

**OCCUPATIONAL SAFETY AND HEALTH HAZARDS ASSOCIATED
WITH SOLID WASTE MANAGEMENT IN BINDURA, ZIMBABWE.**

BY

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APPROVAL FORM

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DEDICATION

This thesis is dedicated to my beloved husband, daughters and my mother for your unwavering love, support and patience throughout the course of my studies. May God richly bless you.

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My sincere gratitude goes to my supervisor Professor Steven Jerie for the priceless encouragement, contributions and support he provided in this paper. His critique, ideas and comments were highly enlightening and educative. I would like to thank the Municipality of Bindura staff, NSSA staff and all the study participants for their contributions to this research. I am also highly indebted to Cliff Zinyemba for the moral guidance and support he provided during my studies.

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ABSTRACT

Solid waste management contributes tremendously in upholding public health by reducing the risk of diseases and environmental pollution. Despite the significance of this job, solid waste workers are exposed to a myriad of work related hazards. The objectives of the study were to identify the types of waste which are hazardous to solid waste workers, followed by examining the nature of hazards and to finally assess the effectiveness of the measures in place to combat the occupational safety and health hazards associated with solid waste management practices at Bindura Municipality and then ultimately come up with the appropriate recommendations.

The study used qualitative and quantitative research design with study participants being sampled using the purposive sampling methods. Data was collected using questionnaires, observations, and interviews as the data collection tools. The data was then analysed using the Statistical Package for Social Sciences (SPSS). The waste collection methods at Bindura Municipality were undertaken through labour intensive systems which involved carrying heavy loads containing rotting organic wastes, contaminated with pathogens and hazardous wastes. The occupational safety and health hazards associated with solid waste management were dominated by physical hazards (65.91%), ergonomic (22.73%), biological and chemical (6.82%) and psychosocial hazards (4.55%) with potential to cause injuries and illnesses. These hazards were present from the waste collection point to the ultimate point of disposal. The solid waste management practices were dominated by strenuous tasks which contributed to the development of musculoskeletal disorders. Lack of training on safe handling of waste was identified as a risk factor, as was established by a Chi square test of association between training on waste handling and injuries and accidents encountered ($p=0.00<0.005$). The major safety intervention was the provision of PPE which is actually the last line of defense. The Municipality of Bindura did not have a documented Occupational Safety and Health (OSH) policy or program. To address these OSH issues, they should adopt an OSH Policy and decentralise OSH issues from the Human Resource Department, thereby creating an independent Safety and Health department. Training of workers is also recommended for them to be competent in identifying hazards, use of personal protective equipment and to enable them to uphold the best safety and health practises.

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LIST OF ACRONYMS AND ABBREVIATIONS

OSH	Occupational Safety and Health
PPE	Personal Protective Equipment
ILO	International Labour Organisation
MSW	Municipal Solid Waste
NIOSH	National Institute of Occupational Safety and Health
USA	United States of America
US- EPA	United States Environmental Protection Agency
CSO	Central Statistics Office
SME	Small to Medium Enterprises
PPE	Personal Protective Equipment

CHAPTER ONE

INTRODUCTION

1.1 Background to the study

Occupational injuries contribute significantly to human and economic costs in developing countries as well as developed countries. They continue to be a serious problem affecting workers at different workplaces and industries. At a global scale, the International Labor Organization (ILO) estimates that 250 million work related injuries and illnesses occur every year, and 330,000 of these accidents are fatal. In addition, annually, an estimated 160 million people worldwide have work related diseases, including respiratory and cardiovascular diseases, hearing loss, musculoskeletal and reproductive disorders as well as mental and neurological illnesses (ILO Report, 2010). Although the statistics of occupational injuries are poorly documented in both developed and developing countries, Sub-Saharan Africa countries appear to have the greatest rate of occupational injuries (Olorunnishola, Taylor and Byrd, 2010). Amongst the occupations contributing to these problems is solid waste handling.

Municipal solid waste (MSW) is composed of various discarded goods mainly left-over food, garden waste, textiles, glass, papers, metals and other spoiled goods (Rushton, 2003). The stages of generation, storage, collection, processing, transportation and disposal of waste are important stages which involve the use of human labour in conjunction with machines or equipment. Solid waste management contributes tremendously in upholding public health by reducing the risk of diseases, however, the job in its nature exposes solid waste workers to high risk of fatal and non-fatal occupational accidents (Kuijjer and Frings-Dresen, 2004). They are exposed to a wide array of injuries and diseases at work, emanating from collection points, during transportation of waste and at dumpsites (Cointreau, 2006). The scope of this study will mainly focus on occupational safety and health hazards associated with waste generation, collection and the handling methods.

The increasingly complicated arena of waste management harbors significant potential for human health and safety risks. Hardoy and Satterwaite (2006) contend that, wastes not properly

and adequately managed may cause serious health and environmental risks which may result in sickness, impaired health and well-being, or significant discomfort among the citizens of the community. The aim of solid waste handling is the removal of garbage to safeguard public health and welfare, as well as to prevent environmental pollution.

According to Rorgoff and Bidderman (2015), a research conducted by American National Institute for Occupational Safety and Health (NIOSH) posits that solid waste workers encountered the third highest frequencies of nonfatal injuries and illnesses compared to other occupations. Observations were linked to the fact that, the solid waste collection job has high risk. Interviews and follow-up studies conducted by Bünger, Schapper-Scheele, Hilgers and Hallier (2007), revealed that workers involved in solid waste management have been found to experience more work-related symptoms and illnesses than other occupational groups. In India, a clinical study on municipal solid waste workers revealed that they experienced morbidity such as respiratory diseases, skin and eye irritations as well as nail infections. The findings of the study on the work related injuries and illnesses revealed that 63.6% of the workers experienced falls, whilst 22% reported to have been involved in accidents, the prevalence of injuries was 73.2%, and 7.1% were exposed to a water borne disease. They also experienced musculoskeletal morbidities which revealed that all major joints were involved (17-39%) (Jayakrishnan, Jeeja and Bhaskar, 2013). Another study in Ghana, at a private waste collection company revealed that solid waste workers are exposed to neck, wrist and back pain (Norman, Kretchy and Brandford, 2013). Several studies on the work related morbidity among solid waste handlers reveal that they are at risk.

Despite the significance of this job, solid waste handlers are exposed to a myriad of hazards in the course of discharging their duties. The major hazards faced by solid waste workers can be classified as chemical, biological, musculoskeletal disorders, mechanical hazards and psychosocial hazards. Amongst the injuries endured by solid waste workers are accidental injuries such as perforation wounds, lacerations, burns, dog and rat bites which are as highly significant as are deep cuts caused by scrap metal, jagged edges of cans and bins, glass cutlets or nails in waste bags. Furthermore, physical injuries also occur when refuse collectors drop heavy containers on their feet or legs (Jerie, 2016).

In addition, Jerie (2016) contends that solid waste workers sustain work related injuries such as sprains, abrasions, fractures, eye injuries and sharp back pain due to their work. Solid waste work according to the same author is associated with incidences of work related diseases such as diarrhoea, viral hepatitis, and higher incidents of obstructive and restrictive disorders. Direct contact with infectious material also exposes solid waste handlers to biological pathogens which cause tetanus and HIV. According to Bastani, Celik, and Schubert (2014), solid waste workers are exposed to safety and health risks due to manual tasks which involve lifting heavy loads; exposure to gaseous emissions from decomposing waste such as hydrogen sulphide, organic compounds and hazardous gases released when carrying out tasks such as waste removal and disposal at the dumpsites. The inhalation and or ingestion of these contaminants expose solid waste workers to respiratory illnesses. Cointreau (2006) contends that, exposure to substantial concentrations of methane, carbon monoxide and carbon dioxide in dumping areas trigger health effects such as headaches and nausea among landfill workers. Solid waste workers are also prone to lead poisoning from emissions released from burning waste with lead-containing batteries, paints, and solders. Disposal sites also expose solid waste workers to injuries incurred due to landslides, fires, and being accidentally buried.

Waste collection is a physically demanding job where labour intensive systems are common in developing countries. The tasks in waste collection include recurrent physical lifting of heavy waste-filled containers which contribute to the development of musculoskeletal disorders. As such, there are high incidences of muscular-skeletal disorders observed among solid waste workers. A survey performed in the United States of America (USA) revealed that, the majority of solid waste worker's compensation claims were related to musculoskeletal disorders related with lifting heavy refuse containers or embarking and disembarking from waste collection vehicle (Rorgoff *et. al*, 2015). A study in Canada on the ergonomics of waste collection revealed that waste collectors lifted sixteen thousand kilograms of waste and per day and on average they walk a distance of eleven kilometres which showed that solid waste collection involves a lot of physical exertion. In this environment, the worker has to be relatively health in order to perform the tasks.

Internationally, solid waste workers are exposed to various health problems that originate from waste streams that they handle. Measures to handle refuse aseptically differ between countries, the worst scenario being in developing countries where there is lack of proper execution of legislation and supporting regulations on work related safety and health issues (Loeweson, 1998). Developed countries have developed standards for handling municipal solid waste which have seen the reduction on its occupational health impacts substantially. Countries like Malaysia have adopted the OSHA 2006 standards which outlines the responsibilities of the worker to wear protective gears while at work for the sake of safeguarding their health. In the United States, the California Occupational Guide of 2002 provides for provision and monitoring of use of adequate protective equipment by workers. The United States Environmental Protection Agency (US-EPA) has formulated legal frameworks which ensure exclusive handling of hazardous wastes such as, ensuring that undertakings maintain records of wastes that are hazardous or toxic and medical wastes.

In developing countries, waste segregation is seldom practised, such that, traces of medical wastes and poisonous industrial wastes are mixed with the domestic waste stream (Akter, Zakir, Trankler and Parkpian, 2007). Consequently, the array of hazards which solid waste handlers are exposed to is magnified. In the same countries waste pickers eke a living from sorting and recycling waste. They are exposed to occupational health hazards which include human faecal matter, paper contaminated with toxins, empty containers with chemical residues such as pesticides, solvents as well as medical waste from surgeries including injections and soiled bandages and batteries containing heavy metals (Akter *et.al*, 2007).

The social status of waste collectors is low, and frequently their working conditions are not favourable (Frings, 2005). In many cases, waste collection is essentially a means of survival which leaves them vulnerable of unsafe working conditions.

Occupational health risks associated with waste handling are still outstanding in most developing countries. In Zimbabwe, for instance, even though there are robust occupational health and safety policies and regulations, the health-related underpinnings of solid waste management still need to be addressed. Little is being done to ensure compliance by employers and polluters with

occupational health and safety legislation and environmental legislation respectively. There has been little research on, and documentation of injury and illness incidences of solid waste workers, in Zimbabwe. Taking this scenario into consideration, this research focuses on unravelling the occupational safety practices and health hazards associated with solid waste handling at Bindura Municipality.

1.2 Statement of the problem

Solid waste handling is a labour intensive occupation characterised by various manual tasks where solid waste workers are in direct contact with waste. Failure by local authorities to adopt modern waste management technologies coupled with the lack of capacity to manage waste has exposed solid waste handlers to a myriad of work related injuries and illnesses in Zimbabwe. A study by Gonese, Hove and Chirimumimba (2002) in the cleansing department of Bulawayo City Council revealed that 97 injuries occurred during the period 2001 to 2002, of which 67 (73%) occurred in the refuse handling section including one fatality.

Refuse removal in Bindura, is hardly in tangent with the waste collection schedule such that garbage remains uncollected for weeks and the common outlook are illegal dumps and overflowing garbage bins. Solid waste workers are obliged to sweep, shovel the garbage by hand and to lift the heavy, overloaded bins. The solid waste workers are exposed to substantial levels of physical, chemical, as well as biological toxins emanating from the rotten waste. Further to that, solid waste workers are assigned with tasks, which are beyond their capacity due to staff shortages, and thus, they carry out their tasks without following the proper lifting and waste handling procedures exposing themselves to risks of ergonomic hazards.

More so, solid waste workers tend to neglect the proper use of personal protective clothing and/or they are ignorant of the safety and health implications of waste handling. The current waste management systems in Bindura involve significant risk of contact with solid waste hazards. Nonetheless, the causes and nature of injuries and illnesses at the Bindura Municipality have not been explored. Therefore, the aim of the research is to identify the occupational safety and health hazards associated with solid waste management practices in Bindura.

1.3 Research Objectives

General objective

To assess the occupational hazards associated with household waste management practices in Bindura.

Specific objectives

1. To identify the types of waste that are hazardous to the solid waste workers at Bindura Municipality.
2. To examine the nature of hazards associated with solid waste management.
3. To assess the effectiveness of the measures put in place to combat the safety and health hazards emanating from solid waste management practices.

Research questions

1. What types of household wastes are hazardous to solid waste workers?
2. Which are the major occupational health risks among solid waste workers, and what method can be used for identifying them?
3. What possible control measures can be implemented to reduce or eliminate the occupational health hazard among solid waste workers?

1.3.1 A conceptual framework of safety and health hazards amongst solid waste handlers

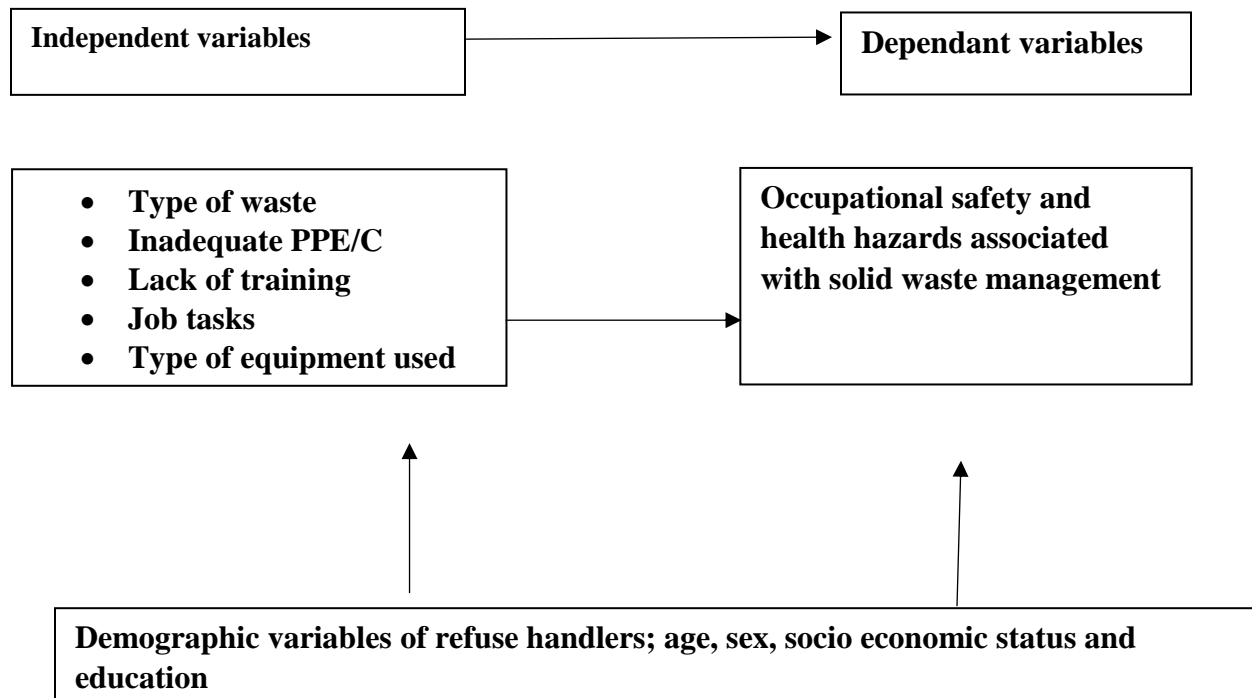


Figure 1.1: Conceptual framework of safety and health hazards among solid waste workers

1.4 Justification

The occupational safety and health risks associated with solid waste management have not been given much attention in Zimbabwe. The current economic meltdown has seen most Local Authorities struggling to remove the waste itself, for the protection of the environment and public health, such that the protection of waste handlers from occupational hazards has become questionable. Further to that, the waste management methods still allows the disposal of mixed wastes such that, it is expected that domestic waste is mixed with hazardous and medical waste thereby creating a greater risk to solid waste workers, the general public and environmental pollution.

The findings of the research will benefit the municipality of Bindura to establish or to enhance a comprehensive occupational safety and health management system so as to eliminate the safety and health risks for the benefit of the workers. This will improve the organisation's performance in service delivery due to increased productivity, reduced absenteeism from work, reduced

compensation costs and ultimately benefit the society and ensure environment protection. The research will provide an understanding to the top management of the safety and health risks associated with solid waste handling which can assist them in determining effective interventions in order to reduce or eliminate the risks. This will include reviewing the existing safety and health measures, the current waste collection practices and resultantly consider interventions such as elimination of hazards and administrative controls such as employee induction, on the job training, premedical examinations, and introducing vaccination programmes as well as training on use of personal protective clothing.

The results of the study will assist the policy makers that is, the Councillors, to have an appreciation of the occupational risks faced by solid waste workers such that they collaborate with the top management on implementing interventions including allocating adequate funds towards safety and health, thereby improving the working conditions. The research is highly significant to the Government of Zimbabwe, Bindura Municipality, business community, the health sector, community based organisations, waste recyclers and the solid waste workers as it will raise awareness of the occupational risks associated with solid waste collection. The identification of occupational hazards will enlighten the concerned solid waste workers to adhere to stipulated codes of practice thereby ensuring a health and safe workplace. In addition, the research findings will benefit other local authorities on planning and implementation of safety and health measures especially for the solid waste workers.

The findings from this research will contribute to the body of knowledge and address some of the knowledge gaps on literature pertaining to the occupational safety and health hazards associated with solid waste handling. More so, the findings will be subject to peer review and as such will be of great benefit for fellow scholars, as it will serve as a basis for further research on occupational risks among solid waste workers. The researcher will benefit greatly from the research by gaining in-depth knowledge of the occupational safety and health risks in relation to solid waste handling and it will provide a platform for the researcher to acquire a practical experience of hazard identification and the critical knowledge on how management systems are vital in managing occupational risks.

1.5 Study area`

Bindura Town is the administrative capital of Mashonaland Central Province. The town covers an area of 10800 hectares with 1950 hectares under current Municipal jurisdiction. It is located at 17° 18' South to 31° 20' East, at an altitude of 1130 metres in the Mazowe Valley about 88 kilometres northeast of Harare.

The soil types that characterise the landscape vary from sandy loamy to red clay soils situated on a terrain which is fairly flat sloping to the Northern direction. The climate in Bindura is warm and temperate with an average temperature of 19.4 °C. Bindura receives an annual average rainfall ranging between 750- 850 mm characterised by a mid-season dry spell, the month of July being the driest, with 1 mm of rain.

Bindura comprises of high and medium density located in the Eastern side of the town, and low density suburbs located in Northern side. The high income low density suburbs in Bindura are Shashi, Cloverhill, Greenhill and the low income, high density suburbs namely Chipadze, Chiwaridzo, Chipindura, and Aerodrome which also has a medium density extension. The settlements in Bindura town are divided into 12 administrative wards, each represented by an elected Councillor. The town has a population of 44 033 people, comprising of 21 242 males and 22 791 females (Central Statistical Office (CSO), 2012). There are 11 172 households with an average family size of 3.9.

Bindura is the commercial hub for the province. The main economic activities of Bindura town include mining (gold and nickel), agriculture (citrus, maize and tobacco), Small to Medium Enterprises (SMEs) and tertiary education. Bindura has three tertiary institutions namely Bindura University, Zimbabwe Open University and Ezekiel Guti University. The town has several major mines like Trojan, Fred Rebecca and other smaller ones. The major employers in Bindura town are mines which employ around 50% of the town's working population (Town Council, 2017). Agriculture contributes significantly to the economic status of the town. The town's location in agro-ecological region 2, receives adequate rains and has good soils which are suitable for crop production. The major crops grown around Bindura are citrus, tobacco, maize, cotton and wheat.

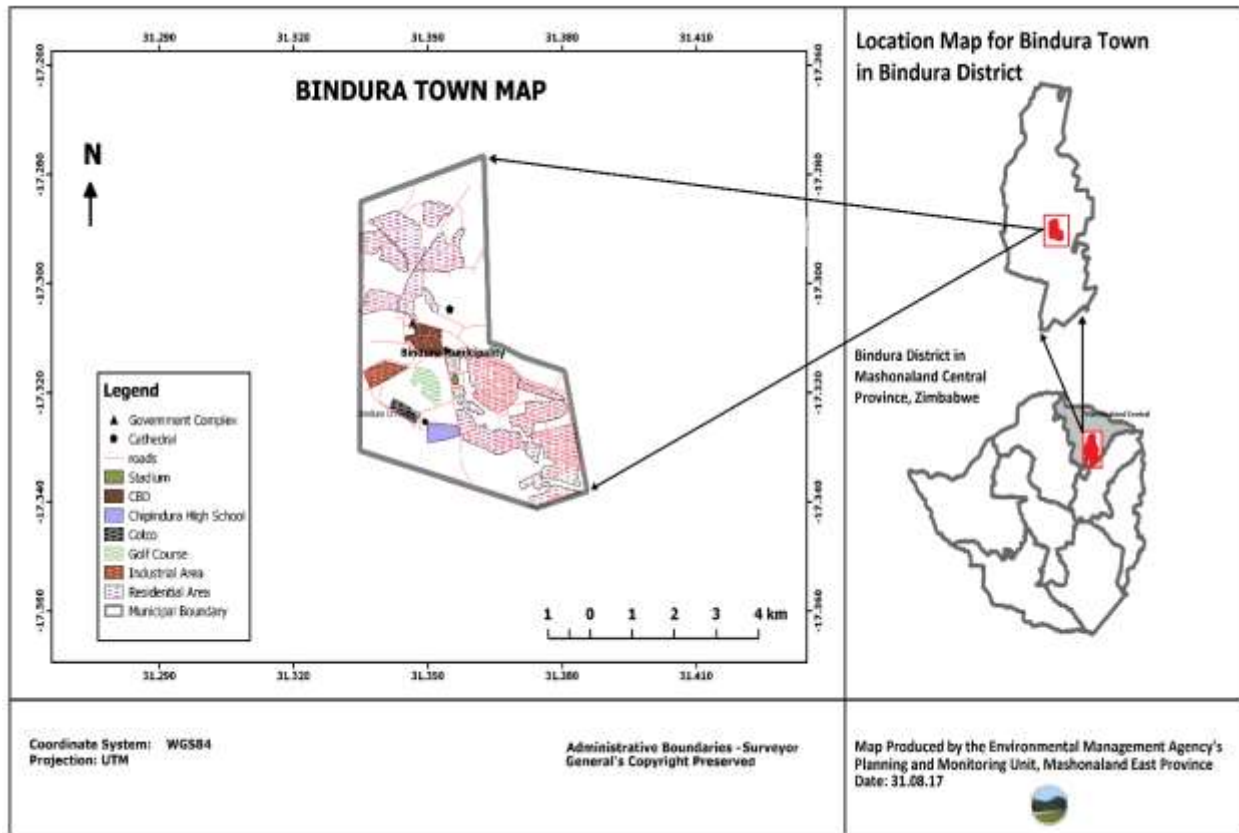


Figure 1.2: Map showing location of the study area

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

Chapter two explores the safety and health hazards associated with solid waste management. Reviewing literature is pertinent in exploring the accumulated body of knowledge on the subject where the author seeks to unravel the level of exposure to risks at work of formal and informal waste workers. The literature also reviews the measures or systems that can be implemented to mitigate the hazards emanating from solid waste handling.

Occupational safety and health (OSH), is a discipline with a broad scope concerned with the overall well-being of people in various workplaces. The field embraces a holistic approach to promote and maintain the social, mental and physical well-being of workers in all occupations. This is achieved through prevention of adverse health effects emanating from workplaces; protecting workers in their occupation by eliminating risks factors which are adverse to workers' health; adapting work to fit the worker's physical and mental needs whilst maintaining conducive conditions. Occupational safety and health (OSH) is defined as the science of the anticipation, recognition, evaluation and control of hazards arising in or from the workplace that could impair the health and well-being of workers, taking into account the possible impact on the surrounding communities and the general environment (Alli, 2008).

The rapid technological and economic change have necessitated the designing and continuous implementation of policies aimed at reducing or eliminating occupational hazards and risks (ILO, 2010). Despite these improvements, occupational accidents and diseases are still too frequent and their cost in terms of human suffering and economic burden continues to be significant.

2.2 Occupational safety and health issues in solid waste management

The handling and disposal of municipal solid waste is a growing global environmental and public-health concern (Jayakrishnan, *et al*, 2013). The management of solid waste has contributed significantly to healthy living by curbing the danger of various water borne diseases and cholera (Kuijjer *et al.*, 2010). Waste handling is associated with various adverse occupational safety and health effects emanating from the waste collection methods used by solid waste handlers when they perform their duty. Tevera, *et al.* (2003) contends that more than one

hundred people die every year due to diseases caused by improper handling of household solid waste. Hardoy, *et al.* (2001) echoed the same sentiments by revealing that diseases emanating from poor household solid waste handling present risks that can be fatal to more than 5.5 million people. In this scenario, solid waste workers are at high risk of contracting occupational diseases and injuries since their work requires them to be in direct contact with wastes composed of diverse elements including traces of medical wastes, from point of generation, collection, transportation and finally, disposal.

The exposure of solid waste workers is not only limited to hazards emanating from waste processing activities such as composting, the hazards are also dependent on factors such as the type of equipment and machinery used and the job tasks related to repair and maintenance of machinery. The risks vary from contamination by biological or gaseous agents, physical injuries related to dust, noise, extreme temperatures, poor lighting, ergonomics and painful working postures and pathogen infested waste such as syringes as well as fires.

According to the American National Institute for Occupational Safety and Health (NIOSH), solid waste workers have the third highest frequency of nonfatal injuries and illnesses compared to other occupations (Rorgoff and Bidderman, 2015). In the waste management sector, fatal accidents are almost three times higher than other occupations. Reviews on workplace hazards in this sector by Cointreau (2006) showed high accidents occurrences at work including the regulated waste management sector. Studies reported that solid waste workers had higher risk of an accident at work compared with a baseline population, and accidents occurrences in Romania were 1.3 times higher, whilst in Denmark they had 5.6 times higher chances of accidents (Kuijer *et al.*, 2010), to 10 times higher in the USA. A study in Northwest Ethiopia by Eskezia, Aderaw, Ahmed and Tadese (2016), revealed that the annual prevalence of at least one occupational injury among solid waste workers was 34.3 %.

Developed countries formulated standards and legislation for handling solid waste which have seen a reduction in the occupational health impacts substantially (Eskezia *et. al.*, 2016). The implementation of these standard operation procedures in handling solid wastes in developed nations have greatly reduced the various hazards associated with pollution considerably. The

solid waste handling systems in developed countries have robust legal frameworks which enforce the segregation of hazardous waste at source such that they have traceable records, they are managed separately in secured transport and disposal facilities. On the other hand, in some developing countries, segregation of medical wastes and poisonous wastes from industries, from domestic waste is not practised, further exposing solid waste workers to a wide array of risks (Rushton, 2003). Nevertheless, such hazards are still prevalent in developing nations. Cointreau (2006) contends that work related to solid waste handling are much higher in developing countries than those in developed countries, because workers are not adequately protected. The regulatory framework and enforcement system to separate hazardous wastes are nearly absent in developing countries (Rushton, 2003).

The waste collection system in developing countries is such that discarded waste is rarely stored in closed plastic or metal containers. Another scenario is that waste is placed on the ground directly, requiring that it may be shovelled by hand exposing the solid waste worker to be in direct contact with waste and are also exposed to strenuous working conditions. In both cases, the waste storage system is accessible to insects and rodent vectors and to scavenging animals. As a result, the likelihood of spreading of flea-borne disease and plague by vectors such as rats is high (Jerie, 2016). Cointreau (2006) also affirms that waste handlers in less economically developed countries contact solid waste more directly compared to their colleagues in developed countries.

Furthermore, solid waste handling in developing countries is by labour intensive methods which involves carrying heavy loads which expose refuse collectors to increased risk of musculoskeletal disorders and the most common complaints by refuse collectors indicate problems with the lower back region. Yang et al., 2001 contends that other affected areas are shoulders, knees, and neck. The waste collection systems requires physical strength, which are linked to numerous risk of musculoskeletal disorders (Jerie, 2016). Various types of hazards that can be correlated to waste management and these are chemical, biological, physical, sharp items, lack of proper planning and psychosocial problems. The common injuries encountered by solid waste workers include strains, cuts, lacerations, twisting and muscle sprains. Kuijer&Frings-Dresen, (2004) contend that injuries encountered by solid waste workers are related to falling from heights or slipping, struck by a sharp object, cuts by scrap metal and broken glass, or piercing object and straining of the body.

The measures for aseptic waste handling differ globally and are highly dependent on ability to provide protective equipment and the knowledge of the worker on adequate use of the personal protective equipment (PPE) (Merson, Black and Mills, 2001). Apart from limited protection, the lack of training of waste handlers contributes significantly to their risk of encountering injuries and accidents. Gonese et. al, (2002) contends that lack of training at the beginning of employment is a risk factor for waste workers. In addition to these, periodic medical check-up programs for all solid waste collectors should be adhered to in order to uphold their social physical and mental well-being (Tiwari, 2008). Solid waste workers are exposed to physical injuries and musculoskeletal disorders due to inadequate use of the provided PPE.

Solid waste workers are vulnerable in Less Economically Developed (LEDs) countries have a lower socio-economic position as a result of poverty, lower educational exposure and poor standards of living. Sabde & Zodpey (2008) contends that this group of workers are directly exposed to hazardous waste and work without adequate personal protection.

2.3 Types of waste that are hazardous to solid waste workers

The exposure to occupational hazards in terms of waste management is determined by the waste composition, the job tasks (collection, transport, and recycling), and the type of equipment used. According to Cointreau, (2006) the health risks imminent to either the worker or residents in the vicinity of waste facilities are determined by composition of waste, the nature of waste and its biodegradability, the methods of handling of waste, the waste processing techniques used and their disposal.

The levels of economic activity in developing countries are relatively low, however, that does not conclude that their solid waste does not contain hazardous wastes which pose serious health risks to the public as well as solid waste workers. Solid waste workers are at risk of occupational health hazards originating from wastes, which include human faecal matter, paper contaminated with toxins, empty containers with chemical residues such as pesticides residues, solvents as well as traces of medical wastes such as injections, soiled bandages and heavy metals in batteries. The Zimbabwean Environmental Management Act Chapter 20:27 defines hazardous wastes as any

substance which is toxic, mutagenic, teratogenic, inflammable, reactive, explosive, corrosive and or infectious.

Waste segregation is seldom practised in developing countries such that soiled bandages, discarded cotton wool, and used injections from medical facilities are frequently found mixed with domestic solid waste (Rushton, 2003). The diverse waste stream contains hazardous solvents, adhesives, plating materials, and pesticides from industries, as well as hazardous asbestos products from construction and demolition activities, cleaning products, personal care products, automotive products, insecticides, and herbicides, and miscellany which incorporates batteries and sharps such as broken glassware (Jerie, 2016; Wilson et al 2006)

The solid waste management system in developing countries such as Zimbabwe allows the collection of mixed waste thereby heightening the health risks caused by the numerous of toxic chemicals. Solid waste such as electronic waste contain heavy metals such as, mercury, cadmium, chromium, lead and arsenic (Jerie, 2016) . These heavy metals are associated various health risks because they are neurotoxic and carcinogenic in nature (Van Eerd, 1997). The accumulation of inorganic arsenic is associated with health problems such as lung, kidney, bladder, and skin disorders due to its cancer-causing properties.

Cadmium is often contained in discarded wastes such as polyvinylchloride, detergent containers and zinc batteries. This heavy metal bio-accumulates in the human body affecting internal organs that include the liver, kidneys, lungs, bones (osteoporosis), the intellect, as well as the central nervous system (Jerie, 2016). According to the same author the accidental injection, inhalation, or skin absorption of toxic waste may result in the development of genetic mutation, cancer, foetal harm and fatality.

The properties of flammable wastes can be defined by their low flash points which can be easily set alight. Corrosive waste are capable of burning and destroying living and non-living tissues when brought into contact with them. Discarded empty containers of fungicides, pharmaceuticals, and batteries may contain traces of mercury which is a highly toxic heavy metal

and it affects the nervous system. Some pesticides are persistent in nature and can cause acute toxic effects as well as chronic toxicity and environmental pollution.

Biodegradable wastes are also an important component of solid waste. Wastes with low lignin content such as food wastes and vegetable are more biodegradable than those with high lignin content such as paper and plastic (Jerie, 2016). The majority of environmental and health problems associated with waste are biodegradable components (Tchobanoglous, 2003). Biodegradable wastes provide habitats for rodents and vermin and they contain various disease causing biological pathogens (Hunt, 2000).

2.4 Hazard identification

Hazard identification involves categorizing all hazards in the working environs. The process encompasses examining workplaces and job tasks for hazards which are inherent in each task. For newly established organisations or for organisations without occupational safety and health systems or programs, the hazards identification process can be used as a starting point. (Taderera 2012). Identification of hazards enables an organization to plan ahead on how to deal with the anticipated hazards and to make decisions on the best risk management methods to employ. In the field of solid waste management, it is vital for both the workers and the employers to be able to identify hazards thus eliminating or reducing the effects of the hazards in that work place.

According to the New Zealand legal provisions within the Health and Safety in Employment Act of 1992, the scope of hazard identification in the field of solid waste management covers all workplaces, inclusive of workshops or yards, streets, disposal sites, transfer stations, waste recovery plants and disposal sites. The process of hazard identification involves task analysis and identifying hazards. Competent personnel in the industry are engaged in the hazard identification process to ensure thorough assessment of the workplace. Hazard identification is done in consultation with accidents and incidents records as well as gathering information from employees.

The hazards which are inherent in solid waste management relate to chemical, physical, biological, ergonomic and psychosocial hazards.

2.4.1 Chemical Hazards

Binion and Gutberlet (2012), contends that exposure to chemicals is associated with anatomical poisoning and skin irritations or injuries, such as burns and respiratory illnesses. Jerie (2016) ascertains that exposure to chemicals cause dermatitis, inflammation of the respiratory system, liver damage and disruption of the central nervous system. The major routes of chemical absorption are through inhalation, dermal contact and ingestion. Although chemical contaminants occur in negligible quantities in solid waste, they pose serious health implications for solid waste handlers.

Toxic heavy metals such as mercury, cadmium, arsenic and lead present in e-wastes are known to be persistent and also tend to bio-accumulate in the blood. A study conducted by Sarkar (2003), in India revealed that waste recyclers working in landfills had high lead content in their blood and the findings led researchers to relate solid waste work with the increased bioaccumulation. In addition, exposure to waste dumpsites has indirect effects on the health of nearby dwellers. Studies conducted in Mexico and developing countries by Medina (2005) and Cointreau (2006), respectively, discovered that breast milk from females who lived near landfills was contaminated with lead and dioxin related-compounds. Chemical contaminants are passed through dust, fumes, vapours and direct contact on the skin. Sarkar (2003) and Englehardt (2000) in Bogale, Kumie and Tefera, (2014) assert that waste handlers are exposed to exhaust emissions of refuse trucks during transportation of waste. In addition, solid waste workers may be affected by various chemical solvents or inhaling burning waste emissions. The inhalation of fuel exhaust and burning waste has been reported to cause inflammation of the respiratory system and reduced functionality of the lungs, infections, and eye irritation (Gutberlet et al, 2008). Cointreau (2006) contends that headaches and nausea, and higher levels of bronchitis are associated with constant exposure to vehicle exhaust fumes.

2.4.2 Physical Hazards.

The common physical hazards that affect solid waste workers include cuts from sharp objects such as pieces of glass, razor blades, scrap metal and pricks from piercing items for example needles. (Jerie, 2016). Cuts and pricks have a long term risk of tetanus resulting from rusty wires and scrap metals. Bruises usually happen through accidentally hitting on equipment, broken limbs and falls from truck platforms cause contusions. The hazards inherent to solid waste handling are mainly vehicle accidents, wounds, being hit by falling objects, broken limbs, falls and lacerations (Gutberlet and Baeder, 2008). Solid waste workers are also exposed to physical hazards such as being accidentally buried in landfills as well as vehicle accidents. Studies among recyclers in Vietnam, revealed that 17% of them were exposed in either a minor or major collision with garbage trucks (Binion and Gutberlet, 2012). Solid waste workers occasionally wear gloves, but they are quickly worn out and rendered useless to needle punctures or cuts from glass (Jerie, 2016). The solid waste handlers are also exposed to harsh weather conditions which fluctuate during the same day as they work for eight working hours. They experience high exposure to solar ultraviolet radiation because of the nature of their outdoor work.

Furthermore, they are exposed to vibrations during transportation of waste to disposal sites as well as working in dusty working areas which are cramped with high traffic volumes. Refuse collectors are at risk of being hit by vehicles especially when they collect bins from both sides of the road.

2.4.4 Ergonomic hazards

Waste collection work is a physically demanding occupation which is characterized by lifting heavy loads, which cause the development of musculoskeletal problems (Jerie, 2016). The job tasks may be characterised by activities such as lifting heavy objects, sitting for long periods of time and or standing, reaching for objects and repetitive tasks which are contribute to the development of musculoskeletal disorders (MSDs). Solid waste workers are exposed to considerable risk for developing ergonomic disorders such as low back pain, painful neck, and may also affect shoulders and arms (Cointreau, 2006 and Cointreau *et. al*, 1998). Pruess , Giroult and Rushbrook (1999) and Poulsen , Breum , Ebbenhøj , Hansen , Ivens and van

Lelieveld (2003) in Jayakrishnan, *et al.* (2013), reviewed many studies where researchers ascertained that mechanical loads lifted during waste collection exceed maximum acceptance limits recommended; during the performance of tasks such as hauling bags of waste which result in compression of the spine and lifting loads that cause excessive twisting to the shoulder resulting in magnified cases of musculoskeletal problems. The same sentiments were echoed by a study that was conducted in Egypt by Abou-ElWafa, El-Bestar and El-Gilany (2012), on the prevalence of MSDs revealed that the most frequently affected body regions among solid waste workers include the low back, then shoulders, neck, knees and thighs and elbows. In Denmark, the frequency of musculoskeletal complaints among refuse collectors were two times higher than for the total Danish workforce. A similar outcome was reported in Taiwan where the risks for musculoskeletal complaints of the low back and elbow/wrist among refuse collectors were more than two times higher than those of their colleagues that worked in the office (Cointreau, 2006). The same author contends that waste collection has substantial risk for low back pain and musculoskeletal disorders of the neck, shoulders and arms. In addition, higher joint problems were also reported from Indian cities Bombay, Calcutta and Bangalore. A study in Zimbabwe's informal sector by Jerie (2016) showed that garbage workers experienced high incidence of repetitive strain injuries because of repeated flexing and twisting motions. The same author further noted that waste collection workers were inadequately trained. In this study most men were observed to have some insight into the occupational hazards of their workplaces but however, they lacked thorough factual occupational health and safety knowledge. Reghunandan, (2008), argues that inappropriate ergonomics combined with non-availability of worker friendly tools and equipment exacerbate the prevalence of musculo-skeletal problems among solid waste workers. Jayakrishnan (2013), contends that waste collection organisations in India purchased refuse collection vehicles which had high loading bays and heavy bins. Trucks with high loading heights increase the chances for injury as contended by Cointreau (2006). (Binion and Gutberlet, 2012) explored ergonomic injuries in informal recyclers unravelling that they suffered from musculoskeletal illness due to the repeated moving of carts and lifting heavy bags filled with solid waste. The long term effects of long working hours, job tasks with difficult working postures and lifting heavy loads results in musculoskeletal disorders (Binion and Gutberlet 2012).

2.4.5 Biological hazards

Pathogen-infested wastes can be generated from improper handling and disposal of medical waste, solid household waste, faecal matter and decomposing organic matter (Binion et. al, 2012). The various biological hazards can be characterised through source of contaminant that is pathogens such bacteria, viruses, fungi and infectious protozoa. Infections of the skin and blood, by pathogens in the solid waste management commonly occur through physical contact with waste and open wounds, zoonosis due to bites by wild or stray animals feeding on waste, and infections transmitted by insects (Jerie, 2016). Wounds and cuts from broken glass, metal edges, or needles are the entry points for infection following exposure to bacteria and viruses and such infections include hepatitis B, fungi, or parasites. Occupational illnesses related to infection by bacteria, fungi, and viruses include contact skin infections, diarrhoea, and skin diseases. Landfill workers are highly prone to infection through inhalation of landfill gases that maybe contaminated. Prolonged exposure to contaminated air in composting operations was reviewed to cause allergic responses such as asthma, chronic bronchitis, and hay fever. According to Van Eerd (1996) and Van Eerd, (1998), other symptoms of biological infection in waste workers include chills, irritation of eyes, nose, and upper respiratory tract, nausea, headache, chest tightness, and feeling of influenza. In addition, the same author in Jerie (2016), ascertained that waste workers experience higher incidents of diarrhoea, viral hepatitis, and higher incidents of obstructive and restrictive respiratory disorders than control groups and they also suffer from dog and rat bites, skin diseases, and jaundice . Studies have shown that workers in paper sorting operations have the highest incidence or chances of lung infections compared to all other waste workers and this is a result of high levels of organic dust and endotoxins. A study in Zimbabwe by Jerie (2016) unraveled that the waste generated in the enterprises of Bindura exposed waste workers to illnesses such as common cold, cough, bronchitis, bronchial asthma, tuberculosis, and respiratory infections.

Microorganisms present in waste cause intestinal diseases such as worms, flukes, and viruses among waste workers (Hamer, 2006). Binion *et.al*, 2012 contends that food poisoning, caused by ingestion of contaminated foods may cause diarrhoea, parasite infection, and nausea. Furthermore, informal waste workers are prone to stomach infections since they come into contact with human and animal excreta (Gutberlet and Baeder, 2008). Other diseases that maybe

experienced by waste workers are plague and leptospirosis which are transmitted through exposure to rodent urine.

2.4.6 Psychosocial hazards

Solid waste handlers have a low social status and their livelihoods are characterized by poverty, starvation, malnutrition, low education level, physical and emotional abuse, lack of training of basic health care and first aid, limited access to health care facilities, as well as precarious living arrangements (Binion and Gutberlet 2012). The social stigma and marginalization that prevails at their various workplaces create unnecessary stress. Solid waste handlers also face constant occupational threats, such as being harassed, or being bullied. A study on recyclers in Guatemala reported that they avoided health clinics and hospitals when injured or sick for fear of discrimination (Frings-Dresen M, 2005). An investigation in Kathmandu, Nepal revealed that 73% of informal recyclers confirmed that they did not wash their hands with soap after work and 65% would not change out of their work clothes (Cointreau, 2006). These examples are evidence that the social stigma attached to working in a dirty environment continue to the home and the solid waste handlers tend to neglect their own upkeep. Additional factors contributing to high psychosocial stress include fatigue, nausea, and headaches. Another study in Brazil demonstrated that traces of minor psychiatric disorders were observed in waste recyclers as well as signs of depression and anxiety. These signs were hypothesized to be caused by constant injuries and monotonous work.

2.5 Hazard assessment

After identifying all hazards, the next step would be hazard assessment. A systematic hazard assessment process is the best way to determine priorities for hazard control. A risk management approach may be used in hazard assessment by prioritising those hazards which are likely to happen as well the magnitude of the consequence if it happens. According to the New Zealand regulations on solid waste handling, it is critical for employers to consult employee representatives when identifying and assessing hazards in the workplace in order to obtain an in-depth appreciation of the hazards including the complex ones.

In the solid waste and resources industry, hazard assessment involves analysing the type of job task and the time required to complete them, the work process and the working environment. The hazard assessment process also involves a critical review of instructions provided by designers, suppliers, importers and manufacturers of equipment. Further to that, the hazard assessment process also involves partaking some technical evaluations for example, on ergonomics and maintenance of equipment. The process of hazard identification should also include analysis of near-miss or injury data in order to assess the magnitude of the hazards.

2.6 Hazard Control

After hazard identification, the next step is to identify the exposed persons and the extent of exposure. The necessary prevention and control measures are then identified and the process of reviewing the effectiveness of the already existing measures is included. Legislation or best practice involves using a hierarchy of controls. After hazard identification, the first control measure is to eliminate the hazard if it is possible to do so. If the hazard cannot be practicably eliminated, substitution becomes the next desired control measure by replacing the process, task or material with a lesser hazardous one. The next step is to implement engineering controls for example putting a barrier between the hazard and the worker. The last resort if the hazard cannot be isolated is to minimise it by following safe work practises such as provision of personal protective equipment, proper maintenance of equipment, safety and health training of employees, supervision of inexperienced or untrained workers and monitoring the employees' health and exposure to the hazard. The hierarchy of controls follows that, considers hazard elimination first because it is the most effective methods and the interventions such as issuing personal protective equipment are considered as the last resort (Health and Safety Executive, 2011).

Workers should be involved in the risk assessment process since they have experience and knowledge about the workplace hazards (European Council Directive 89/391/EEC). In the hazard control process, the employer should ensure that the new control measures are effective and safe, and that the control measure itself does not create new hazards. The workforce should be trained on the control measures adopted and they should ensure that they are implemented properly. The New Zealand legislation also requires the employer to ensure that control measures are regularly reviewed.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

Chapter three explains the approaches and techniques that were used for data collection to explore the safety and health hazards associated with solid waste management in Bindura Town. A multi-methods approach which employed both qualitative and quantitative paradigms was employed in the study. This chapter outlines the research design, methods of sampling, data collection tools and techniques and data analysis, in each instance justifying the choice of methods used.

3.2 Research design

Research design is the conceptual structure within which the research is conducted and it constitutes the blueprint for the collection, measurement and analysis of data (Kothari, 2004). The purpose of the research design is to outline the procedures employed by the researcher from formulating the hypothesis and its operational implications to the final analysis of data.

The study was an explorative case study, which triangulated both quantitative (positivist) and qualitative (intepretivist) approaches. The design enabled the researcher to conduct a critical analysis of the occupational safety and health hazards and the prevalence of work related injuries and illnesses experienced by solid waste workers at Bindura Municipality. The case study design was employed because it isolates significant unique features of distinct events, processes and interactions. The research was explorative in nature because very few studies pertaining to occupational safety and health risks associated with solid waste management have so far been conducted in Zimbabwe.

The research approach applied in the study was multi-methods, and the reason was to combine both qualitative and quantitative methods that would be useful and would complement the strengths and weaknesses of each methods. The elements of qualitative and quantitative research approaches were combined for the broad purpose of breadth and depth of understanding and

corroboration (Johnson et al. (2007). The qualitative data were statements obtained by interviewing all respondents face to face, based on semi-structured questions. The quantitative data were self-reported perceptions gained from a sample of the solid waste workers about the hazards associated with solid waste management. The qualitative data was obtained through open-ended questionnaires, interviews and field observations. The quantitative design focused on hypothesis testing through statistical testing and data analysis to establish relationships between variables such as type of waste and nature of hazards. Quantitative data was collected using close-ended questionnaires. The concurrent research philosophy was used in the study. The concurrent design embroils the simultaneous collection and analyses of both quantitative and qualitative data, merging both and combining them to best understand the research problem (Onwuegbuzie and Johnson, 2006)

3.3 Target population

The target population is the group of elements of interest from which information is desired (Gray, 2004). The study population was drawn basing on the job task performed by solid waste workers who were in direct contact with waste, that is, street sweepers, waste pickers, refuse collectors, refuse truck drivers, and their direct supervisors at the municipality. The management in the Environmental Health department and inspectors from the regulatory authority, NSSA were included, in order to gather their perceptions on occupational safety and health hazards encountered by solid waste workers. Solid waste workers were targeted because they are directly involved in waste collection and removal, and as such, their experiences enabled them to reveal the hazards that were not identifiable by mere observations. The solid waste workers were also targeted in order to gather their perceptions of the effectiveness of the running safety and health programmes or policies at the municipality.

The researcher targeted the immediate supervisors that is, the Environmental Health Technicians and the managerial personnel in the Environmental Health and Services department as well as the Human Resources personnel in order to assess the level of management commitment in OSH issues in the organisation. Their vast experience in solid waste management was also key in identifying the safety and health hazards encountered by solid waste workers. The NSSA

inspectors were also targeted because they regulate OSH issues in all organisations through inspections, assessments and they had knowledge on the statistics on compensation claims of injured workers. In addition, they have vast knowledge on safety and health hazards encountered in various workplaces and as such, they contributed in identification of hazards as well as giving recommendations on how the municipality could achieve an accident preventive culture. Secondary data was also sourced from NSSA publications.

3.4 Sampling size and its determination

A research study can be conducted either by enumerating the entire study population (census survey), where every individual is given an opportunity to respond or by examining only a portion of the total study population in which one is interested (sample survey), where the obtained results are then inferred to the whole study population. The population of solid waste workers at Bindura Municipality was small and as such, the non-probability census sampling approach was employed in this study. All units of the population, that is, forty six, solid waste collectors, street sweepers, drivers, waste pickers and immediate supervisors at Bindura Municipality were included.

The sampling method that was suitable for the study was the non-probability saturation sampling technique. The technique, according to Laerd Dissertation (2012), is a purposive sampling technique that examines the entire population in the survey. Saturation sampling or total population sampling may be selected to study an entire population that exhibit specific characteristics. The Municipality of Bindura had forty six solid waste workers who are directly involved in street cleaning, collection, transportation and waste disposal. Therefore, the total population sampling technique involved all of the 46 solid waste workers to participate in the study.

Purposive sampling involves selecting members from the population to comprise a sample because they specifically meet some prescribed purpose or possess specific attributes of interest that address the purpose of a particular research problem under investigation. This method was used to select key informant interview respondents such as the Environmental Health Officer,

Human Resources manager, Director of Environmental Health Services, NSSA Inspectorate and Promotions Officer and the immediate supervisors (Environmental Health Technician).

3.5 Methods of data collection

The research employed qualitative and quantitative data collection methods. Primary and secondary data sources were used and these were questionnaires, interviews and observations.

3.5.1 Questionnaires surveys

A questionnaire is a data collection instrument comprising of a series of questions and their prompts for the purpose of gathering information from respondents (Abawi, 2013). The questionnaire designed for this survey aimed at collecting information on the occupational safety and health hazards associated with solid waste management. The questionnaires were administered to solid waste workers who are directly involved in solid waste handling. The questionnaires were self-administered in order to ensure response as well as to gain in-depth information about the types of hazards, nature of exposure or outcome that is, injuries and illnesses and the practical measures in place in order to control the hazards.

The questionnaire was partitioned into four sections: sections A (demographic information), section B (types of hazards), section C (nature of hazards, injuries and illnesses) and section D (controls in place to reduce workplace hazards). The survey questionnaire was semi structured, containing both open-ended and closed-ended questions. Close ended and open ended questions were used concurrently to collate qualitative and quantitative data. Close ended questions were used where specific information was required and open ended questions were vital in obtaining the perceptions of the respondents. The respondents marked in the provided boxes mostly in section (A) and completed given spaces on the questionnaire in other sections of the questionnaire. Respondents were asked the same questions to ensured reliability of the instrument.

Demographic information was important because it helped to identify predetermining factors on the choice of occupation, such as educational level, age, social status and as well to gather their perceptions on handling solid waste. Preparation of the questionnaire involved the following steps; listing of required information on the basis of pre-determined hypotheses, framing

questions with suitable scale of measurement, compiling the first draft of questionnaire and pre-testing it, compiling the final draft of questionnaire and then distribution of questionnaires in the selected sample.

3.5.2 Interviews

An interview is a research technique that involves collecting data by asking questions (Abawi, 2013). Interviews were used for the purpose of gathering information on safety and health hazards associated with solid waste management. The interviews targeted the key informants namely Environmental Health Technician, Environmental Health officer, the Director of Environmental Health Services, Human Resources manager and NSSA inspector. Key informants were interviewed with the help of an interview guide, which was used to get in-depth information and deeper insights on the types of solid wastes generated, the existence of OSH policies at the Municipality, safety and health training provided for solid waste workers and the perceptions, attitudes, opinions, and overall implementation of regulations pertaining to OSH. Yin (2011) contends that, guided interviews are particularly useful when the aim of an enquiry is to gather information about the opinions of particular persons or institutions in order to gain qualitative insights into a problem of interest. A total of 5 interviewees participated in the study.

3.5.3 Field observations

Field observations give the researcher an insight of the actual workplace setting and can provide new ideas to the study. Personal observations were undertaken to assess the typical tasks performed during waste collection and disposal and the associated hazards. A hazard identification and risk assessment methodology was used and a checklist was used as the data collection tool. The checklist was covered areas including general workplace environment outlook, signage, provision of PPE/C and use, and environmental pollution. Direct observations were essential in conducting job safety analysis for each task during the handling of waste by solid waste workers at the municipality. The information gathered during walk through surveys is useful in validating data collected from other research instruments.

3.5.4 Secondary data sources

Secondary data is obtained by reviewing literature from the body of knowledge collated by other researchers. It is vital in complementing data obtained from primary sources in order to attain a

comprehensive study. In the context of this research, secondary data was obtained from the Environmental Health department documents, internet, OSH journals, textbooks, newspaper articles, and past research papers. The researcher consulted records such as Personal Protective Equipment distribution lists, waste collection schedules as well as attendance registers in order to verify the frequency of absenteeism from work and to evaluate the measures in place to ensure the safety of solid waste workers. The researcher also made reference to the National Social Security Authority (NSSA) annual reports on accident and injuries imminent in Local Authorities. Review of literature from previous researches were instrumental in identifying knowledge gaps on occupational safety and health hazards associated with solid waste management.

3.5.5 Validity and Reliability of Data Collection Tools

In order to ensure relevance of the research findings more than one method of data collection was used. The use of different data collection tools such as questionnaires, observations and interviews was a strategy that ensured validity. Triangulation of these methods was done to validate the findings. Data on hazards affecting solid waste workers was obtained from workers performing different tasks as well as from the employers and the regulatory authorities, to incorporate information on the practical experience and the theoretical knowledge, thus further triangulating the findings. The results were compared with empirical studies by previous researchers to check for consistency. The respondents were given the assurance of confidentiality and that the research was being conducted for academic purposes only. As a result, they provided information without reservations thereby increasing the reliability of the research. The researcher also consistently checked and verified the collected data to ensure that it satisfied the objectives of the study.

The researcher also ensured validity by pilot testing the data collection instruments prior to the actual data collection by checking if the instructions on the questionnaires were clear and if all questions were adequately answered such that in case there were some questions that remained unanswered the questionnaire would then be corrected before the final data gathering. The use of a checklist in the field observations ensured that all observations were carried out in a methodical way, thus ensuring consistency in data collection.

3.6 Ethical considerations

Research ethics are rules of conduct guiding professional conduct within research. It is necessary to consider ethics prior to carrying out a research. Individual scrutiny is unprecedented when it comes to research ethical behavior (Best and Kahn, 2000). The researcher observed various ethics while carrying out the study. Consent to carry out a research was sort from Bindura Municipality through a written letter of request for permission and it was granted. The researcher ensured that participation of the respondents was voluntary by informing them the purpose of research and the components of the research, prior to their agreement or refusal to participate in study. In this regard, the findings from the research were used for study purposes only.

Gray's (2004), posits that, the purpose of any research is to collect data and not to alter the respondent and/or their opinion. As such, the researcher ensured that there was no influence on the information provided by the respondents. The ethical principle of anonymity was observed in the research and as such, no names of respondents were mentioned thereby maintaining anonymity in the report. Secondary data sources were acknowledged to their respective authors and plagiarism was avoided.

3.7 Data presentation and analysis

According to Kothari (2004) statistics involves processing of data by editing, coding, classification and tabulation and also analysis of data. Quantitative and qualitative data was inputted into the Statistical Package for Social Scientists (SPSS 16.0) program for processing, analysis and interpretation. Qualitative data from questionnaires, interviews and observations was critically analysed and inferences and conclusions were made about the occupational safety and health hazards associated with solid waste management. The findings were presented in table form, graphically, and in the form of pictures.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents the results and the discussion on the findings related to the occupational safety and health hazards associated with solid waste management practices at Bindura Municipality and the assessment of the effectiveness of safety and health programmes in place. The data was collected through questionnaires, interviews, walk-through surveys and secondary data. The study participants were selected from the Department of Health and Environmental Services which is responsible for solid waste management.

4.2 Organisational structure of solid waste management at Bindura Municipality

Bindura Municipality is a local authority under the Ministry of Local Government, Public Works and National Housing. The Town Clerk heads the executive management which comprises of the boards of directors namely Director of Health services, Director of Engineering, Director of Housing and community services, Director of Finance and the Chamber secretary who are the heads of the five departments housed at the Municipality. The Town Clerk also manages a board of councillors who are led by the ceremonial Mayor. The development, operation and maintenance of sanitation services in Bindura are the responsibility of the Bindura Municipality. Solid waste is managed under the Health Services department headed by the Environmental Health Officer. At full capacity, the department operates with more than seventy five solid waste workers but currently, only 46 workers are employed. Considering the rate of infiltration of informal enterprises in Bindura and the uncontrollable increase in waste generation, this staff compliment is inadequate. Figure 4.1 below shows the organogram representing the organisation structure of solid waste management at Bindura Municipality.

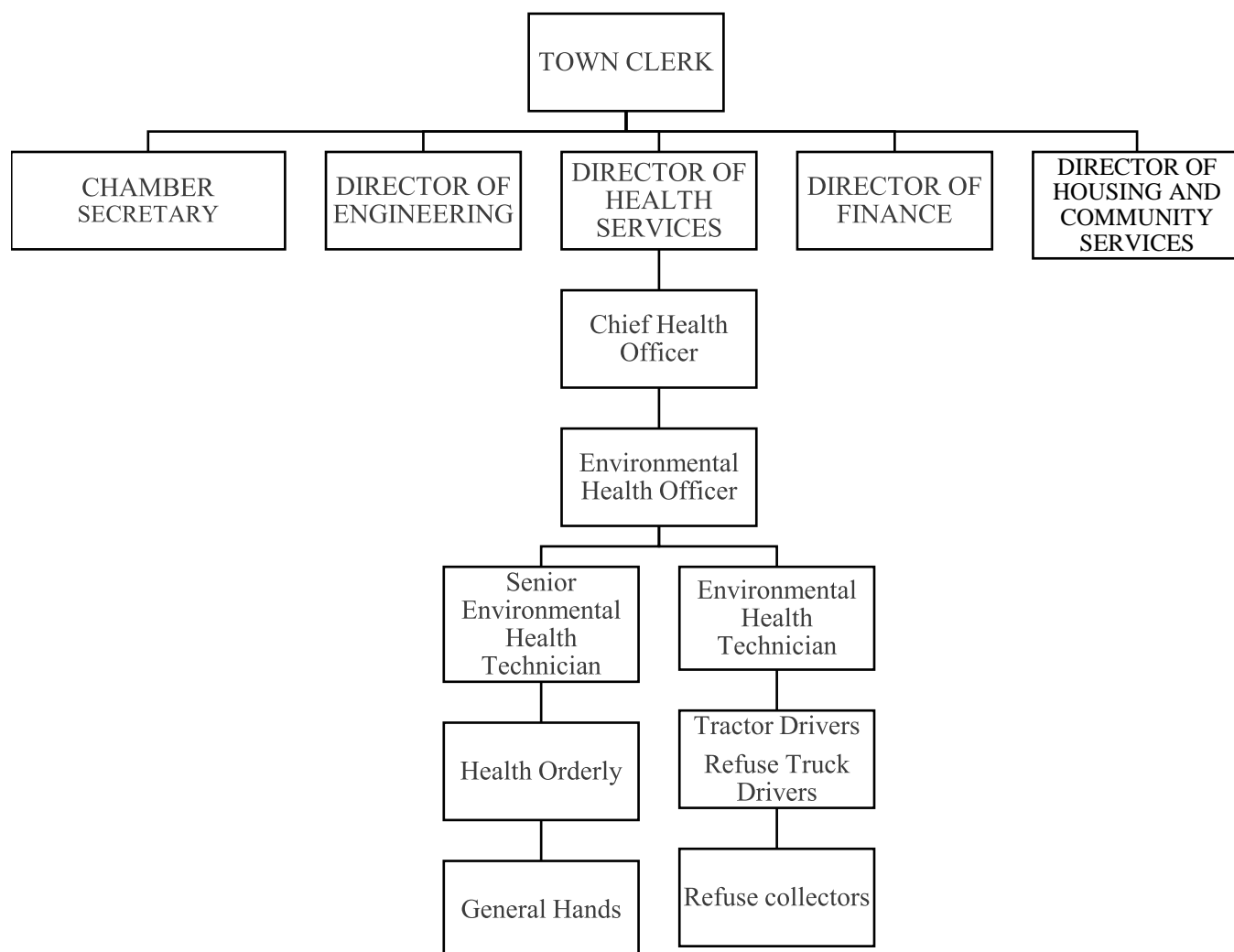


Figure 4.1: Organogram showing organisation structure at Bindura Municipality.

4.2.1 Information on Social Demographic of solid waste workers.

The study covered all solid waste workers employed by the Municipality. A total of 44 out of 46 (95,6%) questionnaires were distributed to employees involved in different solid waste handling tasks. Two respondents declined to participate in the study. Table 4.1 below shows the distribution of employees according to job task where 45.5% (20) of the employees were street sweepers, 34.1% (15) were refuse collectors, 13.6% (6) were waste pickers and 6.8 % (3) were truck drivers. Of these respondents, there were more male than female waste workers

constituting 54.5% and 45.5% of the study population respectively. This showed that solid waste handling is dominated by manual job tasks mostly done by males.

Table 4.1: Distribution of solid waste handlers according to job task

Job tasks	Number of employees	
	(N = 44)	(%)
Truck drivers	3	6.8
Refuse collectors	15	34.1
Street sweepers	20	45.5
Waste pickers	6	13.6
Total	44	100

Of the 44 respondents 81.8% reported having attained secondary education and 18.2% reported having gone through primary education. Most of the workers (43.2%) who took part in the study were in the age group 41-50 years. Employees less than 20 years of age, and those above 50 years, constituted the least number of employees, with 4.5% representations in each age group, followed by those between 21-30 years age group that formed 15.9% of the sample. Lastly, the 31 – 40 year age group constituted 31.8% of the sample size which was the second highest represented age group. The education level and age groups of workers revealed the social status of the workers to be low. The older people dominate the industry showing that it is considered a lowly job by the productive age group.

The questionnaire responses indicated that 38.64% and 29.55% of the respondents had 1-5 years and less than 1 year work experience respectively, as illustrated by Figure 4.2 below.

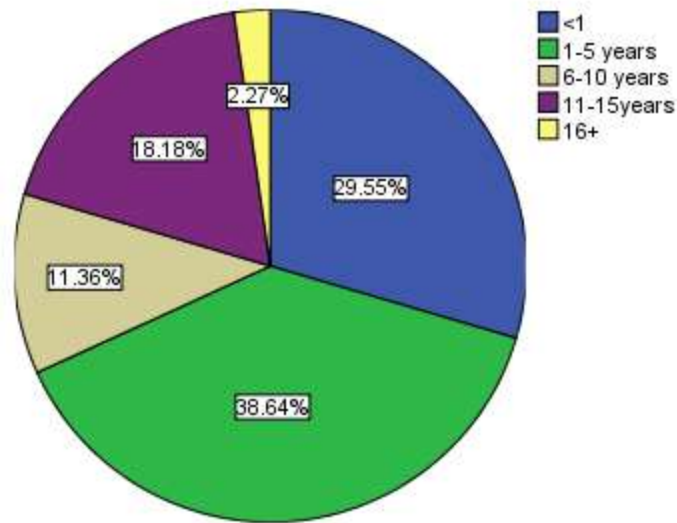


Figure 4.2: Distribution of workers according to number of years at work.

4.2.2 Employment status of solid waste handlers

All solid waste handlers were employed by Bindura Municipality. However, the employment categories were different with 58.1 % of the workers were employed on casual basis whilst 31.3 % were permanently employed. 9.1% were part time workers and only 2.3% were employed on the basis of a contract. A massive staff retrenchment program at Bindura Municipality triggered by economic challenges and some cost-cutting strategies that were adopted implored the incorporation of volunteer waste pickers often referred to as casual workers who are paid on a monthly basis. As a result of the work placement arrangements, the majority (68.7%) of the solid waste workers were not covered by the workers compensation scheme and or medical aid schemes.

4.3 Types of waste generated

The categories of waste generated in Bindura included organic and inorganic waste components. Physical observations of waste types were made and buttressed by information from secondary data from the WASH baseline survey report (2015). According to WASH survey report (2015), organic wastes comprise of food waste, yard waste, sanitary waste, paper and wood whilst inorganic waste contain plastics, glass, metal, electronic, ceramic, medical waste, textile and debris and ashes. The major components of waste that were observed were biodegradable wastes

mainly food and vegetable wastes followed by plastics. These two categories were the most common types of wastes that were mentioned by 45.4% and 18.9% of solid waste workers respectively. The composition of waste were observed to differ according to location of waste receptacles. Vegetable waste and food wastes were observed in market places and household bins respectively. Plastics were mainly observed in shopping centres and these ranged from bulky packaging materials to smaller consumer food packages. Paper waste such as cardboard box was observed in relatively low quantities because waste generators were mandated to dispose of them at the local dumpsite. According to a key informant, Bindura Municipality does not provide services for disposal of medical waste. Instead it was supposedly incinerated at the local hospitals. However, the measures of monitoring medical waste disposal are porous because refuse collectors mentioned that they encountered syringes and soiled sanitary ware from private surgeries. Waste collection in Bindura is performed in a traditional way with most household solid waste being mixed together. There are limited sustainable waste management initiatives on reducing, reuse and recycling. The table 4.2 below shows the types of solid waste found in Bindura urban.

Table 4.2 Characterisation of waste by Environmental Health Department at Bindura Municipality.

Waste category	Examples of waste
Organic	
Food / vegetables	Sadza, vegetables, bones
Sanitary	Diapers, pads, bandages, cotton wool, syringe, razor blades, needles,
Paper	Cardboard box, general paper
Inorganic	
Yard waste	Tree leaves, twigs, dry grass
Wood	Wood shavings, offcuts
Plastics	Packaging plastics, paper bags, polythene
Ceramic	Broken toilets, plates, cups
Glass	Broken glass, empty bottles, fluorescent tubes, energy saving light bulbs

Metal	Scrap metals
Electronic	Broken televisions, irons, cell phones, radios, computers
Debris and ashes	Dust, rubble, wood ash
Textile	Cloth, wool
Hazardous waste	Batteries, pesticide containers, agrochemical containers, oils, paints

Source: WASH survey report (2015)

4.3.1 Hazardous solid wastes identified by solid waste handlers

A survey was conducted to identify the types of waste which inflict injuries and illnesses to municipal solid waste handlers. The different types of waste identified by the respondents were categorised by the researcher into eleven waste categories following the Bindura Municipality Department of Health's waste categories (Table 4.2), namely plastic, paper, glass, metal, food waste, electronic waste, debris, ashes, dead animals and sanitary waste. The highest proportions of solid wastes that were identified by solid waste workers were amongst domestic wastes that is paper, plastic and food waste. Most of the workers mentioned that they encountered paper waste, with a proportion of 61.36%. Food wastes were identified by (56.82%) and plastics were mentioned by 34.09% of the respondents. Questionnaire responses also showed that, 52.27% of the respondents encountered sanitary waste, which contained used pads and diapers with faeces. Human waste exposes all categories of solid waste workers to risk of pathogenic infections such as helminthes and gastrointestinal infections (Hunt, 2000 and Cointreau, 2006)

Observations and interviews responses from refuse collectors revealed that these wastes were mixed and stored in a single receptacle at household level. Mixed wastes may contain hazardous wastes which pose a wide array of health risks for solid waste handlers, as a result of airborne dust, bacteria, faecal coliform bacteria and fungal spores (Guterbet et. al, 2008). Tchobanoglous, Theisen, and Vigil (1993) in Jerie (2016) contends that hazardous wastes can be lethal and may cause detrimental cumulative effects. A slightly lower proportion of respondents (38.63%), revealed that they encountered glass whilst 13.64% of the solid waste workers mentioned that they handled metal. Glass and metal wastes, exposes refuse collectors and street sweepers to

mechanical injuries such as cuts which may cause viral infections such as hepatitis B/C and tetanus (Jerie, 2016). Other categories of waste that were identified by waste workers were dead animals, debris, animal waste and ashes. These waste may be hazardous depending on their different compositions. Table 4.3 below shows the different types of waste identified by solid waste workers.

Table 4.3 Types of waste identified by solid waste workers

Type of waste	Frequency	Percentage (%)
Paper	27	61.36
Plastic	15	34.09
Glass	17	38.63
Metal	6	13.64
Sanitary	23	52.27
Food waste	25	56.82
Debris	3	6.81
Hazardous waste	3	6.81
Animal waste	6	13.64
Dead animals	6	13.64
Ashes	6	13.64

4.4 Occupational hazards associated with solid waste management.

An analysis of the occupational hazards encountered in waste management revealed that solid waste workers are exposed daily to physical, biological, chemical and psychosocial hazards. Figure 4.3 below shows the major hazards which were identified that affect the overall well-being of solid waste handlers.

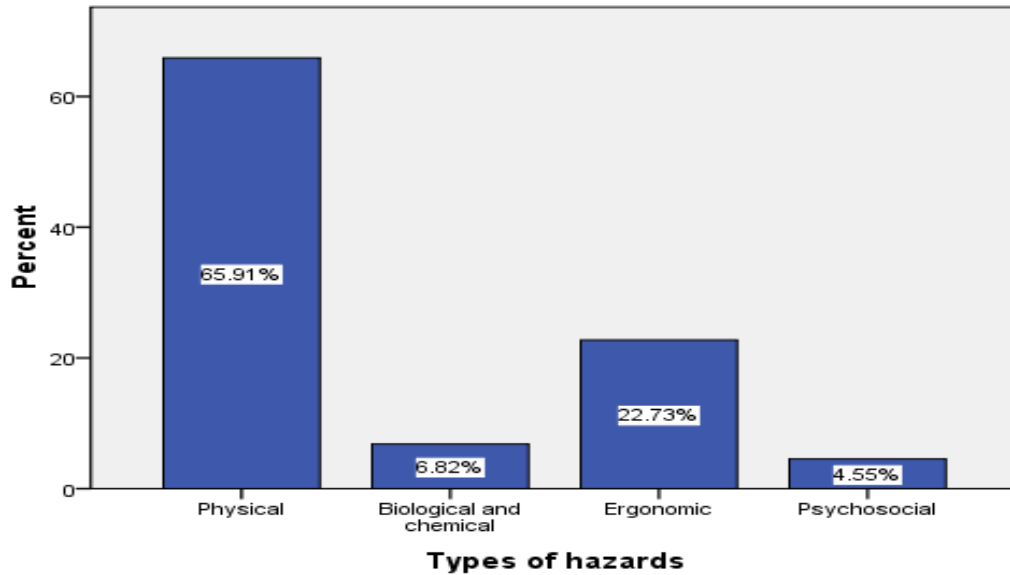


Figure 4.3: Types of hazards encountered by solid waste handlers

4.4.1 Physical hazards

The prevalence of physical hazards was highest among solid waste handlers with a proportion of 65.91% of respondents, who were mainly refuse collectors and street sweepers confirming that they were exposed to various physical hazards. Physical hazards in solid waste handling may constitute cuts from sharp objects such as broken bottles, metal bins with jagged edges, razor blades, glass, scrap metal, hit by moving object and needle pricks from medical waste mixed in the domestic waste stream. 59.1 % of solid waste workers at Bindura Municipality reported that they had been cut by glass, scraps of zinc or iron roof sheets and edges of metal bins. Wounds from sharp objects amongst solid waste collectors were also noted by El-Wahab (2014) and Kuijer and Frings-Dresen (2004). Observations from the walk through survey also revealed that solid waste workers were exposed to dust, smoke from burning waste, vehicle exhaust fumes, noise from traffic and working in heavily frequented roads. Responses from questionnaires revealed that, street sweepers were concerned about the high volumes of traffic that they encountered on a daily basis, citing that they were not provided with reflective vests for better visibility during the course of work. Solid waste workers at Bindura Municipality reported exposure to harsh weather conditions considering that they worked outdoors for eight hours, from early hours of dawn until late afternoon. They also revealed that their work schedule

remained the same throughout all seasons. An interviewee revealed that the hot temperatures affected solid waste workers and most of the time, they removed their PPE because of discomfort. Ergonomic hazards were also significant mainly because of the lack of lifting procedures and manual lifting of heavy loads.

4.4.2 Ergonomic hazards

Ergonomic hazards are significant amongst solid waste workers constituting 27.73 % of the usually identified hazards (Figure 4.2). The questionnaires responses revealed that 38.6% of waste handlers indicated that they experienced acute back pain and painful joints. Ergonomic hazards are amplified by the traditional solid waste management practices in developing countries such as manual lifting, pushing, pulling, and offloading of waste and the maintenance of awkward postures during cleaning (Cointreau, 2006). Responses from questionnaires showed that waste collectors mostly suffered from back pain due to lifting of heavy loads, work overload and lack of control of work organisation. The offloading of the 240 litre metal bins exposes refuse collectors to twisting and forceful lifting at awkward angles which may have an impact. Pruess *et. al*, (1999) in Jayakrishnan, *et al*. (2013), reviewed many studies where researchers acceded that mechanical loads lifted during waste collection exceeded maximum acceptance limits recommended; during the performance of tasks such as throwing waste bags which result in compression of the spine and lifting loads that induce twisting of the shoulder resulting in increased cases of musculoskeletal disorders (MSDs).

A key informant at Bindura Municipality revealed that only two vehicles were used to collect waste in the whole town of Bindura, one compactor and one tractor were an indication that waste collectors were always working behind schedule. High working speeds could possibly also contribute to the development of MSDs because the workers fail to concentrate on following the proper lifting techniques. The respondents explained that their major concern was to achieve their waste collection targets. They also revealed that they had not undergone any training on ergonomics, thereby rendering them ignorant of the proper procedures of lifting heavy waste material.

4.4.3 Biological and chemical hazards

The prevalence of biological hazards among solid waste workers is increased by the frequency of exposure through contact with infectious material on waste vehicles and direct contact with waste. Figure 4.3 shows the proportion of biological and chemical hazards which constituted 6.8% of hazards that were identified. Biological and chemical hazards are mainly caused by working in contaminated environments. Biological hazards can be characterised by contamination through viruses, fungi, protozoa, and other bacteria. Jerie (2016) contends that infections of the skin and blood, by pathogens in solid waste management commonly occur through direct contact with waste and from infected wounds, zoonosis due to bites by wild or stray animals feeding on waste, and enteric infections transmitted by insects. Observations revealed that the working environments of waste workers were covered with leachate from decomposing waste and refuse collectors made direct contact with their hands on contaminated vehicles and they only wore gloves when they were offloading bins. Responses from the questionnaires revealed that solid waste workers were mostly in contact with decomposing food wastes, which are a potential source of numerous pathogens. The risks of biological infections amongst solid waste workers are very high though only 15.9% of respondents revealed that they once had diarrhoea. Another factor contributing to biological hazards was the lack of sanitary facilities, such as wash rooms, where workers should be supplied with soap to cleanse themselves after work.

Chemical hazards are characterised by physiological poisoning and dermatitis injuries, such as burns and respiratory illnesses (Binion and Gutberlet, 2012). Questionnaire responses revealed that solid waste workers were exposed to negligible amounts of chemical-contaminated wastes. However, respondents stated that they encountered empty containers of pesticides, agrochemicals and sometimes old batteries. These responses revealed that solid waste workers are at risk of exposure to lead poisoning. Jerie (2016) notes that lead, bio-accumulates in the blood causing long term health effects on internal organs. Furthermore, contact with skin or inhalation or ingestion of chemicals residues, emanating from hazardous chemicals such as cleaning solvents, insecticides and herbicides can cause dermatitis, central nervous system disorders, and possible liver and kidney damage. Refuse collectors were highly exposed to chemical hazards through direct contact with skin, since they did not put on long- sleeved jackets

to protect their hands. The majority of the refuse collectors were observed whilst wearing short sleeved t-shirts and gloves during work.

The responses from questionnaires revealed that 9.1% of solid waste workers had chest problems and continuous cough. These symptoms could be attributed to exposure to chemical residues and vehicle exhaust fumes. Cointreau (2006), contends that constant exposure to exhaust is associated with a higher level of bronchitis as well as headaches and nausea.

4.4.4 Psychosocial hazards

Other hazards related to solid waste handling are psychosocial hazards which are associated with stress, work overload, public perceptions of solid waste work and the low rewards for the monotonous work. The proportion of psychosocial hazards among solid waste workers was 4.55%. The key informant highlighted that, male solid waste handlers had a tendency to come to work under the influence of alcohol. The dependence on alcohol in order to perform work in itself is a hazard and increases the risks of injuries. A proportion of 9.1% of respondents revealed that they often experienced stress due to the behaviour of the public who intentionally threw litter on the streets after they had cleaned up. Work overload was mentioned by refuse collectors and sweepers who were affected by the retrenchment of staff such that, the work which was previously tasked eight people was performed by two workers only.

4.4.5 Occupational injuries encountered by solid waste workers

Injuries	Frequency	Percent
Cuts, pricks and falls	26	59.1
sprains, strains, broken limbs,	10	22.7
Lacerations	1	2.3
eye injury	2	4.5
back pain	5	11.4

Injuries	Frequency	Percent
Cuts, pricks and falls	26	59.1
sprains, strains, broken limbs,	10	22.7
Lacerations	1	2.3
eye injury	2	4.5
back pain	5	11.4
Total	44	100.0

The respondents were asked to mention the type of injuries and accidents which befall them. The most prevalent injuries experienced by solid waste workers were cuts, prick and falls (59.1%). These findings were consistent with Bogale et. al (2014) who reported that cuts were the most common injuries (57.7%) amongst solid waste workers. Injuries such as cuts were common for most job tasks except for refuse truck drivers and waste pickers, who were either not in direct contact with waste or they chose not to get in contact with sharp objects. A respondent amongst waste pickers expressed that, they picked paper only, in areas that were accessible and they used pokers in precarious places. Unlike the waste pickers, street sweepers had inadequate tools and they were observed removing waste by hand. Respondents amongst this group cited that the gloves that were provided wore out quickly and resultantly exposed them to cuts and pricks. Refuse collectors were also vulnerable to cuts from jagged bin edges, during lifting and offloading, and pricks from bulging sharp objects (glass and scrap metal), which easily pierced through the bin liners and old sacks that were used as waste receptacles. Furthermore, refuse collectors who operated the tractor were at a higher risk of injuries because they lifted the waste receptacles, off-loaded into the tractor and then shovelled the waste manually when they offloaded the tractor at the dumpsite, thereby increasing the duration of exposure to injuries. Similar findings were authored by Gonese *et al*, 2002.

About 22.7% of solid waste workers mentioned that they were at risk of sprains, strains and broken limbs. These respondents were mostly refuse collectors who got injured during lifting and loading as well as, when they embarked and disembarked from the moving vehicles. A key informant highlighted that only one sprain accident was reported in the past year, which could be

a misrepresentation of the actual occurrence of injuries. The underestimation of injuries at Bindura Municipality could be attributed to the lack of accident reporting procedures. Questionnaire responses showed that workers did not report injuries because they regarded them as minor injuries, thus revealing their ignorance to infections such as tetanus, HIV and Hepatitis B/C.

A statistical test, Chi square test of association was conducted at 0.05 confidence interval to determine whether there was an association between encountered injuries and accidents and identified hazards. The following hypothesis were made:

H₀- there is no association between injuries and accidents and identified hazards.

H₁- there is an association between injuries and accidents and identified hazards.

If P > 0.05: Reject H₁ and accept H₀

If P < 0.05: Accept H₁ and reject H₀

Table 4. 5: Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	70.118 ^a	16	.000
Likelihood Ratio	36.855	16	.002
N of Valid Cases	44		

a. 22 cells (88.0%) have expected count less than 5. The minimum expected count is .02.

Therefore, $0.05 > 0.000$, we accept H₁ reject H₀. In this context, there is an association between the types of hazards identified in solid waste handling and the types of injuries and accidents encountered. The statistical significance shows that there is a relationship between hazards and injuries experienced by solid waste workers at the Bindura Municipality. It is thus certain that the solid waste hazards identified at the Municipality of Bindura have a risk of causing harm.

4.4.6 Determining the association between type of waste and hazards encountered by solid waste workers

A Chi square statistical test of significance of association between the type of waste handled and the hazards identified by solid waste workers was tested at 0.05 confidence interval. Two hypothesis were made that is:

H₀- there is no association between type of waste and hazards identified.

H₁- there is an association between type of waste and hazards identified.

If P > 0.05: Reject H₁ and accept H₀

If P < 0.05: Accept H₁ and reject H₀

Table 4.6 Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	33.823 ^a	20	.027
Likelihood Ratio	36.127	20	.015
N of Valid Cases	44		

a. 29 cells (96.7%) have expected count less than 5. The minimum expected count is .09.

Therefore, $0.027 < 0.05$, accept H₁. The results show that there is a strong association between type of waste and hazards encountered by solid waste handlers. It is highly likely that, solid waste workers are exposed to different types of hazards depending on the types of waste they encounter when articulating their individual tasks.

4.4.7 Determining the association between working experience and frequency of injuries and accidents encountered by solid waste workers

A Chi square statistical test of significance of association between working experience and the frequency of injuries and accidents encountered by solid waste workers was tested at 0.05 confidence interval. The following hypothesis was made:

H₀- there is no association between working experience and the frequency of injuries and accidents encountered.

H₁- there is an association between working experience and the frequency of injuries and accidents encountered.

If $P > 0.05$: Reject H₁ and accept H₀

If $P < 0.05$: Accept H₁ and reject H₀

Table 4.7: Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	36.833 ^a	16	.002
Likelihood Ratio	44.209	16	.000
N of Valid Cases	44		

a. 23 cells (92.0%) have expected count less than 5. The minimum expected count is .02.

Therefore, $0.002 < 0.05$, accept H₁. There is an association between working experience and the frequency of accidents and injuries encountered by solid waste workers. Workers with more years on the job tend to encounter less injuries because they have better knowledge of the workplace hazards.

4.4.8 Environmental pollution

Solid wastes by their nature, pose significant human health risk due to environmental pollution which results in contamination of air, water and soil. Observations from walk through surveys revealed that Municipality of Bindura used the traditional solid waste management practises which included four stages of generation, collection, transportation and disposal. At the generation stage,

there were no waste separation initiatives by consumers. Instead, it was observed that residents in Bindura town used a single waste receptacle per household to store waste prior to collection. Refuse collectors pointed out that they offloaded bins containing a mixture of wastes with pungent odours of rotting waste. Furthermore, waste in these areas was collected once a week as per the waste collection schedule such that, the Bindura Municipality Environmental Health

department pioneered the construction of temporary waste loading bays which were located in market places and shopping centres located in the high density suburbs. However, these waste loading bays posed a threat to the surrounding environment, animals and human health because they were poorly designed and could not adequately contain the waste as it was scattered all over the surroundings environs as well as lack of mechanisms to contain leachate from flowing directly into the environment. A key informant asserted that the system was effective during the rainy season because water would wash the leachate away. However, it seemed the environmental pollution implications beyond the collection site were not put into consideration. Latifah et al. (2009) and UN-Habitat (2006), contends that leaks from waste may contaminate soils and water streams, and produce air pollution through emissions such as heavy metals and persistent organic pollutants (POPs) and ultimately create health hazards. Residents in the vicinity of these waste collection areas may be exposed to health risks considering that residents throw away almost everything from industrial solvents to corrosive household detergents. Refuse collectors experience greater exposure to hazards when they shovel the waste by hand and load it into garbage trucks several days after dumping, depending on the waste collection schedule.

During transportation, some of the waste was scattered on the streets mainly in areas where bins were overloaded. Rotting organic waste mainly food leftovers were observed in the waste stream in garbage vehicles during transportation of waste. Hunt (2000), authored that, rotten organic waste creates conducive habitats for disease vectors which breed in and feed within the solid waste. Jerie (2005) echoed the same sentiments adding that organic wastes are breeding sites for mosquitoes and flies. Observations revealed that wastes were infested with flies especially at the dumpsite and they caused a nuisance to workers during offloading. Apart from being a nuisance flies are also vectors of faecal-oral diseases (Hunt, 2000).

Garbage was observed strewn all over in the outskirts of the town and several storm drains were evidently blocked by waste. These observations were similar to Cointreau (2006), who authored that in developing countries, enormous waste quantities are left uncollected resulting in blockage of drainages which result in the formation of habitats for insect breeding, flooding and waste dumps. Musadamba, *et al.* 2011 and Jerie (2011), posit that garbage does not only spoil the aesthetic value of the environment but it creates serious health risks. Illegal dumps were

observed along the major highways where the residents ignorantly dumped wastes without considering the associated environmental and health impacts. The disposal dumpsite in Bindura town did not conform to the legal standards provided for by the Environmental Management Act Chapter 20:27. An unlined, disused mine pit at *Kitsiyatota* was observed to be the point of solid waste disposal and it was evident that the levels of pollution were hardly monitored. It was observed that the dumping area was not monitored and there were no dump attendants, the situation giving access to scavengers who were not monitored.

Fires were observed at the dumpsites. These could be attributed to the high methane gas content that is produced as a byproduct of waste decomposition. Saungweme (2012) and Chifamba (2007) contends that the burning of waste can lead to the release of toxic smoke, greenhouse gases and harmful substances into the atmosphere which contribute to the formation of acid rain . These toxic gas emissions includes polyaromatic hydrocarbons, carbon monoxide, sulphur oxides, nitrogen oxides and volatile organic compounds (Thornton, 2002). Prolonged burning of waste increases the chances of surface and ground water pollution by oily materials. In terms of monitoring underground contamination by solid wastes, there were no monitoring activities at the Municipality and the dumpsite area had no monitoring boreholes.



Plate 1: Temporary waste loading bay at Chipadze high density suburb.

4.5 Measures established to prevent injuries and illnesses.

The research aimed at evaluating the effectiveness of the safety and health measures that were running at the Municipality. The methods used by the Bindura Municipality to prevent injuries included the use of personal protective equipment. Below are the findings that reveal the current measures that are in place at the municipality.

4.5.1 Training on safe handling of waste

The results show that only 13.6% of employees were trained on safe handling of waste before starting the job and 6.8% received on the job training (Table 4.6). The majority of waste handlers (79.5%) had never received any form of training or job orientation. However, training is one major element of an occupational safety and health management system which should cover all workers at organisational level including initial induction, refresher courses and continuous safety awareness programmes. Lack of training may be detrimental for efficient implementation of an organization's safety and health management system. Gonese *et.al*, (2002) asserts that the absence of training at the beginning of employment is a risk factor and thus training is vital to circumvent accidents. The results showed that there are no running safety and health management systems at the Municipality. This might have contributed to lack of training for waste handlers because they could not be trained to adhere to standards that do not exist. An interviewed key informant affirmed that the Municipality had no OSH policy. Another key informant revealed that workers were not receiving training because the Municipality did not have a Safety and Health Officer. Although efforts were made to formulate a Safety and Health committee at the organisation, the Human Resources Manager revealed that it was non-functional.

Table 4.8: Training on safe handling of solid waste

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Before being employed	6	13.6	13.6	13.6
On the job	3	6.8	6.8	20.5
Not trained	35	79.5	79.5	100.0
Total	44	100.0	100.0	

4.5.1 Pre-placement and Periodical Medical Examinations

The research revealed that all the 44 respondents, had not undergone pre-employment medical examinations when they were employed. Pre-employment medical examinations are a prerequisite for every employee and a requirement in all workplaces regardless of the type of activities in the undertaking as outlined in Statutory Instrument 68 of 1990 and International Labour Organisation Convention No. 155. The respondents revealed that they were initially incorporated as voluntary workers who were later engaged as casual workers and as such, medical examinations were not done. The key informant highlighted that in terms of health surveillance of employees, the Municipality provided contributory medical aid schemes to permanently employed workers only. Periodical medical examinations were not being conducted as revealed by 95.6% of solid waste workers. Only 2 (4.5%) indicated that they went for periodical medical examinations at their own cost whenever they felt that their health has been compromised. In terms of fulfilling the organisation's responsibility to provide periodical medical examination facilities, the Municipality has nothing in place. Failure to conduct pre-employment health examinations may potentially risk the health of workers as they may be deployed to do work that might worsen pre-existing health conditions. The current situation at the Municipality does not provide an opportunity for early detection of occupational disease and their rectification and thus, the solid waste workers are highly exposed to an array of health hazards.

4.5.2 Inadequate use of PPE

The respondents were asked if they were using PPE. The responses from questionnaires revealed that only 13.64% used PPE while 86.36% did not use PPE. Respondents exhibited knowledge on the importance of PPE and they mentioned that use of PPE was vital in preventing harm from hazards such as broken glass and sharp objects.

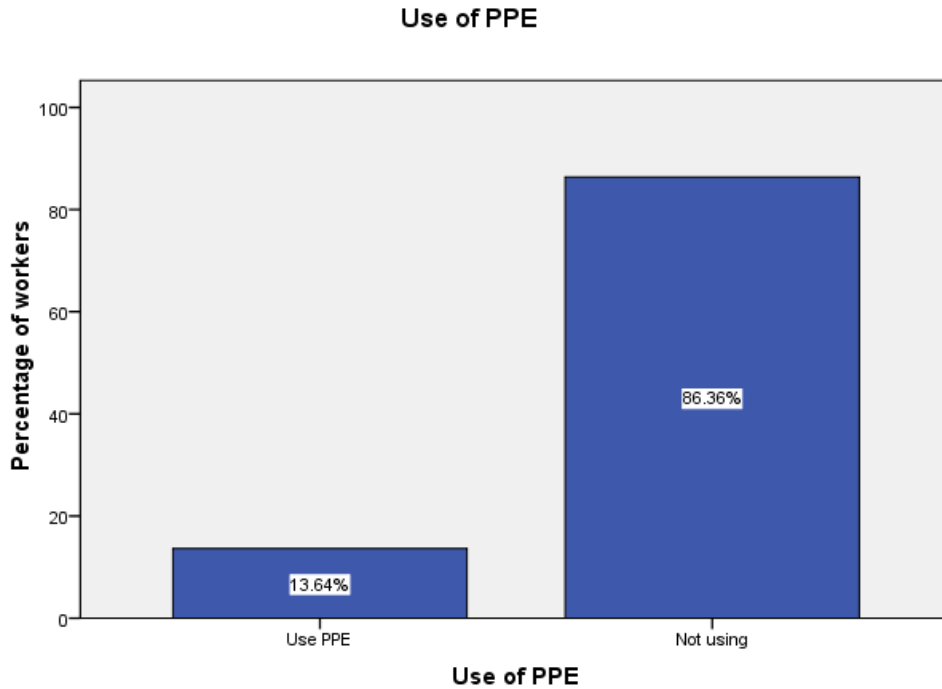


Figure 4.5: Proportion of workers using PPE

The respondents were asked the reasons why they were not using PPE and 84.09% indicated that the Municipality did not provide them with any PPE and 9.09% mentioned that PPE caused discomfort because of hot temperatures (Figure 4.6). About 6.82% of the waste handlers revealed that PPE was unpleasant and slowed them down at work. These responses reveal that the management is failing to meet their legal obligation to provide adequate PPE in terms of S. I 68 of 1990. Although PPE is the last line of defense according the OSH hierarchy of controls, its effective use provides a barrier between the worker and the hazards in the workplace thus reducing the health impacts. In another dimension, the observed inappropriate use of PPE could be due to lack of training on the proper use of PPE.

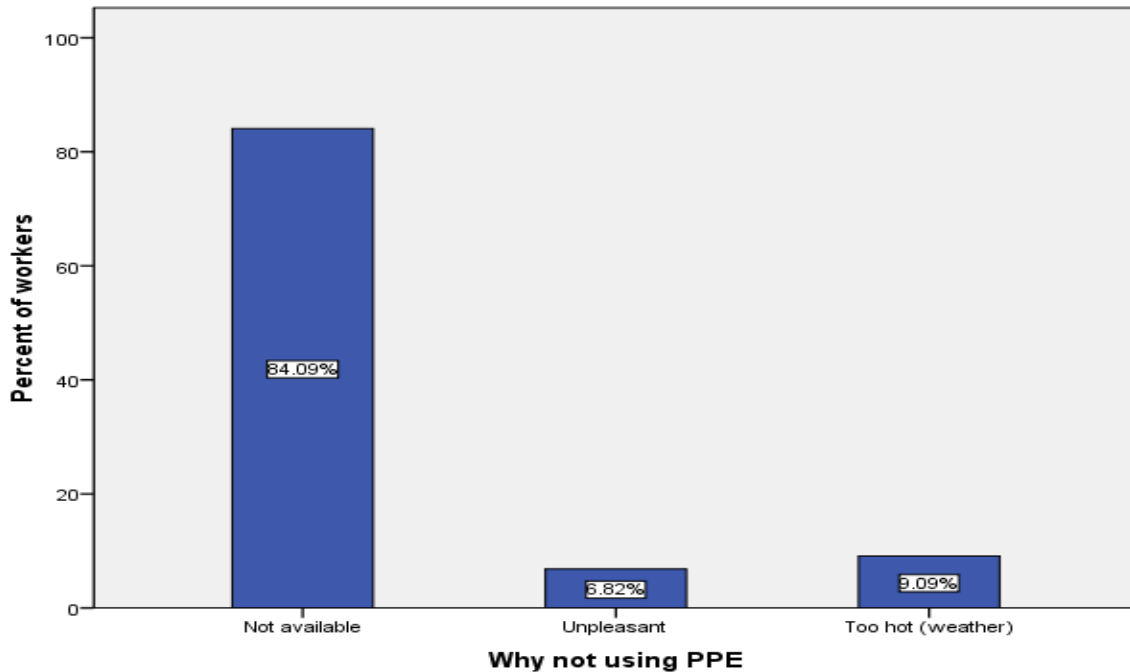


Figure 4.6: Reasons for not using PPE/C

Observations from the walk through survey revealed that all waste workers had inadequate PPE. Street sweepers wore gloves only when they were handling waste. Most workers did not wear face masks to protect themselves from dust and smoke. One refuse collector cited that respirators caused discomfort and made it difficult to breathe. According to findings by Jerie (2016), bin loaders and landfill workers complained that the material used to make respirators was not suitable as they faced similar breathing problems when they burned waste. Observations also revealed that amongst all waste handlers, none were using earplugs to guard against hearing loss. A respondent in the refuse collection team complained about exposure to high noise levels and lack of communication with the driver during transit from point of collection to the dumpsite which posed more hazards for refuse collectors.

4.5.3 Determining association between training on safe handling of waste and use of PPE

A Chi square statistical test of significance of association between the training on safe handling of waste and use of PPE was tested at 0.05 confidence interval. Two hypothesis were made that is:

H₀- there is no association between training on safe handling of solid waste and use of PPE.

H₁- there is an association between training on safe handling of solid waste and use of PPE.

If $P > 0.05$: Reject H₁ and accept H₀

If $P < 0.05$: Accept H₁ and reject H₀

Table 4.9: Chi square test

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	30.860 ^a	1	.000
Likelihood Ratio	33.119	1	.000
N of Valid Cases	44		

a. 1 cells (25.0%) have expected count less than 5. The minimum expected count is 2.95.

Therefore, $0.00 < 0.05$, accept H₁. The results show that there is an association between training on safe handling of waste and use of PPE. The lack of training on safety and health issues pertaining to solid waste management could have contributed to the unsafe practice of not using PPE.

4.6 Absence of Safety and Health Structures

Key informants at the Municipality of Bindura cited that efforts were once made by establishing a Safety Committee but it was never functional. Another key informant also confirmed that safety and health issues were not getting the priority they deserve, citing the lack of a practicing SHE practitioner in the organization and financial constraints in establishing an OSH Policy. There was neither a documented OSH policy nor a documented running safety and health programme or procedure and this showed the ignorance of safety and health issues within management staff at the Municipality. The lack of management commitment is another critical risk factor that was observed at the Municipality. A key informant cemented this observation by confirming that the budget for PPE was not prioritized such that solid waste workers were allocated with PPE once, annually, which is inadequate. The immediate supervisor affirmed that workplaces were not inspected that is, hazard identification was not practiced at the Municipality

leading to the perceived increase of injuries and accidents. He also revealed that ignorance of proper use of the available PPE by solid waste handlers was a risk factor which increased the likelihood of injuries and accidents. The immediate supervisor cited the need for establishment of an OSH Policy in the organization and training of all workers.

4.7 Suggestions made by solid waste workers on measures that can be put in place to address OSH issues in the workplace

Respondents were asked to suggest measures that could be put in place to improve the current OSH situation. About 63.64% of solid waste workers suggested that the Municipality should provide them with adequate PPE. Such a response indicates that some of the solid waste workers were aware of the risks associated with waste handling and the importance of using PPE. A proportion of 13.64% solid waste handlers suggested that they should be provided with milk in order to curb chest problems. This proportion of workers showed ignorance of the safety and health hazards associated with their job. A smaller proportion (9.02%), suggested that the Municipality should provide them with soap for washing and bathing after work. The other proportions of workers suggested that the Municipality should recruit more workers in order to ease the burden of work overload that is, increasing staff compliment (6,82%) and as well, opportune them a chance to go for periodical medical examinations (6.82). Questionnaire responses exhibited that, solid waste handlers were anxious about their safety and health.

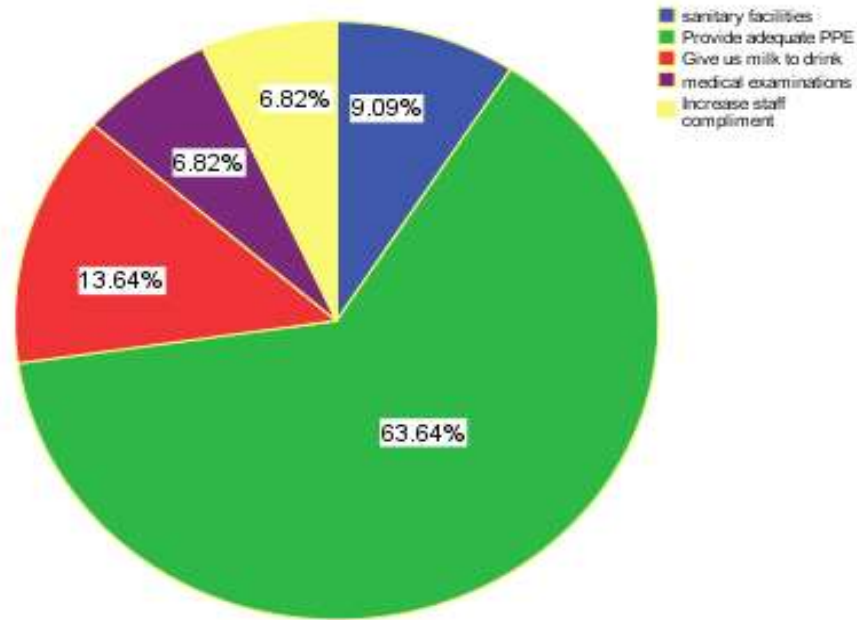


Figure 4.7: Measures suggested by solid waste workers

4.8 Occupational Safety and Health Legislation governing solid waste management

Occupational Safety and health legislation pertaining to the maintenance of accident free workplaces are guided by the ILO Convention No. 155: Occupational Safety and Health. Zimbabwe ratified the convention and through its guidelines and formulated the standing occupational safety and health regulations, namely the Statutory Instrument 68 of 1990 which ensures the promotion of workers physical, social and mental well-being in every workplace. The regulations provide for compensation of workers injured at work, notification of occupational accidents and submission of injury claims to NSSA and in particular provide guidelines on the OSH duties of employers, formation of safety and health committees as well as duties of employees. The Municipality did not have any documented accident reporting procedures. Instead, a reactive approach was employed, where injured workers were referred to local health services providers, and the injury claims were forwarded to the National Social Security Authority (NSSA) through the Workers Compensation Injury Fund (WCIF). There were no First Aid facilities to cater for injured persons at Bindura Municipality neither was there an Emergency Preparedness and Response plan.

Another piece of occupational safety and health legislation relevant to solid waste handling is the Pneumoconiosis Act (Chapter 15:08) of 1996. It is the principal Act that provides for the health of all workers employed in dusty occupations. The Act provides that medical examinations must be carried out on workers employed in dusty occupations and these include pre-employment, periodical and exit medical examinations. Solid waste handlers are required to undergo pre-employment, periodical and exit medical examinations. However, the conditions of employment at Bindura Municipality did not comply with these requirements. The goal of the Pneumoconiosis Act is to provide for compensation of employees in the event that they develop pneumoconiosis, which is an, irreversible disease of the lungs caused by the inhalation of inorganic and/or organic dust, after they leave work. The Act prohibits employees from working in dusty occupations without valid certificate of fitness from the Medical Bureau under NSSA.

Sometimes solid waste workers are employed on a part time basis and frequently they may not be covered by safety and health provisions. Solid waste workers who were employed as casual employees at Bindura Municipality were not prioritised on safety and health issues. The Part-Time Work Convention, 1994 (No. 175), stipulates that “measures shall be taken to ensure that part-time workers receive the same protection as that accorded to comparable fulltime workers in respect of occupational safety and health” Alli B (2008). The provisions have not been fully implemented in Zimbabwe but they are critical in ensuring the worker’s rights to decent work.

The promulgation of the Zimbabwe National Occupational Safety and Health Policy of 2014 was a positive step towards the enforcement of OSH issues in all workplaces. The guidelines provided by the policy includes; promotion of the adoption of an accident preventive culture by all undertakings through hazard identification and risk assessment for every work place, awareness raising on OSH issues and establishment of emergency preparedness and response plans. The lack of records on accident and injuries at the Municipality showed that the management does not have a full appreciation of the hidden costs associated with occupational injuries such as lost time injury frequency rate, reduced productivity due to absenteeism and the negative social implications associated with loss of income due to incapacitating injuries at work.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

It can be concluded that, solid waste workers at Bindura municipality encountered a myriad of preventable health hazards because of their work practices. The waste collection method in Bindura was undertaken through a labour intensive systems which involved lifting heavy waste loads containing biodegradable wastes, infested with disease causing pathogens and hazardous wastes. As a result, solid waste workers were exposed to various injuries, illnesses and musculoskeletal disorders. However, the safety interventions at Bindura municipality did not follow the hazard identification and risk assessment process. Their major safety intervention was the provision of PPE which is actually the last line of defense. PPE does not eliminate the hazards, it only provides a barrier from the hazards. This intervention proved to be inadequate because the municipality of Bindura were not consistent in providing adequate protective equipment and the solid waste workers that were given were not using it constantly to ensure their own safety, which is contrary to S.I 68 of 1990. This could be attributed to the fact that workers lacked training on PPE use and there were no measures to monitor the consistent use of personal protective equipment. The non-use of PPE by workers may also be linked to their low social status which renders them vulnerable to unsafe working conditions.

The most critical findings of the study that contributed to OSH problems at the Bindura Municipality were, lack of an OSH policy which can be related to the lack of management commitment to OSH issues that was observed. An OSH policy is critical in providing guidelines for implementing the Hierarchy of controls (**HEEAP**) process in which the critical steps are: **H**azard identification, **E**limination, **E**ngineering controls, **A**dministrative controls and **P**rovision of PPE. The first step requires identifying the occupational risks associated with solid waste management activities. The next step involves eliminating the hazard for example in solid waste management by removing processes that expose workers to hazardous waste. Engineering controls may include redesigning the workplace to suit the worker, for example redesigning the waste collection vehicles to minimize loading heights. Administrative controls are also critical as

they can be used to remove workers from continuous exposure by rotating them on job tasks as well as, by substituting equipment for the most preferred and safest ones. As mentioned before, PPE should be provided as the last line of defense. The major impediment in ensuring occupational safety and health of solid waste workers in Zimbabwe is the lack of a comprehensive waste policy that offers a holistic approach to safety, health, and environmental management issues.

5.2 Recommendations

1. The Government of Zimbabwe should adopt a Waste Policy which entails occupational safety, health and environmental management issues.
2. The Municipality of Bindura should initiate the adoption of an OSH Policy and as well, engage a SHE Officer who will ensure that all the safety and health measures are observed in the organisation and as well, facilitate the establishment of a safety committee, in order to create a platform for communication between workers and the employers to promote a consultative approach in executing OSH issues.
3. The National Social Security Authority should conduct safety and health awareness campaigns and as well, offer safety education courses, starting with top management personnel, and extending down to every supervisory level and to field personnel. Training of top management will enhance their commitment to OSH issues.
4. The top management at Bindura Municipality should allocate an adequate budget to support occupational safety and health for the entire organization, which include casual and part-time workers. This will enable the implementation of safety and health initiatives such as regular provision of adequate personal protective equipment and putting in place emergency preparedness and response plan.
5. The Municipality should increase the frequency of waste collection from once a week, in order to effectively manage waste as well as to reduce the workload for solid waste workers.

6. Solid waste workers should be provided with vaccination programmes, pre-employment and periodic health surveillance in order to detect early signs of disease and monitor their ability to work.

7. Municipalities should provide sanitary facilities where workers can wash after work to ensure that effective personal hygiene is maintained.

8. Further research should be done to come up with job guidelines concerning number of working hours and maximum weight limits for different job tasks in solid waste handling. This will curb the prevalence of musculoskeletal disorders among solid waste handlers.

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APPENDIX 1

Questionnaire for solid waste workers.

My name is Shuvai Chikombe, a student at the Midlands State University and I am currently carrying out a study with a goal to examine the occupational safety and health problems encountered by solid waste workers at Bindura Municipality. You are required to assist this research by completing this questionnaire and providing your views. The information you will provide is confidential and will be used for academic purposes only.

SECTION A: Demographic information

- 1. Gender: Male Female
- 2. Age group
Below 20 21-30 31 – 40 41 – 50 51+
- 3. Educational qualifications
None Primary Secondary Tertiary
- 4. How long have you been working at Bindura Municipality?
< 1 1-5years 6-10 years 11-15 years 16+
- 5. What is your employment category?
Part-time Casual Contract- based Permanent

SECTION B: Types of hazards

- 6. May you please specify your job / tasks?.....

- 7. Do you feel that your safety and health is at risk when you are carrying out your job?
YES/NO
- 8. What common injuries or accidents are encountered by solid waste workers within the Municipality?
.....
.....

b. What are the causes of these injuries or accidents?

.....
.....

9a. What type of household waste do you handle?

.....
.....

b. What hazards does an employee at your workplace encounter during the course of his/ her duties?

.....
.....

SECTION C: Nature of hazards

10a. Have you ever suffered from any occupational injuries and or illnesses since joining the municipality? YES/NO

b. How often do you encounter workplace injuries and accidents?
Rarely Daily Weekly Monthly

11. Which of the following symptoms do you often experience and what do you think is the cause?

Back pain Painful joints Nasal irritation Eye irritation Skin irritation
Diarrhoea Continuous cough Stress Noise induced hearing loss
Nausea None Other (specify)

.....

12. What type of equipment do you use at your workplace?

.....
.....
.....

SECTION D: Controls that are put in place to reduce workplace hazards

.....

13a. Did you ever receive induction before you started the job? YES/NO

b. If yes how long was the induction period?

.....

14. Did you receive any pre-employment medical examination when you got employed?

YES/NO

15a. Have you been receiving periodical medical examinations? YES/NO

b) If yes how frequently are those check-ups done?

.....

16. Did you receive any safety and health training? YES/NO

b) If yes, when did you undergo safety and health training at the Municipality?

Before being employed

On the job

Not trained

17. Do you use PPE when carrying out your tasks? YES/NO

b.) What are the reasons for not using PPE

.....

18. What measures are currently in place to reduce existing hazards or risks that you are facing

.....

.....

19. Suggest other measures that can be put in place to reduce exposure of solid waste workers at the Municipality.

.....

.....

THANKYOU

APPENDIX 2

INTERVIEW GUIDE FOR ENVIRONMENTAL HEALTH OFFICER AND EHT

1. Does your organisation have a documented Safety and Health (OSH) Policy? YES/NO
- 2a) Does the policy ensure the safety and health of all persons at the workplace including casual employees? YES/NO
2. Which OSH programmes or systems have been implemented to ensure the safety of solid waste workers?
- 3a.)Are there any challenges being faced in implementing the OSH POLICY? YES/NO
- b) If yes may you explain the challenges.
4. Are there any training programs for solid waste workers on safety and health issues and proper job procedures? YES/NO
5. To what extent does management commit itself in prioritizing the safety and health of solid waste workers?
6. Do you have a safety committee in place? YES/ NO
7. How frequently do you engage voluntary groups (CBOS) and part time workers as solid waste workers.
8. From your experience, which types of injuries and diseases are experienced by solid waste workers?
9. Does your organisation have any accident or incident reporting procedures?
10. What do you think can be done, to improve the safety and health of solid waste workers?

APPENDIX 3

INTERVIEW GUIDE FOR DIRECTOR ENVIRONMENTAL HEALTH SERVICES

1.) Does your organisation have a documented Safety and Health (OSH) Policy? YES/NO

2a) Does the policy ensure the safety and health of all persons at the workplace including casual employees? YES/NO

3. Which OSH programs or systems have been implemented to ensure the safety of solid waste workers?

4. a.) Are there any challenges being faced in implementing the OSH POLICY? YES/NO

b) If yes may you explain the challenges.

5. Are there any training programs for solid waste workers on safety and health issues and proper job procedures? YES/NO

11. To what extent does management commit itself in prioritizing the safety and health of solid waste workers?

12. From your experience, which types of injuries and diseases are experienced by solid waste workers?

13. Does your organisation have any accident or incident reporting procedures? YES/NO

14. What do you think can be done, to improve the safety and health of solid waste workers?

APPENDIX 4

INTERVIEW GUIDE FOR HUMAN RESOURCES MANAGER AND HR OFFICERS

1. What type of injuries, accidents and work-related diseases are frequently reported among solid waste workers?

- 2a. Has there been any fatal accidents/injuries/diseases (resulting in death or disability) amongst solid waste workers in the past years? YES/NO

- b.If yes what was the nature and cause.

3. How is OSH administered at the Municipality? (SHE representatives, safety talks, induction, safety signs, control performance review, inspections)

- 4a. Has there been any solid waste workers who were compensated, given time-off work or have a change in work stations as a result of incurring work-related injuries or accidents? YES/NO

- b. What was the cause of the injury or accident?

5. Are there any training programs for solid waste workers on safety and health issues and proper job procedures? YES/NO

- b) If yes may you state the training programmes.

6. Do you have a safety committee in place? YES/ NO

7. To what extent does management commit itself in prioritizing the safety and health of solid waste workers?

8. What measures have you put in place to deal with safety and health hazards among solid waste workers?

9. What are your recruitment or selection methods for solid waste workers and how is induction training for new workers and those who have been on extended leave conducted (code of conduct, safety procedures).

10. How long are the working hours for solid waste workers?

11. What do you think can be done, to improve the safety and health of solid waste workers?

APPENDIX 5

Interview guide for NSSA inspector

1. From your experience what are the safety and health hazards usually associated with solid waste handling?
2. In what ways should Occupational safety and health be administered in Municipalities to address safety and health issues for solid waste workers?
3. Are there any legislation or regulations for occupational health and safety that specifically address solid waste workers in Zimbabwe?
4. To what extent does national legislation or regulations address health and safety issues in solid waste handling?
5. Do you carry out inspections in municipalities to specifically address safety and health issues pertaining to solid waste workers?
6. What risk factors at the municipality would you consider likely to increase injuries and accidents?
7. What challenges do you think are being faced by the council in administering a SHE POLICY and other safety and health statutory requirements?
8. In your own perspective, how effective is the occupational safety and health management system?
9. What do you think should be done to enhance safety and health at the municipality?

APPENDIX 6

Observation Guide

Aspect	Observation	Status/comment
Working environment <i>Extreme weather temperatures</i>	-Is outdoor temperature conducive for work - exposure to dust - vibrations -contaminants	
Equipment/machinery/tools <i>Push carts, sweeping brooms, shovels, rakes, wheel barrows, dust pans</i>	-are there in good working condition -are they designed for the work - Working posture	
Personal Protective equipment <i>Worksuits, respirators, helmets, gloves, hearing protection, safety shoes</i>	-condition -availability - is it being consistently used by workers -is it suitable for the work	