4

The researcher presented descriptive demographic data in Tables 1-2 as indicated above. It shows that most people working at the hospital were female, constituting at least *68%* of all participants. Among these participants, most of them are qualified nurses with a composition of *87%*. Out of 100 participants at this hospital, only two Pharmacists and 3 Pharmacy technicians participated. Generally, there are few doctors at the hospital, only 4 participated.

Table 3: Socio-Demographic Characteristic of Respondents

Demographic Characteristic		N=100 n (%)
Gender	Male	34(34)
	Female	66(66)
Age Group	18-25	5(5)
	26-33	4(4)
	34-40	10(10)
	41-47	22(22)
	48+	59(59)
Occupation	RGN/PCN	85(85)
	Medical Doctor	2(2)
	Pharmacist	2(2)
	Pharm Technician	3(3)
	PCN	4(4)
	Nurse Aid	4(4)
Which class of Medicine expire most	DDA	1(1)
	Prescription	97(97)
	Over the Counter	2(2)
Time kept Expired Medicine	One month	0(0)
	One Year	89(89)
	More than 5 years	19(19)

Is there delay on Disposal of expired Medicines	No	14(14)
	Yes	86(86)

Most of the medicines that expired were prescription medicine (57%) and over the counter medicines were at 25%. Sixty three (63%) of the expired medicine were disposed of after one year period and only 3% of the expired medicine were disposed of after 5 years.

Table 4 Socio-Demographic Characteristic of Respondents		Yes n =86	No n=14	Total n=100	p-value	COR(95%CI)
Demographic Characteristic of Respondents						
		N (%)	N (%)	N (%)		
Gender	Male	30(35)	4(12)	34(34)		Ref
	Female	56(65)	10(15)	66(66)	0.6	1.5(0.4-4.6)
Age Group	18-25	4(5)	1(7)	5(5)		Ref
	26-33	3(4)	1(7)	4(4)		
	34-40	8(9)	2(14)	10(10)		
	41-47	16(19)	6(43)	22(22)		
	48+	55(64)	4(29)	59(59)	0.1	1.5(0.9-2.2)
	RGN/PCN	74(86)	11(79)	85(85)	0.5	0.9(0.6-1.3)
	Medical Doctor	2(2)	0(0)	2(2)		
Occupation	Pharmacist	1(1)	1(7)	2(2)		Ref

	Pharm Technician	3(4)	0(0)	3(3)		
	PCN	2(2)	2(14)	4(4)		
	Nurse Aid	4(5)	0(0)	4(4)		
Which class of Medicine expire most	DDA	1(1)	0(0)	1(1)		
	Prescription	84(98)	13(13)	97(97)	0.2	0.2(0.1-2.3)
	Over the Counter	1(1)	1(7)	2(2)	-	-
Time kept Expired Medicine	1 year	71(83)	10(12)	81(81)	0.331	0.5(0.1-1.91)
	More than 5	15(17)	4(21)	19(19)	-	Ref
Storage of expired medicine	With unexpired	74(86)	12(14)	86(86)	0.1*	2.8(1.0-7.8)
	Separate room	9(10)	2(14)	11(11)	-	Ref
	Pharmacy Store	3(4)	0(0)	3(3)	-	-

*Significant at p<0.05, Ref=Reference Group, COR-Crude Odds Ratio

4.3.2 Bivariate Logistic Regression Analysis

Bivariate analysis was conducted to identify factors associated with delay on disposal of expired medicines at Masvingo General Hospital. Most of the demographic characteristics which were gender, age group, and occupation as RGN/PCN [COR: 0.9(95%CI: 0.61-1.30), p=0.5] were not associated with delay on disposal of expired medicine. The majority (97%) of the respondents indicated that most of the expired medicines were prescription although it was not statistically significant when compared with the delay of disposal of expired medicine at 0.05 levels. The expired medicines which were being stored with unexpired medicines were 2.8 times more likely to delay disposal as compared to those expired medicines stored in a separate room [COR:2.8(95% CI:1.0-7.8),p=0.1].

Table 5 Multivariate logistic Regression for delay in disposal of expired medicine

	AOR	**Std. Err**	**|z|**	**p>|z|**	**(95% CI) for (AOR)**
Occupation	-0.3	0.2	-1.2	0.2	(-0.8-0.2)
Kept with Unexpired	1.9	0.8	2.2	0.0*	(1.2-3.6)
Late Disposal	-2.7	1.3	-2.0	0.0*	(-5.3- -0.1)
Attend therapeutic committee	-2.0	1.0	-1.9	0.0*	(-4.1-0.1)
Harmful to Aquatic	-1.5	1.1	-1.2	0.2	(-3.7-0.8)
Period of expiry	-1.0	0.8	-1.2	0.2	(-2.6-0.6)
Constant	22.2	8.6	2.5	0.0	5.4-39.2

|z| is the regression coefficient divided by standard error.

p value is used in hypothesis testing to help you support or reject the null hypothesis. The p value is the evidence against a null hypothesis. The smaller the p-value, the stronger the evidence that you should reject the null hypothesis

4.3.3 Multivariate logistic Regression for delay in disposal of expired medicine

Stepwise multivariate analysis was conducted to estimate the measures of association while controlling for confounding. All variables that were significant at 0.25 level (p-Value <0.25 in the Bivariate were included in the model.

The following were independent factors which were related to the delay in disposal of the expired medicine at Masvingo Hospital, keeping expired medicines in the same room with unexpired medicines was 1.9 times more likely to delay disposal of expired medicines [AOR:1.9 (95% CI: (1.3-3.5), p=0.0], those who indicated that there is delay in expired medicine disposal had 130% reduced odds on delay of disposal of expired medicine [AOR:-2.7(95%CI:-5.32—0.05), p=0.04]. Pharmacists who attended therapeutic committee meeting were 100% less likely to delay the disposal of expired medicine [AOR:-2.0(95% CI: -4.1-0.1), p=0.1).

4.3.4 Equipment availability variable

Equipment availability as one of the independent variable believed to be the root cause of the delay to dispose expired medicines. Most responses from participants fall below the mean score of 2 (Disagree), that is most of the respondents did not agree with the given statements, except of the respondents who said, “The hospital relies on City

Council landfill to dispose expired medicines". The statement received a score of at least 4 (agree). The skewness coefficients indicate that data is somehow not normally distributed, of which in our case it imposes little or no danger when it comes to regression analysis.

Staff as an independent variable believed to be a root cause of the delay in the disposal of expired medicines at the hospital. The mean score of items indicate that most participants did not agree with the statements. For instance, participants did not agree that there are frequently trained on the dangers of expired medicines to human life and the environment. Staff at the hospital was not much prepared to mitigate the dangers of delaying the disposal of expired medicines.

4.3.5 Staff variable

Table 6: Staff as a root cause of delay in disposal of expired medicines

N=100

	Mean Score	Std. Deviation
Staff at the hospital have adequate information regarding the disposal of expired medicines	1.8	1.0
Staff at the hospital are frequently trained on the dangers of expired medicines	1.6	0.8
Staff at the hospital have normal working time and no	2.8	1.1

excessive overtime		
At the hospital there is adequate pharmacy staff	1.6	0.7

4.3.6 Administrative variable

Administration variables in this study which included the availability of a working routine system for disposal of expired medicines, an effective hospital therapeutic committee, and a computerized system to alert on expired medicines as the independent variables that are believed to cause a delay of the disposal of expired medicines at the hospital. The averages mean score of 1.5 shows that respondents disagreed.

4.3.7 Donations variable

Donation as one of the independent variable presumed to cause a delay on the disposal of expired medicines. Most respondents with at least mean score of 3.5 agreed that most donated medicines expire and the medicines come when about to expire. The majority of the respondents agreed that there is a delay of disposal of expired medicines at Masvingo Provincial Hospital (a mean score of at least a *4.00*).

4.3.8 Delay variable

The impact of expired medicines on human life and the environment was assessed. The impacts are presumed to be influenced by the delay to dispose expired medicines at the

hospital. Most respondents believed that expired medicines are detrimental to human life and the environment when wrongly disposed with an average mean score of 3.1.

Table 7: Delay Bivariate Regression

Variable	Coefficient	p-Value
Work		
Equipment	0.1	0.7
Administration	-0.2	0.1
Staff	0.5	0.0**
Donation	0.1	0.6
Impact	-0.1	0.6
Effect	0.5	0.0**

4.3.9 Work environment variable

On the work environment which is believed to cause a delay to the disposal of expired medicines, It was noted that all questions regarding to work environment constructs scored at most 3 (Neutral) that is most participants did not agree with the statements. The standard deviations were very low with the highest being *1.2.* This indicates that the respondents believe that the work environment did not contribute to the delay of disposal of expired medicine.

4.4 Reliability analysis

On this section the researcher tested the consistency or reliability of scores given by respondents. For a construct to pass the reliability test, it has to score more or equal to *0.7.* The reliability indices for each variable are given in Table 8. From the table, it is clearly indicated that all variables have reliability index of more than 0.7 which is acceptable for further analysis.

Table 8: Reliable Scores

Variable	**Cronbach's alpha**
Work environment	0.7
Equipment	0.8
Staff	0.8
Administration	0.8
Donation	0.8
Impact	0.9

Multivariable logistic Regression analysis was used to investigate the causal effect relationship between the independent variables and the dependent variables. The strength of the relationship was measured by the regression estimates. Table 4 represents the regression estimates that show the significance of the relationships. An estimate or a relationship was significant at < 0.05 *p-value*. The first model investigated the causal effect relationship between the independent variables namely; work environment, equipment, administration, staff and donation against the dependent variable Effect. Note: the variable effect meant 'delay the disposal of expired medicines'. Results

showed that work environment had a positive effect on the delay of disposal of expired medicines (*$F_{(1, 98)}$ =1.7; P-value =0.03; estimates: constant=3.8 with P-value = 0.00; Beta=2,1 with P-value = 0.02*). The researcher developed a regression equation for work environment;

$$Delay = 3.7 + 2.1 * Work(1)$$

In Table above, it is shown that equipment had a negative effect on the delay of disposal of expired medicines (*$F_{(1, 98)}$ =1.1; P-value =0.01; estimates: constant=4.4 with P-value = 0.00; Beta=-3.1 with P-value = 0.01*). The negative effect implied that *1%* increase in the provision of equipment to use, the delay of disposal of expired medicine droped by a certain percentage of time. The regression equation was as follows;

$$Delay = 4.4 - 3.1 * Equipment(2)$$

Administration had a positive effect on the delay of disposal of expired medicines (*$F_{(1, 98)}$ =0.0; P-value =0.029; estimates: constant=4.1 with P-value = 0.00; Beta=3.0 with P-value = 0.029*). The regression equation was as follows;

$$Delay = 4.199 + 3.006 * Administration(3)$$

Staff had negative effect on the delay of disposal of expired medicines (*$F_{(1, 98)}$ =1.1; P-value =0.02; estimates: constant=4.5 with P-value = 0.00; Beta=-2.1 with P-value = 0.02*). The regression equation was as follows;

$$Delay = 4.5 - 2.1 * Staff(4)$$

Donation had a negative effect on the delay of the disposal of expired medicines (*$F_{(1, 98)}$ =0.2; P-value =0.03; estimates: constant=4.3 with P-value = 0.00; Beta=-3.0 with P-value = 0.03*). The regression equation is was follows;

$$Delay = 4.3 - 3.0 * Donation(5)$$

The researcher hypothesized that the relationship between the delay on the disposal of expired medicines and the impact of expired medicines to human life and the environment.

The hypothesis that was tested :

- H_0: The relationship between the delay on the disposal of expired medicines and the impact of expired medicines to human life and the environment.
- H_1: The relationship between the delay on the disposal of expired medicines and the impact of expired medicines to human life and the environment.

4.5 Chapter summary

The researcher tested the hypothesis using regression analysis with results displayed in Table above. (*$F_{(1, 98)}$ =1.2; P-value =0.014; estimates: constant=3.3 with P-value = 0.00; Beta=3.1 with P-value = 0.014*). Results showed that there was an indirect effect of delaying the disposal of expired medicines on the impact of expired medicines on human life and the environment.

CHAPTER 5 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

In this chapter, the researcher gives a summary of the study process and findings and discussing whether study objectives were met by the study findings while giving any conclusions on the root cause of late disposal of expired medicines at Masvingo

Provincial Hospital. The researcher will go on to give recommendations to the policy makers and the organizations lastly, areas for further study will be suggested in this chapter.

5.2 Discussion

5.2.1 Demographics characteristics of the study participants

The researcher discovered that the staff at Masvingo Provincial Hospital comprises 43% of nurses of old age, women in particular. Large population of old age at the Hospital could be a contributing factor to the delay of the disposal of expired medicines since this age is prone to forget much and lack of sophisticated systems to alert them when medicines expire. These findings are the same by Boehringer, (2004) who discoved that staff old aged staff had dificult in using computerised sytem and when they use the manual system the records have to be accuratly written and updated as they can easly forget or misplace information.

Another observation is that only few, two pharmacists to be specific, serve the whole large hospital by issuing medicines. The pharmacy compliment is very small and considering the manual system at the hospital it become very difficult to monitor and do frequent checks on expiring dates

5.2 Root cause analysis

The expiration of medicines at the health facilities is a big concern due to its double burden. It leads to wastage of potentially life-saving drugs and causes unnecessary expenditure on the disposal of those expired medicines. Bhayana et al. (2016) found

this study necessary in his study when he recommended it for further research to have a root cause analysis. He furher urgues that expiration of medicines could ultimately result in disruption of health services delivery and poor quality of health services thus constraining the attainment of universal health

The results revealed that the population is already at risk of threats from environmental pollution and public health due to unsafe disposal of healthcare waste. The researcher failed to reject H_0 and conclude that there is an indirect effect of delaying the disposal of expired medicines on the impact of expired medicines on human life and the environment. The improper disposal of unused medicines is a worldwide concern because of its impact on the environment, economy, and health. This finding is consistent with Bhayana et al. (2016) argues that the delay in the disposal of expired medicines was atributed to hospital conditions and working environment. He further argued that the cause of this day are man made and some are as a result of ignorance.

In this study the absence of a disposal committee within the hospital and lack of incineration facilities were sited as some of the root causes of the delay to dispose expired medicines. This is a contradiction to a study done by Armitage & Christian (2003) were they highted poor comuinication between the departments with the administration staff as the root cause. The concerned deparment as the pharmacy is supposed to work closely with the administration and communicate on medicines to be disposed.

5.2.2 Work environment variable

Generally, there is an indication that at the hospital the rooms used to keep expired medicines are not ideal. The dangerous medicines cabinet is housed in the main pharmacy were the other medicines which have not expired are. This is also the same room used for paper work by the pharmacy staff and chemical reactions are a likely to occure since the medicines take more than five years without being disposed. These findings are the same from a study which was done by Kristina, (2018) where a hospital had the office of the pharmacist inside a store room were expired medicines were kept. The pharmacist reacted to the medicines duu to the change in the chemical composition of the medication, which posed a threat to the breathing patterns. In some cases, bacteria may grow in the medication.

Working in such an environment which is injurous to the health of a person is prohibitaed in accordance to the Public health act chapter 15.17. It is a life threating issue considering the unknown chemical compositions of the different medicines that will be inhaled from time to time. Such is the case at Masvingo Provincial Hospital.

During the time when the researcher was going through the record and minutes the store room was also observed. It was observed that medicines which are not the dangerous medicines share the store room with those that are not expired in the main pharmacy. These findings are similar from a study done by Mani & Thawani (2019) when the researcher found out that inadequate working environment in the pharmacy attributes to the sharing of the same space for expired and non-expired medicines.

5.2.3 Equipment variable

The incinerator is one of the equipment to disposed expired medicines. However a high temperature incinerator is require for the complete destruction of the medicines. From the observations the hospital has a coal burner which is not ideal for the destructions. Similar findings were reported by a study conducted at a tertiary hospital in Dar Es Salaam Tanzania. The local for Masvingo authority does not also have an engineered land fill to dispose the medicines. This contributes to the delay of the disposal of expired medicines as the hospital will need to look for alternative sources. From the records the medicines are now being disposed at Chimanini at a private institution which has an incinerator.(Stackelberg el al., 2006) in his study found out high temparature incinenerators were costly hence the challenge for most hospitals to procure such.

This is however different for the study done by Daughton (2003) when he lighted that the absence on a high temperature incinerator should not hinder the quick disposal of expired medicines. Some liquid pharmaceuticals such as syrups and intravenous (IV) fluids, can be diluted with water and flushed into the sewers in small quantities over a periodof time without serious public health or environmental affect. Fast flowing watercourses may likewise be used to flush small quantities of well-diluted liquid pharmaceuticals or antiseptics. The assistance of a hydrogeologist or sanitary engineer may be required in situations where sewers are in disrepair or have been war damaged. He also noted that as the construction of a hospital is being done a incnerator is one major area to be looked into as a method of clinical waste disposal.

5.2.4 Administration variable

At Masvingo Provincial Hospital just like other hospital in Zimbabwe the disposal of expired medicines is administered under the administration department. The monitoring of this function is often neglected as seen from the results. The hospital had no therapeutic committee to sit and move the agenda of disposal of expired medicines. Generally, it is deduced that the system used to monitor on medicines until they expire is not adequate. According to this study, majority of the participants sited administration issues as a challege. (Ahmed & Mustaq, 2003) noted that most of the hospital administrator were practicing in appropriate methods of disposing the medicines cause they were not aware of the consequences to the environment, the lack of proper guidance for safe disposal rendered them vulnerable for such practices. Most of the hospital administrators are not clinicians hence the disposal of expired medicines is not taken as an urgent matter.

At Masvingo Provincial Hospital expired medicines which are in the category of dangerous medicines took twenty five years before they could be collected or sent for distruction. This is because it was now state proporty and an audit had to be undertaken before medicines control authority could come to collected the medicines. This is another cause found to be delaying disposal of medicines.These findings are the same as in a study by Bettington el al. (2018) where few countries were found to have adequate administrative provisions for writing off expired medicines pharmaceutical stock. In the public sector drugs are the property of the state, for which strict accounting procedures are necessary. If procedures exist at all, they tend to be complicated and time-

consuming, and in practice the disposal ofexpired stock is difficult. This applies both to drugs that are procured through the normal channels and to donated drugs.

5.2.5 Donation variable

There is a general indication that most of the medicines at the hospital are donated from other institutions, inside and outside the country. Furthermore, most of the participants concur with the statement which says that most of donated medicines come in when the date of expiry is near. In most of the African countries the majority of the medicines in the hospitals are donated. This donation syndrome the African countries have makes it very difficult to reject such there by overlooking the date of expiration. A similar study conducted in King Khalid University Hospital and King Abdul-Aziz Medical City in Riyadh, Saudi Arabia also found out that donated medicines are the ones that are quick to expire (Sanchez-Medina et al., 2011).

Inappropriate donations may be minimized by donors adhering to the hospital donations policy for medicines donations is one such document missing at Masvingo Provincial Hospital to mitigate the donation of expired medicines. The key principle should be that medicines donated should address the expressed needs of the recipients and that the date of expiration on arrival shall be no less than one year, unless there is clear evidence from the recipients that they have the logistic and managerial capacity to store and distribute shorter dated medicines efficiently. Mwita et al. (2019) in his study found the same motion that the absence of a hospital donations policy which can be reviewed from time to time can turn developing world hospitals into dumping zone.

There is a challenge with the majority of African countries with Zimbabwe included. Medicines donationed from various organisations have been suplementing the health delivery system due do to the economic melt down in the said country. A study which was carried out by Amster, (2016) is consistent with these findings resembeing that medicines donated by non govermental organisations help sustain the Government medical expence bill. In this regard it becomes difficult to reject the medicines donations even with those which are nearing the date of expiration in a bid to maintain the relationship. It how ever becomes the burden of the hospital to dispose such medicines in time as this involves a budget for the disposal especillay in the cases for Masvingo Provincial Hospital were there is no high temprerature incinerator and the services have to be seeked outside the institition.

The blind donation of medicines based on unsubstantiated assumptions of recipient needs and logistic capacities is a major factor in the production of expired medicines. Of course, recipient hospitals are free to dispose of donated items that they cannot use, but even this can become an administrative headache. Health facilities face challenges in regards to safe storage and disposal of expired medications. In large quantities medications can become a chemical waste problem threatening environmental contamination. Ruhoy & Daughton (2008) found out a similar incident when Venezuela struggled to deal with huge quantities of expired medicines donated after floods and landslides two years ago. Costly disposal measures have also been required in Armenia, Mostar, and Kosovo.

Good medicines donations save lives and are much needed, especially in times of crisis. The indirect benefits should not be underestimated either. The collection of medicines

and medical products can act as a focal activity for supporters and donators, promoting interest in the work of a mission hospital or relief organisation and a sense of meaningful participation.

5.3 Conclusion

The adopted framework in Figure 1 was used as the framework of this research. Conclusively, the researcher can safely say that work environment (e.g, availability of infrastructure at the hospital), availability of equipment at the hospital to dispose expired medicines, monitoring of medicines/medicines and expired medicines by the administration, staff compliment at the hospital and donations of medicines by outsiders are the root causes of the delay to dispose expired medicines at MPH.

Furthermore, many medications have been shown to exist in trace amounts in ground water, surface bodies of water and drinking water as a result of improper medicines disposal creating a serious concern. Unfortunately, most water treatment plants are designed to filter sediments and bacteria or viruses but not filtering chemicals or medications which may be hazardous particularly on prolonged use of contaminated water. Most developed countries do monitor the presence of pharmaceutical wastes or personal care products in waste and or open water. This practice is uncommon in developing countries (Bettington el al., 2018).

5.4 Recommendations

Specific finding	**Recommendations**
Expired dangerous medicines are being kept	There is also need to lobby to

in the same before disposal increasing pharmacist's exposure to fumes and gasses.	Government to have a central expired medicine center where all expired medicines will be returned and controlled by the government centrally. This will make it easy less stressful for institutions to send expired medicines without delay.
Some medicines have a slower uptake because Masvingo Provincial Hospital is a tertiary hospital which offers high level health care from specialist.	The shelf life of donated medicines must be assessed. There is need for the hospital administrator to verify donated medicines if they will have the desired shelf life in relation to the consumption rate. This also needs to be observed when donations come so that the Hospital avoids stocking unwarranted medicines for their level.
Generally, there is an indication that at the hospital the rooms used to keep expired medicines are not ideal.	Monitoring expired medicines using the digital platform which can easily raise an alarm to remove medicines from the shelves. The hospital should also have a functional and active committee which will deliberate on issues regarding the disposal of expired medicines. There is need to increase the staff complement of Pharmacists so that they will be able to monitor the drug supply chain and identify those medicines on the expired list.
Medicines are expiring at Masvingo Provincial Hospital	Liaise with other hospital who might be in need of the medicines before they expire.
The local for Masvingo authority does not	The medicines control authority in

also have an engineered land fill to dispose the medicines.	Zimbabwe should have a routine system of collecting all the expired medicines especially the dangerous medicines which need a specially condemnation process.

5.5 Suggestions for Further Research

This study uncovered many unanswered questions regarding the knowledge of the dangers of expired medicines among health professionals and the others showed ignorance on the issue. There is need for further research outside the hospital to establish how expired medicines are discarded in homes. A lot of researches have been carried out in other countries on how these expired medicines are handled but in our Zimbabwean context the unavailability of a center where individuals can take their expired medicines for destruction is a major issue of concern.

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Appendix 1: consent form (English)

Study Title: Root cause analysis on delayed disposal of expired medicines at Masvingo Province Hospital .

This is a research being carried out by Sithabile Matava a student undertaking a master's degree in Public health at Africa University Mutare Zimbabwe. The results of this study will be used to improve the disposal of expired medicines at Masvingo provincial Hospital and for study purposes only.

Confidentiality and consent

I have read the information concerning this study and I understand what will be required of me and what will happen to me if I take part in it. I further understand that at any time I may withdraw from this study without giving any reason.

Yes_____ No _____

I agree that any information from my interview may be used in this study

Yes_____ No _____

I am aware that I will not be mentioned by name in this study

Yes_____ No _____

Signed_____

Witness…….

Date_____

Thank you .

Appendix 2: Consent form (Shona)

Musoro wedzidzo: **Midzi inokonzeresa kunonoka kuraswa kwemishonga yakapera muchipatara cheMasvingo mudunhu 2018-2020, Masvingo mudunhu reZimbabwe**

Uku kutsvagurudza kuri kuitwa naSithabile Matava mudzidzi anotora dhigirii reHutano hwevanhu ku Africa University Mutare Zimbabwe. Mhedzisiro yekudzidza iyi ichashandiswa kuvandudza kuraswa kwemishonga yakapera muchipatara cheMasvingo mudunhu uye nekuda kwekudzidza chete.

Kuvanzika uye kubvuma

Ndakaverenga ruzivo nezve chidzidzo ichi uye ndinonzwisisa zvichazodiwa kwandiri uye zvichaitika kwandiri kana ndikatora chikamu mazviri. Ini ndinotonzwisisawo kuti chero nguva ini ndinogona kubva mukudzidza uku ndisina kupa chero chikonzero .

Hongu_____ Kwete _____

Ini ndinobvuma kuti chero ruzivo kubva kubvunzurudzo yangu runogona kushandiswa muchidzidzo ichi

Hongu_____ Kwete _____

Ndinoziva kuti handizotaurwe nemazita muchidzidzo ichi

Hongu_____ Kwete _____

Saina_____

Chapupu.....

Zuva_____

Tinotenda .

Appendix 3: Key informative questionnaire

Study Title: root cause analysis on delayed disposal of expired medicines at Masvingo provincial Hospital, Zimbabwe

Questionnaire number……..

Date……

Please fill in or tick was appropriate:

Section A: **Demographic and Socio Economic Data**

1. Please indicate your gender in the appropriate box

   ☐ Male ☐ Female

2. Please indicate your age in the appropriate box

   18- 25 ☐ 26-33 ☐ 34-40 ☐ 41-47 ☐ 8+ ☐

3. Please indicate your occupation at the Hospital

   Pharmacist ☐

   Pharm tech ☐

   Medical doctor ☐

   Nurse ☐

   Nurse aid ☐

   Cleaner ☐

Section B: Hospital Information

Please indicate your level of agreement with the following statements: Please tick the appropriate box. 1-strongly disagree; 2-Disagree; 3-Neutral; 4-Agree; 5-Strongly agree.

4. **Working environment**	**1**	**2**	**3**	**4**	**5**
Expired medicines are kept in a large room together with other inventories					
Expired medicines are kept in a room together with unexpired medicines					
Expired medicines are kept in a small room difficult to access					
Expired Dangerous medicines are kept in their own room					
5. Equipment	**1**	**2**	**3**	**4**	**5**
There an engineered ;landfill to dispose expired medicines in Masvingo City					
At the Hospital there is absence of a high temperature incinerator to dispose expired medicines					
The hospital rely on City Council landfill to dispose expired medicines					
6. Administration issues	**1**	**2**	**3**	**4**	**5**
At the Hospital there is lack of routine system for disposal of expired medicines					
At the Hospital there is lack of an effective Hospital therapeutic committee					
The Hospital rely on manual monitoring system for disposal of expired medicines					
The Hospital has a computerized system to alert on expiring dates					
7.Donations and Procurement	**1**	**2**	**3**	**4**	**5**
Most of the medicines are donated					
The donated medicines come when there are about to expire					
There is a Hospital procurement section					
Procurement of medicines is done timeously and expiring date are checked before receiving					

8.Hospital staff	**1**	**2**	**3**	**4**	**5**
Staff at the Hospital have adequate information regarding the disposal of expired medicines					
Staff at the Hospital are frequently trained on the dangers of expired medicines to human life and the environment					
Staff at the Hospital work overtime, as a result they forget to check on expired medicines					
At the Hospital, there is adequate pharmacy staff					
Pharmacists at the Hospital routinely check on expired medicines					
9 Effects	**1**	**2**	**3**	**4**	**5**
At the Hospital, expired medicines are always disposed lately					
10 Impact of expired medicines	**1**	**2**	**3**	**4**	**5**
Expired medicines are harmful to human life					
Expired medicines are harmful to aqua life when disposed into rivers and dams					
Expired medicines are harmful to animals when disposed on land					
Expired medicines are harmful to the environment e.g. trees and grass					
Expired medicines cause air pollution when wrongly disposed					
Expired medicines cause water pollution when disposed in rivers and dams					
Expired medicines cause soil pollution when disposed in soil					

11 Which class of medicines that expire most at your Hospital? Please indicate your answer in the appropriate box.

D.D.A ☐

Prescription ☐

Over the counter ☐

12 For how long are the expired medicines kept before disposed?

1 month ☐ 1 year ☐ more than 5 years ☐

Thank you for your cooperation.

Appendixes 4: Shona questionnaire

Shona key inodzidzisa hurukuro

Yekudzidza Musoro: midzi inokonzeresa kunonoka kuraswa kwemishonga yakapera muchipatara cheMasvingo mudunhu 2019-2020, Masvingo mudunhu reZimbabwe

Nhamba yemibvunzo....

Zuva.....

Chikamu A: **Demographic and Socio Economic Data**

1.Ndapota nyora kuti uri murume here kana kuti mukadzi

☐ Murume ☐ Mukadzi

2.Ndapota ratidza kutu une makore mangani okuberekwa mubhokisi riripazasi

18- 25 ☐ 26-33 ☐ 34-40 ☐ 41-47 ☐ 8+ ☐

3.Ndapota nyora mubhokosi basa rauri kuita pachipatara

Pharmacist ☐

Pharm tech ☐

Medical doctor ☐

Nurse ☐

Nurse aid ☐

Cleaner ☐

Chikamun B: Mashoko Echipatara

Tapota ratidza kubvumirana kwako nemashoko anotevera: Tapota tara bhokisi rakakodzera. 1-kupikisa zvakasimba; 2-Kusabvumirana; 3- Neutral; 4-Kubvumirana; 5-Kubvumirana zvakasimba.

1.Nzvimbo yekushanda Yakapera Nguva Mishonga ine Njodzi inochengeterwa mukamuri mavo	**1**	**2**	**3**	**4**	**5**
2.Mishonga yakapera inochengetwa mukamuri pamwe chete nemishonga isingashandiswe					
3.Mishonga yakapera nguva inochengetwa mukamuri duku rakaoma					

kuwana					
4.Mishonga yakapera inochengeterwa mukamuri hombe pamwe chete nemamwe mabhuku					
5.Midziyo Chipatara chinovimba nehurongwa hwemawoko hwekurasa mishonga inenge yapera basa	**1**	**2**	**3**	**4**	**5**
6.Pachipatara pacho hapana chekupisira kupisa kwepamusoro chekurasira mishonga yakapera					
7.Nyaya dzehutungamiri					
Chipatara ichi chine hurongwa hwekombuta hwekuzivisa pamazuva anopera basa	**1**	**2**	**3**	**4**	**5**
8.Pachipatara panoshaikwa komiti inoona nezvekurapa kwechipatara inoshanda					
9.Ikoko kwakagadzirwa ;rashi rekurasira mishonga yakapera basa muguta reMasvingo					
10. Pachipatara pari kushaikwa hurongwa hwekurasa mishonga inenge yapera basa					
11. Mipiro uye Kutenga	**1**	**2**	**3**	**4**	**5**
Mishonga mizhinji inopihwa					
Mishonga yakapihwa inouya kana yava kuda kupera					

Pane chikamu chinotengwa nechipatara					
Kutengwa kwemishonga kunoitwa nenguva uye misi inopera inotariswa isati yapihwa					
12. Vashandi vepachipatara	**1**	**2**	**3**	**4**	**5**
Vashandi vepachipatara vane ruzivo rwakakwana maererano nekuraswa kwemishonga yakapera basa					
Vashandi vepachipatara vanogarodzidziswa nezvenjodzi dzemishonga yakapera kuhupenyu hwevanhu nenharaunda					
Vashandi vepachipatara vanoshanda overtime, somugumisiro vanokanganwa kutarisa mishonga yakapera					
Kuchipatara, kune vashandi vepamishonga vakakwana					
Vemishonga pachipatara vanogarotarisa mishonga inenge yapera basa					
13 Mhedzisiro	**1**	**2**	**3**	**4**	**5**
Kuchipatara, mishonga yakapera inogara ichiraswa mazuvano					
14 Zvakashatira mishongo isisashandi	**1**	**2**	**3**	**4**	**5**
Mishonga yakapera inokuvadza kuhupenyu hwevanhu					
Mishonga yakapera inokuvadza kuhupenyu hwemvura kana yakarasirwa munzizi nemadhamu					
Mishonga yakapera inokuvadza mhuka kana yaraswa panyika					

Mishonga yakapera inokuvadza kune zvakatipoteredza e.g. miti nouswa					
Mishonga yakapera inokonzera kusvibiswa kwemhepo kana yakaraswa zvisizvo					
Mishonga yakapera inokonzera kusvibiswa kwemvura kana yakaraswa munzizi nemadhamu					
Mishonga yakapera inokonzera kusvibiswa kwevhu kana yaraswa muvhu					

15 Ndeipi mhando yemishonga inopera zvakanyanya pachipatara chako? Tapota ratidza mhinduro yako mubhokisi rakakodzera.

D.D.A ☐

Prescription ☐

Over the counter ☐

16 Mishonga yakapera inochengetwa kwenguva yakareba sei isati yaraswa?

1 mwedzi ☐ 1 Gore ☐ anopfuura makore mashanu ☐

Tinotenda .

Appendix 5: Observation checklist

1) Availability of a storeroom for expired medicines Yes ☐ No ☐

2) Estimate the quantities of expired medicines……...

3) Are the dangerous drugs separated and labelled

……..

4) Number of people working in the pharmacy?

……

5) Are they adequate? Yes ☐ NO ☐

6) Is there an incinerator or coal burner

…….

7) What temperature can the incinerator burn to?

8) Is it closer to where people leave?

……

……

Is there an engineered landfill…