EVALUATION OF MUNICIPAL SOLID WASTE ILLEGAL DISPOSAL IN MASVINGO CITY, ZIMBABWE: TOWARDS A SUSTAINABLE SOLID WASTE MANAGEMENT MODEL

By

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DECLARATION

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I declare that the thesis is a result of my original work and has never been previously submitted for a degree award at any other University. All the sources that I have used have been indicated and acknowledged by means of complete reference.

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ABSTRACT

Municipal solid waste management (MSWM) is a global problem as most local authorities fail to dispose MSW safely. In view of this, the study was aimed at evaluating environmental and health risks associated with municipal solid waste (MSW) illegal disposal as well as constraints faced by Masvingo City in MSWM, with a view to developing an alternative sustainable management model. The study, informed by the philosophy of pragmatism, employed a mixed methods design in which quantitative and qualitative data werecollected concurrently. Questionnaires comprising both close and open-ended questions, semi-structured interviews and site visits were used to collect data. The study population comprised participants from Masvingo City's residential areas, Masvingo City Council employees, Environmental Management Agency (EMA) officials and informal waste pickers. A sample of 406 participants, comprising 354 residents from high-density, 16 residents from medium-density, 24 residents from low-density suburbs, six council employees, two EMA officials and four informal waste collectors participated in the survey. Concurrent triangulation was employed to analyse data. Basic numerical analysis was used for quantitative data while thematic data analysis was employed for qualitative data. Three main findings which emerged from the study were (a) Land pollution, air pollution, surface water pollution and loss of urban beauty, were the main environmental risks as at least 59 % of the respondents noted the four as environmental risks associated with illegal municipal solid waste disposal (b) Cholera, skin problems and malaria were the main health risks; and, (c) The main constraints related to MSW management were inadequate environmental education, lack of cooperation and participation from waste generatorsand lack of resources by Masvingo City . From the findings, 66 %, 52 % and 49 % of participants noted inadequate environmental education, lack of

cooperation and participation, and lack of resources respectively as constraints faced by Masvingo City in MSWM. Basing on the findings of the study, it can be concluded that MSW disposal in Masvingo was a threat to the environment and human health and, as a result, a sustainable MSWM model was developed for Masvingo City.

Key words: Illegal disposal; Incineration; Integrated; Masvingo City; Minimisation; Municipal solid waste management; Recycle; Segregation; Sustainability; Waste hierarchy.

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Special appreciation goes to all respondents in Masvingo City for providing data of high value. This thesis would not have been possible without them.

This work is dedicated to my wife, Lillian, and daughters Anotida and Anenyasha.

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EMA: Environmental Management Agency

ISWM: Integrated Sustainable Waste Management

MCC: Masvingo City Council

MSW: Municipal Solid Waste

MSWM: Municipal Solid Waste Management

MSWD: Municipal Solid Waste Disposal

NGOs: Non-Governmental Organisations

SWM: Solid Waste Management

TARSC: Training and Research Support Centre

UNDP: United Nations Development Programme

UNEP: United Nations Environmental Programme

WHO: World Health Organisation

WMH: Waste Management Hierarchy

OUTPUTS FROM THIS STUDY

The thesis is the output of the study with a potential to have the following three journal articles:

1. Improper municipal solid waste disposal and the environment in urban Zimbabwe: A case of Masvingo City.
2. Municipal solid waste management as anurban challenge in Africa: A review.
3. Safety and health risks associated with poor municipal solid waste disposal in African cities: A review.

1 INTRODUCTION AND BACKGROUND

1.1 INTRODUCTION

Municipal solid waste management (MSWM) has remained a thorn in the flesh for local authorities worldwide (Addaney and Oppong, 2015; Mbue *et al.*, 2015; Hettiarachchi *et al.,* 2018; Yukalang *et al.,* 2018). The global nature of the problem is revealed in Bangladesh (Das *et al.,* 2014), India (Saikia and Nath, 2015), Pakistan (Mahar, 2014), Latin America (Magalini *et al.,* 2015; Lethbridge, 2017), Nigeria (Mansur, 2015) and Ghana (Ampofo *et al.,* 2016), among others. The above scholars pointed out that MSWM was of great concern for many local authorities. Measures have been in place to improve the management of municipal solid waste after world leaders agreed in 1992, at the Conference on Environment and Development in Brazil, that MSWM was a global problem. However, strategies have been negatively affected by high rates of urbanisation and population growth which make it difficult for local authorities to manage solid waste safely (Choudhury and Choudhury, 2014; Samwire *et al.,* 2017; Makarichi, 2018; Li Zhou, 2020). The information above implies that management of municipal solid waste is achallenge to local authorities, especially in low-income countries experiencing faster rates of urbanisation than high-income countries. Illegal MSW disposal is dominant in developing countries, so local authorities in these countries should be innovative in managing increasing municipal solid waste (MSW) under their jurisdictions.

The quantity and composition of solid waste generated in a given area depends on its level of income. MSW has a higher content of organic matter in developed than in developing countries (Joshi and Ahed, 2016). High-income countries produce more

per capita than low-income countries. According to Ramachar (2012), Simelane and Mohee (2012), Kasala (2014) and Chacharoenwattana and Pharino (2015), municipal solid waste generation was between 0.2 kg and 1,0 kg/capita/day in developing countries, while in developed countries it was between 1,3 kg and 3.0 kg. However, in terms of efficiency in MSWM, high-income countries are better than low-income countries, despite generating more per capita. This is so because they have technical and financial capacity. In relation to the above information, municipal solid waste (MSW) generation rate in most African cities is around 0.7 kg/capita/day and outpaces collection rate, thereby making safe disposal difficult (Simelane and Mohee, 2012; Emelumadu *et al.*, 2016).

The United Nations Environmental Programme (2015), Amugsi *et al.* (2016) and Vucijak *et al.* (2016) argue that waste management aims to promote public health and protect the environment. Similarly, the integrated sustainable waste management (ISWM) model suggests that waste must be managed in a way that safeguards public health and the environment. Sustainable Development Goal 11 of sustainable cities has a 2030 target of minimising negative environmental effects associated with managing municipal solid waste (UN, 2019). This implies that MSWM should fulfil sustainable development goals. Municipal solid waste management in some African cities is associated with environmental risks and health problems since local authorities are not able to collect and safely dispose generated solid waste (Mahar, 2014; Dhlamini *et al*., 2017). Poor MSW collection and disposal have been noted in Egypt (Aboll-Elwaya, 2012), in Nigeria (Butu and Msheila, 2014), in Sudan (Karija, 2014), in Tanzania (Kasala, 2014) and in South Africa (Mangizvo and Mupindu, 2012).

Zimbabwe experiences poor municipal solid waste collection. Municipal solid waste collection rates in towns and cities of Zimbabwe declined from above 75 % in mid 1990s to nearly none (Mafume *et al.*, 2016; Chanza *et al.*, 2017). As a result, a significant proportion of generated MSW in Zimbabwean urban areas is disposed of in a manner that does not protect the environment (Financial Gazette, 2016; Jerie, 2016). Thus, human health and the environment are negatively affected by MSW disposal (Makwara and Magudu, 2013; Kinobe, 2015).

Globally, literature shows that cholera was a risk in Philippines (Atienza, 2004), malaria in Nepal (Panta, 2013), poor cognitive development in China (Shamim *et al.,* 2015), respiratory problems in Malaysia (Aminudin and Rahman, 2015), injuries in Latin America (Cruvinel *et al.,* 2019), water and air pollution in India (Saikia and Nath, 2015) and loss of aesthetic value in Pakistan (Ejaz *et al.,* 2010). In relation to Africa, studies conducted in Kenya (Muniafu and Otiato, 2010), Sudan (Karija *et al.,* 2013), Nigeria (Butu and Mshelia, 2014), Botswana (Gwisai *et al.,* 2015) and Ghana (Yoda *et al.,* 2017) show that water pollution, typhoid, cholera, respiratory problems and malaria were risks associated with MSWM.

The risks of MSW illegal disposal on health and environment varies in Zimbabwean cities. For example, Masocha (2004) noted diarrhoea, malaria, typhoid, dysentery, skin infections and fire as main risks in Victoria Falls, while Makwara and Magudu (2013) and Nyanzou and Jerie (2014) identified fever, burning eyes, acute respiratory infections, groundwater pollution, bad odours, distortion of aesthetic value of suburbs, and floods as main risks associated with MSW illegal disposal in Harare. Mangizvo (2010) indicated land pollution as a risk in the city of Gweru. Given that there were

diverse environmental and health risks associated with MSW illegal disposal in different cities in Zimbabwe, it can be possible for a different location such as Masvingo to have unique risks. Therefore, it was necessary to evaluate risks associated with illegal waste disposal in Masvingo City.

The study was conducted to evaluate the extent and impact of municipal solid waste illegal disposal in Masvingo City, Zimbabwe. The focus was on the environmental risks, health risks associated with MSW illegal disposal, and constraints faced by stakeholders in MSW management. Previous studies related to the problem under investigation were also conducted in Masvingo as indicated in Table 1.1.

Table 1.1: Previous studies on solid waste management in Masvingo

Theme	**Author**	**Outcome**
Waste management at Mucheke dumpsite	Mangizvo, 2008	Bad practices leading to contamination
Work related environmental health risks of garbage handlers	Makwara, 2011	Diseases and cuts on waste pickers
Challenges of waste management	Mapira, 2011	Lack of financial resources
Solid waste management as an urban challenge	Huvengwa, 2012	Illegal dumping as a result of irregular collection
Challenges and opportunities	Begede, 2014	Limited vehicles leading to infrequent collection Room for recycling centre
Challenges of solid waste management	Musingafi *et al.,* 2014	Open dumping leading to global warming

As shown in Table 1.1, risks to urban population in general and those associated with non-official disposal sites (open space disposal) were not covered. Mangizvo (2008) highlighted waste management at Mucheke dumpsite, while Makwara (2011) noted work related environmental health risks of rubbish handlers. This suggests that risks of municipal solid waste illegal disposal have not been adequately covered in

Masvingo. The challenges of solid waste management were also highlighted in Masvingo (Mapira, 2011; Huvengwa, 2012; Begede, 2014; Musingafi *et al.,* 2014). The last published studies on challenges in Masvingo were conducted in 2014 (Begede, 2014; Musingafi *et al.,* 2014). Since Masvingo is currently experiencing rapid residential expansion, it could be possible for it to have different challenges. Thus, it is necessary to conduct a study in Masvingo City since studies from elsewhere cannot be extrapolated in this city due to very low degrees of accuracy.

Common constraints in studied cities were lack of financial resources (Musademba *et al.,* 2011; Addaney and Oppong, 2015; Delgermaa and Matsumoto, 2016). In addition to the shortage of refuse trucks and inadequate funds, Masocha (2004) noted inadequate human resources as a challenge in Victoria Falls, Zimbabwe. Diverse constraints were noted in these cities due to different circumstances such as level of awareness, involvement of Environmental Management officials and financial abilities. Given different circumstances, it could be possible for Masvingo to have unique constraints, hence the focus on Masvingo City.

1.2 RESEARCH PROBLEM

Literature in Pakistan (Mahar, 2014), in Cameroon (Mbue *et al.,* 2015) and in Lesotho and Botswana (Simelane and Mohee, 2012) revealed that MSW collection rate was poor in Patan, Duala and Gaberone, respectively. Heaps of municipal solid waste are common in residential areas in Zimbabwe as a result of infrequent solid waste collection (Nyanzou and Jerie, 2014; Financial Gazette, 2016). Management of municipal solid waste in Masvingo leaves a lot to be desired (Huvengwa, 2012; Musingafi *et al.*, 2014; Newsday, 2017). Less than half of municipal solid waste

generated in Masvingo is collected (Chanza *et al.*, 2017; Newsday, 2017). Unlawful disposal of municipal solid waste is associated with environmental risks and diseases.Thus, it was the intention of the researcher to evaluate municipal solid waste illegal disposal.

1.3 RESEARCH QUESTIONS

The researcher sought to answer this main research question: To what extent is municipal solid waste illegal disposal a concern in Masvingo City? The main research question was answered through the following sub-questions:

1. What are the environmental risks and impact associated with MSW illegal disposal inMasvingo?
2. Are there any health risks associated with MSW illegal disposal inMasvingo?
3. What are the constraints faced by stakeholders in MSWM in Masvingo?

1.4 AIM AND OBJECTIVES

The aim of the study was to evaluate municipal solid waste illegal disposal in Masvingo City, Zimbabwe, with a view to developing a sustainable waste management model.

The above aim was fulfilled through the following specific objectives, which were to:

- determine environmental risks of MSW illegal disposal in Masvingo;
- assess health risks of municipal solid waste illegal disposal in Masvingo; and
- examine constraints faced by stakeholders in MSWM in Masvingo.

1.5 SIGNIFICANCE OF THE STUDY

The study evaluated municipal solid waste illegal disposal in the city of Masvingo. This research was in line with threesustainable development goals, namely, Goal 3 of good health and wellbeing; Goal 6 of clean water and sanitation; and Goal 11 of sustainable cities and communities, since the study was on health and environmental risks of illegal MSW disposal. The study may be of great importance to Masvingo City Council, Ministry of Environment, Tourism and Hospitality Industry, Ministry of Health and Child Care, residents, NGOs and researchers in ways explained below.

1.5.1 Masvingo City

The proposed sustainable waste management model may have the potential to benefit local authorities by enhancing a deeper understanding of solid waste management. From the model, the local authorities may be able to dispose solid waste safely. The proposed model has five key interventions aimed at reducing risks. Suggested interventions include the following:

i. Adequate environmental education;
ii. Separation at source;
iii. Regular refuse collection;
iv. Composting, recycling and reuse; and
v. Use of sanitary landfill.

Implementing the suggested interventions may enable local authorities to dispose solid waste safely.

1.5.2 Ministry of Environment, Tourism and Hospitality Industry

The Ministry of Environment, Tourism and Hospitality Industry may benefit in policy

formulation and implementation since the study highlighted land pollution, air pollution, surface water pollution and loss of urban beauty as the main environmental risks. The health status of the environment is crucial for the ministry. The main cause of environmental degradation was brought to light by the current study, that is, improper management of municipal solid waste. Thus, the information availed by the present study may enable the Ministry of Environment, Tourism and Hospitality Industry to make the right decisions in terms of policy formulation and implementation.

1.5.3 Ministry of Health and Child Care

The Ministry of Health and Child Care may also benefit since it would be aware of the fact that cholera, skin problems and malaria were the main health risks associated with MSWD. This would enable the Ministry to design strategies to reduce or eliminate these solid waste related risks.

1.5.4 Residents

Residents of Masvingo City would be aware of the fact that skin problems, malaria and cholera are the health risks of municipal solid waste illegal disposal and this knowledge would assist them in improving their safety and health through safe solid waste disposal.

1.5.5 Non-Governmental Organisations

Non-Governmental Organisations (NGOs) may use the findings, such as on constraints faced by the local authority, for example lack of money, lack of fuel and inadequate environmental education, so that they design appropriate interventions in terms of assisting the local authority.

1.5.6 Researchers

Future research work may use the study as a baseline study for future studies in municipal solid waste management. The focus of the study was on evaluating the environmental risks, health risks and constraints faced by Masvingo City. Future studies may evaluate environmental and health risks of solid waste disposal in rural areas, risks of liquid waste disposal in urban areas and factors determining refuse collection fees.

1.6 THESIS STRUCTURE

The thesis has five chapters which are illustrated in Figure 1.1.

1.6.1 Chapter One: Introduction and background

As shown on Figure 1.1, Chapter One introduced the study. It presented the background, research problem, research questions, aim and objectives, significance of the study and thesis structure.

1.6.2 Chapter Two: Literature review

Chapter two highlights literature review in which terms and concepts associated with municipal solid waste management (MSWM), environmental risks and health risks of MSWM are discussed. The constraints encountered by stakeholders in municipal solid waste management, as well as theoretical framework of the study are also highlighted in this chapter.

1.6.3 Chapter Three: Research design and methodology

The research design and methodology are explained in Chapter Three. Research philosophy, design, data collection and data analysis were the main thrust in this

chapter.

1.6.4 Chapter Four: Results and discussion

In this chapter, findings of the study are presented and discussed under the following sub-headings: “Environmental risks of MSWM”; “Health risks of MSWM”; and “Constraints leading to poor municipal solid waste management”.

1.6.5 Chapter Five: Conclusions and recommendations

Conclusions are made and recommendations of the study proffered in the chapter.

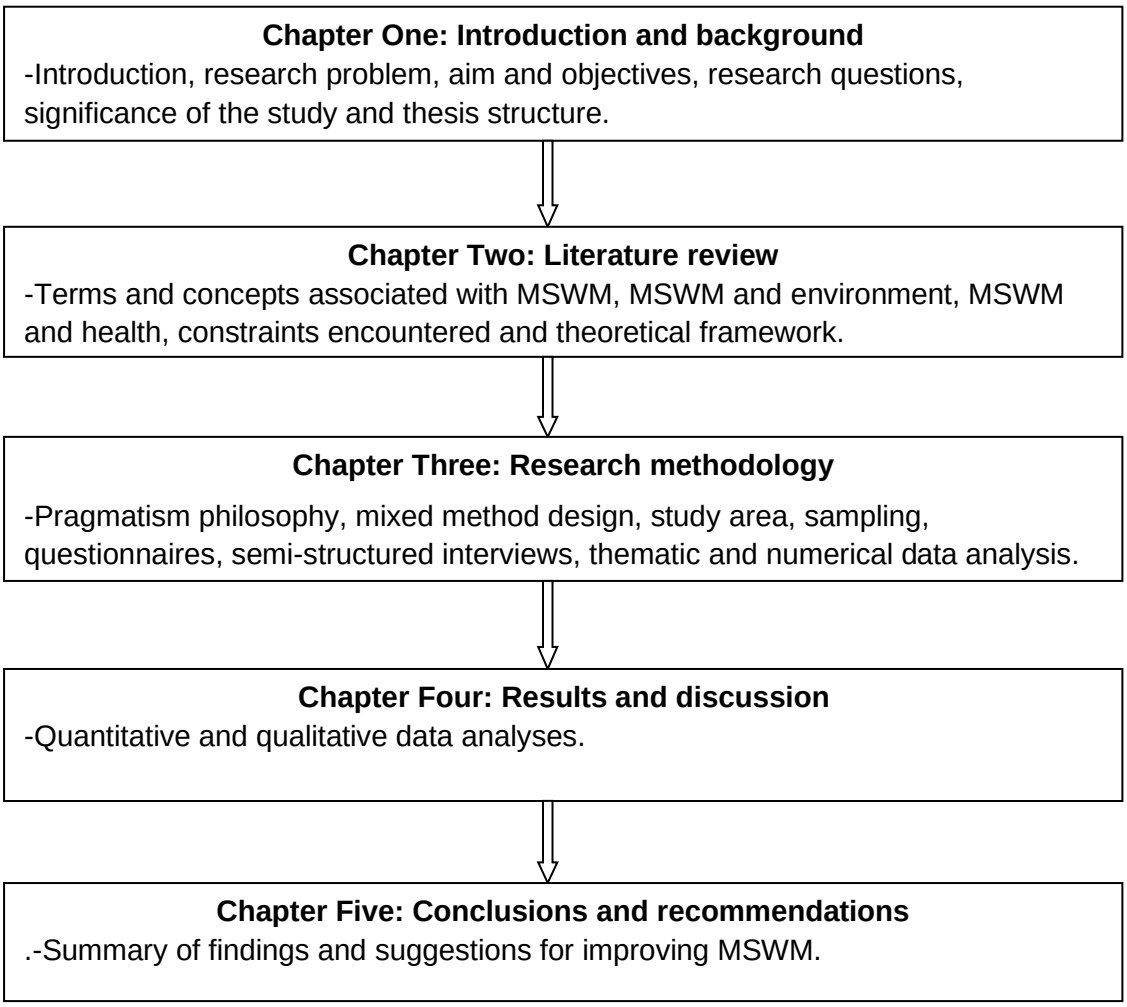


Figure1.1: Summary of thesis structure

1.7 CHAPTER SUMMARY

This chapter introduced the study. It covers the research problem, research questions, aim and objectives, significance of the study and thesis structure. The next chapter will be on literature review.

2. LITERATUREREVIEW

2.1 INTRODUCTION

The present study sought to evaluate municipal solid waste illegal disposal in Masvingo City. Literature related to municipal solid waste management was reviewed under sub-headings drawn from sub-research questions highlighted in Chapter One. ‘MSWM and the environment’, ‘MSWM and health’, and ‘Constraints encountered by stakeholders involved in MSWM’ were sub-headings drawn from sub-research questions. It was essential to present terms and concepts associated with MSWM first and the theoretical framework of the study last as illustrated in Figure 2.1. Furthermore, the section highlighted gaps filled by the present study.

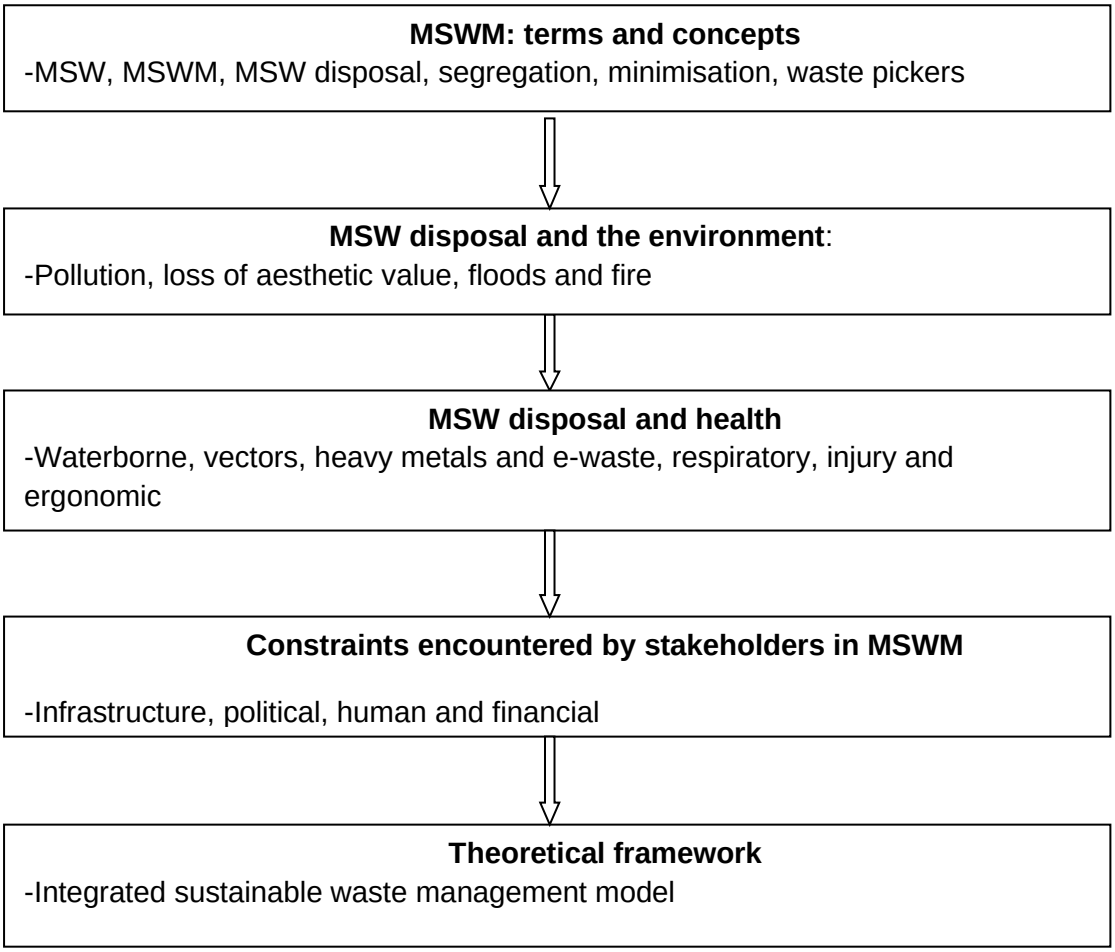


Figure 2.1: Flow diagram of literature review

2.2 TERMS AND CONCEPTS ASSOCIATED WITH MSWM

2.2.1 Municipal solid waste

Municipal solid waste (MSW) can be defined as non-liquid and non-hazardous waste generated in urban areas and is managed by local authorities (Challcharoenwattana and Pharino, 2015; Yukalang *et al.,* 2017). According to Makwara (2011), Ramachar *et al.* (2012), Amugisi *et al.* (2016) and Bui *et al.* (2020), MSW is waste generated in urban areas and is disposed of not through the pipe. The above definitions imply that MSW is in solid state, generated in towns and cities and catered for by local

authorities. Municipal solid waste types include residential, commercial, municipal services, construction and demolition, and institutional, as noted by EPA (2011) and Hoornweg and Bhada-Tata (2012). Mihelcic and Zimmerman (2010) and Kaza and Bhada-Tata (2018) highlighted that types and composition of MSW depend on source and there are five categories (Table 2.1). The categories include residential, commercial, institutional, construction and demolition and municipal services.

Table 2.1: Municipal solid waste categories (Hoornweg and Bhada-Tata, 2012)

Source	Typical waste generators	Types of solid waste
Residential	Single and multifamily dwellings	Food waste, paper, cardboard, plastics, textiles, yard waste, leather, wood, glass, metals, ashes
Commercial	Stores, hotels, restaurants, markets, office buildings	Paper, cardboard, plastics, glass, metals, e-wastes, food wastes
Institutional	Schools, hospitals (non-medical waste), prisons, government buildings, airports	Cardboard, plastics, paper, metals, glass, food waste, e-wastes
Construction and demolition	New construction sites, road repair, renovation sites, demolition of buildings	Wood, steel, concrete, bricks, tiles
Municipal services	Street cleaning, landscaping, beaches, parks	Street sweepings, general waste from parks, beaches

Table 2.1 shows that residential, commercial, institutional, construction and demolition, and municipal services are the five sources of municipal solid waste. Residential waste is from where people reside, that is, from high-density, medium-density and low-density suburbs, as shown in Table 2.1. The quantity of residential waste generated increased significantly during the COVID-19 pandemic lockdowns as noted by Kulkarni and Ananthrama (2020). In a related study, Solid Waste Association of North America (2020) established that residential waste quantity in the United States increased by at least 20 % in April 2020. Waste from offices, stores, hotels and markets is known as commercial (Table 2.1). Institutional waste is from institutions such as schools and prisons. Waste from construction sites and demolition buildings is called construction and demolition waste, while that from street sweeping, parks and landscaping is referred to as municipal services waste (Table 2.1). Residential and commercial are the main sources of MSW as each of them contributes 40 % of the total MSW (Mihelcic and Zimmerman, 2010; EPA, 2011), as illustrated in Figure 2.2. Therefore, the other three sources (institutional, construction and demolition and municipal services contribute 20 % of the total municipal solid waste. Institutional is the least source of municipal solid waste (three percent) as shown in Figure 2.2.

Composition of MSW is also determined by the level of economic development. In developing countries, MSW has a high proportion of organic matter of above 48 %, while in developed countries the proportion is low, being below 35% (Challcharoenwattana and Pharino, 2015; Joshi and Ahmed, 2016). According to Ziraba *et al. (*2016), organic matter is biodegradable while inorganic matter is non-biodegradable. Biodegradable waste means that waste can decompose, producing various gases depending on the availability of oxygen. In contrast, non-biodegradable

waste cannot decompose even under suitable conditions.

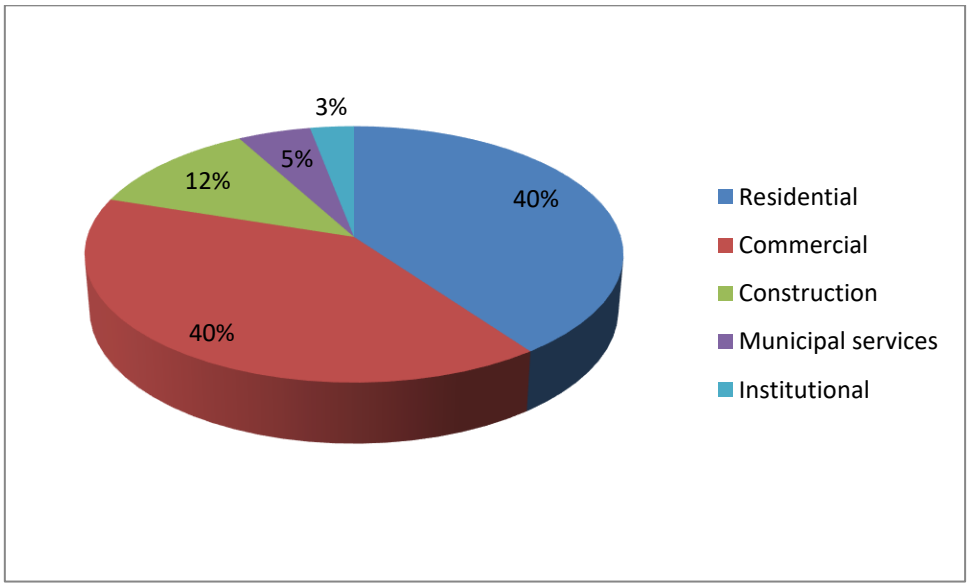


Figure 2.2: MSW percentage contribution by source (Source: Mihelcic and Zimmerman, 2010)

2.2.2 Municipal solid waste management

Anchor and Nwafor (2014) and Ziraba *et al.*(2016) defined municipal solid waste management as a process involving collection, carrying, modifying and safe disposal of MSW.Thus, management should be friendly to the environment and should promote public health. According to Dladla *et al.* (2016) and Ziraba *et al.* (2016), MSWM is regarded as improper if it is associated with environmental risks and health problems. The majority of governments agreed that management of MSW is essential in each country and unsustainable disposal was highlighted as the number two problem in towns and cities (UNDP, 1998; Zhu *et al.,* 2008). The above information implies that MSWM is a global concern and local authorities should be innovative to ensure proper disposal of solid waste. The elements of municipal solid waste management are presented in Figure 2.3.

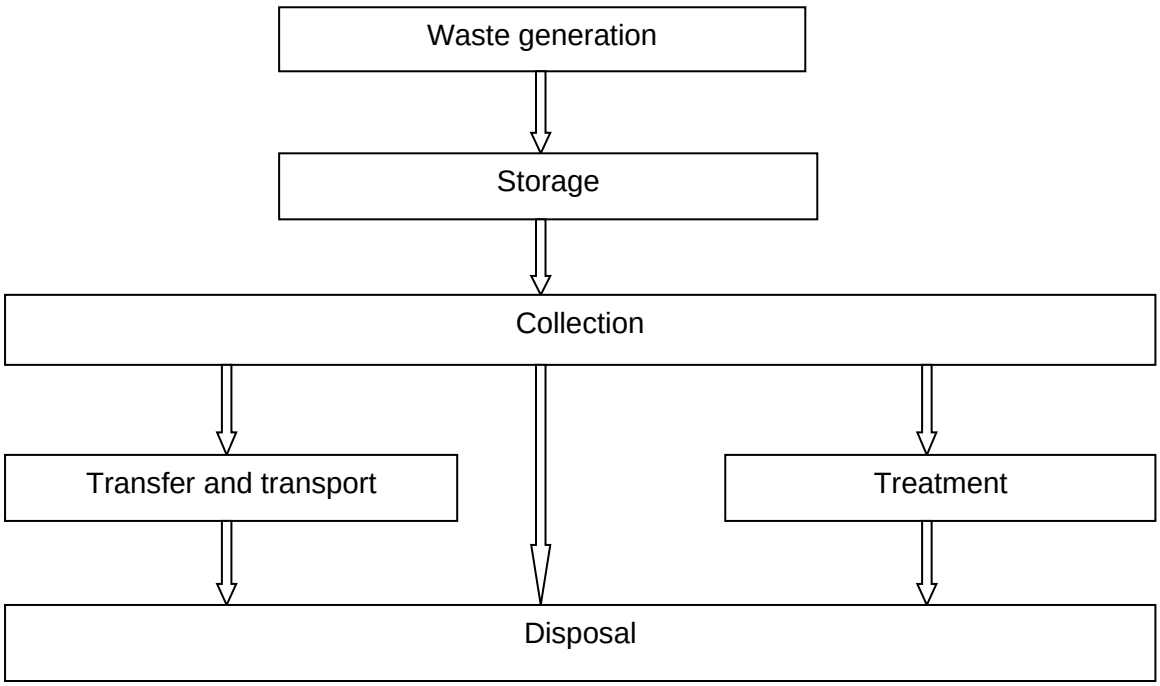


Figure 2.3: Elements of MSWM (Source: Rasmeni and Madyira, 2019)

2.2.2.1Municipal solid waste generation

Municipal solid waste generation represents the first stage of the waste management process as shown in Figure 2.3 and involves activities that produce waste, as noted by Momoh and Obadebeye (2010). Globally, increased rates of population growth and urbanisation have resulted in a sharp increase in the amount of generated MSW, as noted by Makarichi *et al.* (2018). Studies conducted by Abel (2007) and Dunfa and Krishna (2013) on municipal solid waste generation in Ogbomoso, Nigeria, concluded that the quantity of municipal solid waste generated depends on income level and size of household. In a related study, Jadoon *et al.* (2014) revealed that high-income households had the highest/capita/day while low-income households had the lowest/capita/day in Gulberg Town, Lahore, Pakistan. Basing on information above, it

can be concluded that a large household produces more solid waste per day than a small household on condition that income is similar while a high-income household produces more waste than a low-income household given that household size is similar.

2.2.2.2Municipal solid waste storage

According to Buor (2019), solid waste storage is the next element of MSWM after generation. Storage of generated solid waste is difficult in most developing countries due to lack of receptacles (Magundu *et al*., 2013). To enable the storage of different types of waste separately, colour-coded bins should be availed as noted by Nishimwe *et al*. (2016). The type of receptacle used for storage has a spatial variation (Ross, 2013; Mangudu *et al*., 2013). It varies from place to place depending on level of income. Low-income households usually use plastic bags while high-income households use metal or plastic bins. Most low-income households cannot afford to purchase bins. To safeguard the environment and promote public health, generated waste should be kept in closed containers (Ross, 2013; Vucijak *et al.,* 2016).The above information suggests that storage of solid waste is a crucial element of MSWM.

2.2.2.3Municipal solid waste collection

Solid waste collection is an element of MSWM which involves carrying solid waste to suitable destinations (Simelane and Mohee, 2012). Solid waste is taken to transfer facility, treatment facility or final disposal as illustrated in Figure 2.3. Municipal solid waste collection can be negatively affected by diseases. According to Kulkarni and Ananthrama (2020), movement of collection workers was restricted because of the COVID-19 outbreak and this reduced waste collection frequency. Amoah and Kosoe (2014) observed that community bins, door-to-door, block and curb side were four

solid waste collection types common worldwide. Community bins involve carrying of solid waste by community members and placing it in bins located at most appropriate places, while door-to-door collection is placing of bins at doorsteps by waste generators at a given time for collection by those responsible (Amoah and Kosoe, (2014). Block collection involves carrying of bins by households and emptying waste directly into collection vehicles at set places and times. Curb side collections involve waste generators carrying containers and emptying them at the curb and then returning the empty container.

Municipal solid waste collection has spatial variation. Collection is more regular in high-income countries than in low-income countries. Studies in Pakistan (Mohsin and Chinyama, 2016), Nigeria (Butu and Msheila, 2014), Sudan (Karija *et al.,* 2013) and Zimbabwe (Chanza *et al.,* 2017) revealed that less than half of generated waste was collected. Thus, MSW collection in low-income countries was poor. Within a given urban area, collection can also vary. In related studies, Mahar (2014) and Mandevere and Jerie (2018) established that the percentage of MSW collected was higher in low-density than in high-density suburbs. Mandevere and Jerie (2018) established that in Harare, Zimbabwe, influential people who include political leaders reside in low-density suburbs. As a result, local authorities collect solid waste from these areas regularly in order to please influential people. Mandevere and Jerie (2018) further indicate that those residing in low-density suburbs have the capacity to collect generated waste from their areas of residence to disposal sites. Thus, illegal disposal is rare in low-density suburbs. In contrast, illegal disposal is dominant in high-density suburbs, as noted by Omar (2018). Below is a presentation on municipal solid waste treatment.

2.2.2.4 Municipal solid waste treatment

Treatment involves any process of modifying the nature of waste, aimed at enhancing its disposal (Rasmeni and Madyira, 2019). This implies that it is the processing of solid waste to improve its disposal. Solid waste treatment is rare in low-income countries. Lack of solid waste treatment is revealed in Ghana (Amoah and Kosoe, 2014). The mentioned authors concluded that local authorities in low-income countries do not implement the entire functional elements of MSWM, as focus was on collection and disposal. Having explained solid waste treatment, in the next section is a presentation how municipal solid waste is disposed.

2.2.2.5 Municipal solid waste disposal

Municipal solid waste disposal is the suitable disposition of MSW in line with environmental laws of a given area and is the last option of the waste management hierarchy (Nanda and Ping, 2013). In relation to this, municipal solid waste disposal involves getting rid of material no longer in use and is the final stage of the MSWM (Abdel-Shafy and Mansur, 2018; Vaverkova *et al.,* 2018). Basing on the preceding definitions, it can be deduced that waste disposal is the final functional element of municipal solid waste management and should be friendly to the environment. Rundell (2002) defines illegal disposal as disposal that is not allowed by the law. Therefore, illegal waste disposal refers to getting rid of discarded or discharged material in a manner which is against the law. According to Zhu *et al.* (2008), Aljaradin and Persson (2012), Joshi and Ahmed (2016), Kaza and Bhada-Tata (2018) and Vaverkova *et al.* (2018), land filling, incineration, composting, open dumping and recycling are the common municipal solid waste disposal methods worldwide. Following is a discussion on the identified disposal methods.

2.2.2.5.1Land filling

Land filling is a method of municipal solid waste disposal which involves compaction and covering of solid waste (Koda *et al.,* 2015; Nor Faiza *et al.,* 2019). Aljaradin and Persson (2012), Hoornweg and Bhada-Tata (2012) and Cuartal *et al.* (2017) identified uncontrolled and sanitary methods as the types of landfills. According to Aljaradin and Persson (2012), Alam and Ahmade (2013) and Alam*et al.* (2020), uncontrolled landfills cause harm to the environment due to lack of precautionary measures. This implies that uncontrolled landfills are unsustainable as they result in environmental problems. Sanitary landfill involves implementation of precautionary measures and is associated with safe disposal of solid waste (Kaza and Bhada-Tata, 2018). This means that the disposal facility is well-constructed and operated, in such a way that it safeguards the environment and protects public health. Proper siting, provision of impermeable bottom liner, collection of landfill gas, leachate collection and daily compaction and covering of solid waste are measures to ensure that sanitary landfill is sustainable, as noted by Chadar and Kerti (2017), Cuartal *et al.* (2017) and Vaverkova *et al.* (2018).

Sanitary landfill reduces health and environmental risks (Dajic *et al.,* 2016; Chadar and Keerti, 2017). However, the main disadvantage is that it requires a lot of money and, as a result, low-income countries cannot afford it, thereby resorting to uncontrolled land filling which causes environmental and health problems (Aljaradin and Persson, 2012; Joshi and Ahmed, 2016). The information presented above shows that sanitary land filling is common in developed countries, while improper land filling is dominant in developing countries (Simelane and Mohee, 2012). Incineration will be presented in the next section.

2.2.2.5.2 Incineration

Alam and Ahmade (2013), Kaza and Bhada-Tata (2018) and Kulkarni (2020) defined incineration as a solid waste disposal method involving controlled burning of solid waste at high temperatures of around 1000 ^{0}C, in the presence of a lot of oxygen. Controlled burning is common in countries such as Japan, due to limited land (Hoornweg and Bhada-Tata, 2012). According to Atalia *et al.* (2015), Chadar and Keerti (2017) and Solid Waste Management in Singapore (2019), benefits of incineration include increasing the life span of a landfill, suitability for different weather conditions, low cost of transport as a result of siting incinerators close to waste sources,and heat from incinerators is used for electricity generation. Solid Waste Management in Singapore further indicates that incineration provides between two and four percent of the country's electricity need. In related studies, incineration is a source of electricity in China and India, which are the two most populous countries in the world (Kumar and Smadder, 2017; Istrate *et al.,* 2020; Kulkarni, 2020). However, incineration is associated with various problems. For example, Kaza and Bhada-Tata (2018) revealed that incineration is expensive and, as a result, it is rare in low-income countries. In addition, flue gas can pollute air and waste in most low-income countries is not suitable for combustion due to high level of moisture content (Challcharoenwattana and Pharino, 2015; Joshi and Ahmed, 2016). Having presented incineration, composting will be presented in the next section.

2.2.2.5.3 Composting

Joshi and Ahmed (2016) defined composting as a disposal method which involves the conversion of organic matter into humus, provided oxygen and moisture are available.

Composting is different from natural decaying in the sense that it includes controlling of oxygen, temperature and moisture levels, whereas there is no controlling under the natural decaying process (Kaza and Bhada-Tata, 2018). According to Atalia *et al.* (2015), the advantages of composting include low operational costs, improving soil fertility, thereby reducing the need for inorganic fertilisers, and absence of methane production because of the availability of enough oxygen. However, if composting conditions are not met, for example in developing countries, because of inadequate separation of solid waste, humus is of poor quality (Otieno and Taiwo, 2007). Having presented composting, the next task is to present open dumping, which will be done in the next section.

2.2.2.5.4 Open dumping

This is the disposal of municipal solid waste on any open space (Zhu *et al.,* 2008; Oberlin, 2011; Simelane and Mohee, 2012). Okot-Okum and Nyengere (2011) and Joshi and Ahmed (2016) established that open dumping is the most affordable of all disposal methods and that is the reason why it is the most common in developing countries, but it is associated with various negative environmental and health risks. In a related study, open dumping was one of the main disposal methods in Indian cities (Ahluwalia and Patel, 2018). Similarly, Dladla *et al.* (2016) found out that more than 49 % of generated MSW in developing countries is disposed of through open dumping. Dladla *et al.* further indicated that about 70 % of solid waste in Africa was disposed of in open spaces. A study conducted in Bawku, Ghana, by Dout *et al*. (2017), established that lack of cooperation among waste generators resulted in unlawful disposal. Contrary to that, waste management was a success in Teocelo, Veracruz, Mexico, also a developing country. De Medina Salas (2020) pointed out that inclusion of residents and environmental awareness made waste management effective in

Teocelo, Mexico. In Zimbabwe, disposal of solid waste on open space is not allowed in terms of the Environmental Management Act (Cap 20:27). The present study evaluates the effects of municipal solid waste illegal disposal. Recycling will be discussed in the next section.

2.2.2.5.5Recycling

Recycling is any activity involving converting discarded material into a new valuable one and is an important component of the waste management hierarchy (Jibril *et al.,* 2012; Amugsi *et al.,* 2016). Thus, the original form of the waste is changed. Materials such as paper, metal, glass and plastic waste can be recycled. The rate at which given material is recycled is determined by regulations and availability of market (Wilson *et al.,* 2006). Wilson *et al.* further indicated that major industries in China and India rely on recycled raw materials. The finding suggests that rates of recycling of similar material can have a spatial variation due to differences in market size and differences in degree of government intervention. There is a lot of recycling in China and India because of availability of market and government support.

Various benefits are associated with municipal solid waste recycling. According to Dias *et al.* (2008), Jibril *et al.* (2012) and UNEP (2013), recycling has many advantages. One of them is that it decreases the volume of waste burnt, thereby lessening the quantity of greenhouse gases into the atmosphere. The amount of waste taken to landfills is also reduced which, in turn, protects the environment by reducing pollution. In addition, recycling slows down the rate at which natural resources are exploited and it also reduces waste production (Almasi *et al.,* 2019). Furthermore, recycling has economic benefits. Worldwide, thousands of informal waste collectors earn a living as a result of recycling, though earnings range from US$1 to US$7, depending on area

(Marello and Helwege, 2014). Therefore, reprocessing of waste materials is sustainable because it protects the environment and reduces the rate of resource exploitation, thereby catering for present and future generations. Despite the mentioned benefits, recycling has disadvantages. Marshall and Farahbakysh (2013) and Mmereki *et al.* (2016) argue that a lot of money is needed for establishing recycling plants and recycled materials are not as durable as newly-manufactured material.

2.2.3 Waste separation

According to Yi Xiao *et al.* (2007), waste separation is a process of segregating solid waste into different elements mainly at sources of generation. This implies that solid waste can be segregated into biodegradable and non-biodegradable. In India, it is compulsory for those who generate waste to separate it into decaying and non-decaying (Kulkarni, 2020). Kulkarni also indicates that MSWM regulations in India enable those who collect waste to punish waste generators for failing to sort waste, by charging spot fine. Segregating of waste was implemented at established separating facilities in Scotland (Zero Waste Scotland, 2019). In high-income countries, especially in Western Europe, waste sorting is a success as a result of effective laws, environmental awareness, cooperation and availability of equipment for separation (Rai *et al*., 2019; De Medina Salas *et al.*, 2020). For low-income countries the scenario is the opposite. De Medina Salas *et al.* (2020) state that limited awareness and lack of stakeholder involvement militate against separation at source in most developing countries. In relation to this, Taiwo *et al.* (2016) established that good environmental education was needed to improve separation at source in Johannesburg, South Africa. In addition, incentives can promote separation of waste. In a study conducted in Nepal, Rai *et al.* (2019) found out that the Bharatpur Metropolitan City provides about half subsidy for stakeholders who buy composters and collect plastic waste from each

household. This is done to encourage waste generators to sort solid waste so that they compost organic waste. The above findings indicate that for waste separation to be successful, equipment for separation and legislation must be in place. In addition, stakeholders should be actively involved and there should be effective environmental awareness.

According to Ogwueleka (2009) and De Medina Salas *et al.* (2020), sorting is essential because the volume of solid waste transported to landfill is reduced. In addition, segregation enhances composting, recycling and reuse (Gundupalli *et al.,* 2017; Minelgaite and Liobikiene, 2019). In a study of municipal solid waste management in Harare, Zimbabwe, Mangundu *et al.* (2013) concluded that implementing components of the waste management hierarchy was difficult due to mixed waste. Thus, waste separation is sustainable because it improves the life span of the disposal sites. Waste minimisation will be presented in the next section.

2.2.4 Waste minimisation

High rates of urbanisation and population growth have significantly increased the quantity of municipal solid waste generated, threatening the environment and public health (Choudhury and Choudhury, 2014; Samwire *et al.,* 2017).Therefore, waste generation should be minimised in order to reduce negative environmental and health risks associated with MSWM. Waste minimisation is the most preferred option of the waste management hierarchy (Hoornweg and Bhada-Tata, 2012; UNEP, 2015). This implies that it is a key element of sustainable waste management. Waste minimisation is also called source reduction and it aims to prevent waste from being generated. Waste prevention strategies include using less packaging, using products which last longer and reusing products (Hoornwerg and Bhada-Tata, 2012). Plastic bags can be

reused when shopping, while plastic containers can be reused for storing water, salt and sugar. According to UNEP (2015), it is one of the “4R” principle. “4Rs” stand for reduce, reuse, recycle and recover and are key components of the waste management hierarchy.

Waste reduction has a spatial variation. The efficiency of waste reduction depends on level of awareness, level of community involvement, availability of financial resources and level of recycling technologies capacity (De Medina Salas *et al.,* 2020). Low-income countries are associated with lower waste reduction than high-income countries due to inadequate awareness, limited community involvement and scarcity of financial resources, as noted by Dout *et al.* (2017). In addition, reduced waste means reduced illegal disposal, which reduces environmental and health risks associated with municipal solid waste management. According to Gillespie (2017), waste reduction is key for achieving Sustainable Development Goal 11 of sustainable cities and communities. Waste pickers will be discussed in the next section.

2.2.5 Waste pickers

These are waste collectors who earn a living by recovering and selling recyclables (Comaru and Werna, 2013; UNEP, 2013). Some waste pickers are employed by local authorities (formal) while others are self-employed (informal). Waste pickers are an important component of recycling. Informal waste pickers experience various health problems because of risky working conditions and the situation is worsened by poverty and lack of personal protective equipment (Dias *et al.,* 2008; Marello and Helwege, 2014). Comaru and Werna (2013) and UNEP (2013) established that informal waste workers include all age-groups of both genders. Informal waste pickers work on disposal sites (Scheinberg *et al.,* 2011).

According to Marello and Helwege (2014), various names referring to informal waste workers were used and they include waste collectors, waste pickers, garbage handlers, recyclers and scavengers. All the terms listed, except 'scavengers' are used without problems. UNEP (2013) argues that the term 'scavenger' implies comparison with animals. Waste picker was used to refer to informal waste collector in this survey. The quantity of recyclable waste such as plastic is reduced on waste dumps (Wilson *et al.,* 2006; Ramachar *et al.,* 2012). Hence, informal waste pickers play an important role in municipal solid waste management. Despite playing an important role in municipal solid waste management, public policies towards informal recycling have been negative. Waste pickers may be victimised by law-enforcement agents. For example, informal waste collectors have been ill-treated by police in Colombia, as noted by Wilson *et al.* (2006). There has been a change in attitude towards informal waste workers in developing countries. For example, Parishwad *et al.* (2016) observed that informal sector involvement in India was now enhanced by legal and policy framework. To promote informal recyclers, there is need for policy makers to develop a positive attitude towards these recyclers and integrate them in the formal system. Involving them in waste management programmes would be an advantage. Having discussed terms and concepts associated with municipal solid waste management, MSWM and associated environmental risks will be discussed in the next section.

2.3 MUNICIPAL SOLID WASTE DISPOSAL AND THE ENVIRONMENT

Nature of municipal solid waste management determines associated environmental risks in a given urban area (Mahar, 2014; Dhlamini *et al.,* 2017; Lethbridge, 2017; Gujre *et al.,* 2020).Zohoori and Ghani (2017) and Balasubramania (2018) noted that the unlawful disposal common in poor countries has resulted in environmental

deterioration. Studies conducted, for example in India (Rana *et al.,* 2015) and in Pakistan (Mohsin and Chinyama, 2016), revealed that disposal of solid waste on open spaces threaten the environment. Similarly, studies carried out in Uganda (Okot-Okumu and Nyengere, 2011) and in Nigeria (Olukannie *et al.,* 2014) also revealed that the quality of the environment was negatively affected by improper disposal of municipal solid waste. Local authorities should properly manage municipal solid waste to safeguard the environment (Elagroudy *et al.,* 2016). Pollution, loss of aesthetic value, floods and fire are some of the risks associated with MSW illegal disposal. In following section, pollution as an environmental risk associated with MSW illegal disposal will be discussed.

2.3.1Pollution

Environmental pollution can be defined as reduction in the value of environmental components (Zohoori and Ghani, 2017; Alam *et al.,* 2020). Thus, pollution involves deterioration of environmental components such as land, water and air. Unplanned disposal of waste can pollute surface and groundwater as a result of leachate, while uncontrolled burning of solid waste can cause air pollution (Aljaradin and Persson, 2012; Hoornweg and Bhada-Tata, 2012; Zohoori and Ghani, 2017). Information from literature, for example in Latin America and the Caribbean (Hettiarachchi *et al.*, 2018) and in India (Saikia and Nath, 2015; Vilas, 2015; Dhere and Barkede, 2016; Alam *et al.,* 2020), highlighted that improper disposal of municipal solid waste resulted in water, land and air pollution. Similarly, land and water were polluted in China due to unsanitary landfills, as noted by Zhou *et al.* (2017). Related studies conducted, for example in Kenya (Muniafu and Otiato, 2010), inEthiopia (World Bank, 2012), in Tanzania (Kasala, 2014), in Nigeria (Babayemi and Dauda, 2009; Butu and Mshelia,

2014), and in Khartoum, Sudan (Yadi, 2018) revealed that illegal disposal of municipal solid waste resulted in deterioration in quality of surface and groundwater, land and air. Figure 2.4 shows a polluted water body in Dar es Salaam, Tanzania.

Figure 2.4: Polluted water body in Dar es Salaam, Tanzania (Source: Kasala, 2014)

In Zimbabwe, studies conducted, for example in Victoria Falls (Masocha, 2004), in Gweru (Mangizvo, 2010) and in Harare (Nyanzou and Jerie, 2014), established that water and land were polluted as a result of poor municipal solid waste disposal. The preceding studies suggest that improper disposal of waste is a threat to the environment because it is associated with various forms of environmental pollution and the problem is dominant in developing countries due to lack of capacity for disposing waste in a way that is friendly to the environment. The present study sought to determine whether the identified risks are applicable to Masvingo City.

Municipal solid waste illegal disposal can also damage ecosystems. Studies on municipal solid waste management and the biotic environment, for example, in Europe (UNEP, 2006; Gregory, 2009), in the Philippines (Aloy *et al.,* 2011), Pakistan (Ali *et*

al., 2014) and in the Carribean (Riqueleme *et al.*, 2016), noted that the growth of animals and plants was disrupted by municipal solid waste, which compromised food availability for organisms. In India, cadmium and lead in MSW had a negative impact on fungal and bacterial population, respectively (Lin *et al.,* 2019; Pan *et al.,* 2020). Studies in Africa, for example, in South Africa (Njeleka, 2010), Cameroon (Ndum, 2013) and in Gweru, Zimbabwe also revealed that both flora and fauna were negatively affected by MSW illegal disposal. Seepage from illegally- disposed heavy metals can kill plants and organisms. Basing on preceding information, it can be deduced that poor waste management is a threat to biodiversity because various decomposers lose their lives, thereby retarding nutrient cycling which, in turn, slows down the growth of vegetation. Thus, improper disposal of waste causes damage to the environment, implying that it is not sustainable. Pollution results in loss of aesthetic value. Reduced aesthetic value will be discussed in the next section.

2.3.2 Reduced aesthetic value

Illegal disposal of municipal solid waste is a threat to the urban environment, as it is associated with reduced aesthetic value. Literature on municipal solid waste disposal in Rawalpindi City, Pakistan (Eljaz *et al.*, 2010) and in Indian urban areas (Khati, 2015; Balasubramania, 2018) revealed that illegally disposed MSW reduced the natural beauty of the urban areas. In a related study on MSW disposal and property values in Bahalwalpur, Pakistan, Mohsin and Chinyama (2016) concluded that improper disposal of MSW was associated with low property values as a result of reduced urban beauty. Mohsin and Chinyama (2016) further indicate that houses near dumping sites had lower rent and lower selling prices than houses far away from dump sites. Reporting on Kampala, Uganda, Kinobe (2015) argued that urban beauty was reduced

as a result of infrequent collection of municipal solid waste. Similarly, soot caused by uncontrolled burning of solid waste at Alice dumpsite in South Africa resulted in loss of urban beauty, as noted by Mangizvo and Mupindu (2012). In studies on MSWM in Nigeria, Adewusi and Onifade (2006), Ogedengbe and Oyedele (2006), and Wokekoro and Uruesheyi (2014) established that property value decreases with decreasing distance from dump sites and the negative impact of disposal sites is around six percent, depending on the distance from the disposal site. These results were in harmony with findings in India and Pakistan. In relation to the local context, Zimbabwe, studies in Gweru (Mangizvo, 2010) and in Mutare (Mafume *et al.,* 2016) indicated that poor MSWM resulted in loss of urban beauty.

Basing on preceding studies, it was concluded that reduced urban beauty as a result of poor waste management can lead to reduced property values. To maintain urban beauty, municipal solid waste disposal methods should be friendly to the environment. Considering that environmental risks of municipal solid waste illegal disposal was documented in relation to cities other than Masvingo, it is the intention of this study to determine if residents of Masvingo share similar sentiments and if direct observations can corroborate that, with respect to current waste management practices in Masvingo City. Having discussed MSWM and aesthetic value, MSWM and fire will be discussed in the next section.

2.3.3 Fire due to flammable gases emission

Fire is associated with disposal sites due to bacterial degradation of municipal solid waste producing flammable gases (Zohoori and Ghani, 2017). Reporting on the situation in Asia, Das *et al.* (2014) revealed that methane gas from uncontrolled landfill sites in urban Bangladesh was causing fires. Similar studies in India, for example in

Mumbai (National Aeronautics and Space Administration, 2016) and in New Delhi (Times of India, 2017), revealed outbreak of fire at Deonar landfill in 2016 and at Ghazipur in October 2017. Duncan (2018) noted that in March 2015, Riverton City Dumpin Jamaica burned for a fortnight. In a related study in Jordan, Aljaradin and Persson (2012) found out that lack of collection of landfill gases increased the risk of fire at landfills.

Fire is fuelled by the presence of numerous scrap tyres. Lagos, Nigeria, is a case in point (Aderemi and Falade, 2012). Studies in Zimbabwe also revealed that improper municipal solid waste management was associated with fire. For example, Mandimutsa (2000) and Jerie (2006) established that the Golden Quarry dump in Harare burned in August 2000 due to methane gas generated by anaerobic decomposition of MSW. In addition, Kharlamova *et al.* (2016) noted that fire was a common problem at Pomona dumpsite in Harare, Zimbabwe and resulted in the death of one person in 2013.

The mentioned studies indicated that improper disposal of MSW is a threat to the environment since flammable gases are produced, thereby causing fires and emission of secondary toxic and greenhouse gases. However, it should be noted that the extent of severity and impact is a function of waste composition, as toxic waste may not allow proliferation of methanogenic bacteria. Thus, there is variation of risks for each site and to determine a holistic management model, one must perform studies across different municipalities. Landfill gases should be collected and used for energy generation so as to promote sustainability at these sites (Hoornweg and Bhada-Tata, 2012; Dajic *et al.,* 2016). The measure has been successfully implemented in

developed countries, where the risk of fire has been greatly reduced through effective collection of landfill gas, enhanced by the availability of technical capacity and financial resources (Cuartal *et al.,* 2017; Vaverkova *et al.,* 2018). Below is a discussion on municipal solid waste disposal and floods.

2.3.4 Floods

Municipal solid waste can be a threat to the environment if not properly managed because it can cause floods in urban areas (Lamond *et al.,* 2012; Van Niekerk and Weighmann, 2019). Studies on municipal solid waste management in Rawalpindi, Pakistan (Ajaz *et al*., 2010), in Mexico and Indonesia (Lamond *et al.,* 2012), and in Chandigarh City, India (Rana *et al.*, 2015) revealed that illegal disposal of MSW in drainage channels slows down movement of water, resulting in floods.

Related studies came up with similar findings. For example, Boadi and Kuitumen (2003) and Yoada *et al.* (2014) established that unlawful disposal of municipal solid waste led to flooding during the rainy seasons in Accra, Ghana. According to Butu and Msheila (2014) and Ojo (2014), flooding was common in Kano and Abeokuta, Nigeria, as a result of municipal solid waste in drains. Similarly, municipal solid waste in waterways causes flooding, resulting in damage to infrastructure in Keko and Morogoro in Tanzania (Kasala, 2014; Chengula *et al.,* 2015*;* Van Niekerk and Weghmann, 2019). Studies conducted in Dakar, Senegal (African Population and Research Center, 2016) and in Kinshasa, DRC (Van Niekerk and Weighmann, 2019) also revealed that there was high risk of flooding due to illegal waste disposal. Figure 2.5 shows blocked drains in Ota, Nigeria (A) and Rawalpindi, Pakistan (B).

A B

Figure 2.5: Solid waste in drains, Ota, Nigeria (A) and Rawalpindi, Pakistan (B) (Sources: Olukanni *et al*., 2014; Ajaz *et al*., 2010)

Lamond *et al.* (2012) identified some of the urban areas affected by municipal solid waste induced floods in the world. The affected areas include Bamako, Cotonou, Lagos, Marikina, Jarkata, Mumbai, Mexico City and Managua as shown in Table 2.2.

Table 2.2: Urban areas which have been affected by flooding due to solid waste (source: Lamond *et al.,* 2012)

Urban area	Reason for flooding
Bamako (Mali)	Poor waste management
Cotonou (Benin)	Indiscriminate dumping of solid waste
Lagos (Nigeria)	Blocked drainage
Marikina (Philippines)	Partly to waste clogging the river
Jakarta (Indonesia)	Blocked channels
Mumbai (India)	Plastic bags blamed
Mexico City (Mexico)	Waste block drains leading to flash floods
Managua (Nicaragua)	Waste in rivers

Makwara and Magudu (2013), reporting on Zimbabwe, indicates that Harare, Bulawayo and Chitungwiza were affected by municipal solid-waste-induced floods. The information above shows that illegal solid waste disposal causes floods by disturbing the movement of water in drains and in rivers, thereby threatening human safety and property. The problem is not limited to Africa but affects other developing countries worldwide. While the studies above report environmental risks associated with illegal disposal of MSW in different cities of the world, including some Zimbabwean cities, there remains a gap with regards to Masvingo City, hence the current study which sought to determine environmental risks associated with illegal MSW disposal. Having discussed environmental risks associated with municipal solid waste management, MSWM and health will be presented in the next section.

2.4 HEALTH RISKS

The way municipal solid waste is managed could pose health risks (Nyanzou and Jerie, 2014; Mohammed and Eyasu, 2017; Ncube *et al.*, 2017; Gutberlt, 2018; Mouhoun-Choaki *et al.,* 2019; Tsheleza, 2019). Mahar (2014), Mansur (2015) and

Ferronato and Torreta (2019) postulated that illegal disposal of municipal solid waste in developing countries resulted in health risks. Reviewed health risks included waterborne, vectorborne, respiratory, heavy metals and e-waste, injury and ergonomic.

2.4.1 Waterborne diseases

Municipal solid waste management can be associated with waterborne diseases, depending on how the waste is disposed of (Yoada *et al.,* 2014; Lethbridge, 2017). Literature, for example in Laguna, Philippines (Atienza, 2004) revealed that cholera was a result of improper municipal solid waste disposal. A study conducted in Juba, Sudan, (Karija *et al.*, 2013) noted that there was risk of typhoid and cholera due to illegal municipal solid waste disposal. Similar studies in Kaya, Burkina Faso (Kafando *et al.,* 2013), in Ghana (Ashitey, 2014) and in Tanzania (Palfreman, 2014; Chengula *et al.,* 2015) established that illegal disposal of municipal solid waste has resulted in increased cases of cholera and diarrhoea. Palfreman (2014) indicates that more than 690 cases of cholera were reported in Tanzania between 1998 and 2005, as a result of illegal dumping of solid waste. Illegal disposal of food waste results in water contamination, thereby increasing chances of cholera. In Harare, Zimbabwe, municipal solid waste related cholera caused deaths of over 3500 people between 2008 and 2009 (Federation of Red Cross and Red Crescent, 2010; Saungweme, 2012). The preceding literature suggests that if one functional element (disposal) of municipal solid waste management is not properly implemented, human health is threatened because of waterborne diseases such as cholera, typhoid and diarrhoea.

2.4.2 Vectors

Municipal solid waste can be a threat to human health as it provides breeding grounds for vectors (Atalia *et al.,* 2015; Nor Faiza *et al.,* 2019). According to Riqueleme *et al.* (2016) and Lethbridge (2017), vectors are organisms which can spread diseases. This indicates that they are organisms responsible for transmitting diseases. Cases of vectorborne diseases have increased greatly worldwide as a result of poor municipal solid waste disposal, with malaria having the highest number of deaths (Lozano *et al.,* 2012; WHO, 2019). Therefore, malaria is the deadliest MSW induced vectorborne disease worldwide. Illegal disposal of MSW results in stagnant water, thereby promoting the breeding of mosquitoes. Mosquitoes breed where there is stagnant water. Larvae is aquatic and can only move away from stagnant water at adult stage, as noted by Mokuolu *et al.* (2016).

In a study on municipal solid waste management in Butwal, Nepal, (Panta, 2013) established that disposal sites promoted the breeding of mosquitoes, implying that there was risk of malaria in Nepal. Related studies in India (Atalia *et al*., 2015; Shaoli and Biswajit, 2016), in the Carribean (Riqueleme *et al*., 2016) and in Latin America (Lethbridge, 2017) concluded that yellow fever and bubonic plague were among vectorborne diseases emanating from municipal solid waste disposal sites. Yellow fever is transmitted to human beings by infected mosquitoes called Aedes and bubonic plaque can be spread by rats. Fleas in rats spread the plaque. Illegal MSW disposal sites provide food for rats. Thus, dumpsites provide convenient shelter for rats.

According to Kinobe (2015), piles of solid waste in Uganda increased the population of mosquitoes, thereby increasing the risk of malaria. Similarly, Mansur (2015),

reporting on the situation in the state of Jigawa in Nigeria, noted that there was risk of plague and malaria because illegal MSW dumps. Mouhoun-Choaki *et al.* (2019) reported that disposal of solid waste on open spaces increased insect vectors such as flies and mosquitoes in Algeria. In Ghana, mosquito population increased due to improper disposal of solid waste, thereby increasing the risk of malaria (Yoada *et al.*, 2014; Doke *et al.,* 2017). Similarly, the risk of vectorborne diseases in Sudan was high as organic waste at Tayba landfill enhanced the breeding of rats (Yadi, 2018).

In relation to Zimbabwe, Nyanzou and Jerie (2014) noted that malaria and fever were common in Harare due to open space waste dumps. The nature of diseases can vary with location. The present study sought to assess vectorborne diseases associated with illegal MSW in Masvingo City.

2.4.3 Heavy metals and e-waste

Human health is in danger from e-waste due to heavy metals used on circuit boards. E-waste includes electronic equipment such as computers, printers, telephones, calculators, televisions and refrigerators that are no longer in use (WHO, 2015; Balde *et al.*, 2017). E-waste comprises heavy metals such as lead, cadmium, nickel, mercury and arsenic, as shown in Table 2.3. The major pollutants from burnt e-waste include dioxins and furans. Jaishankar (2014) and Joon *et al.* (2017) found out that global health effects of mercury, cadmium, manganese and nickel exposure included dermatitis, cancers and weakening of nervous and digestive systems. In a study on MSWM and related health risks in China, Shamim *et al.* (2015) noted that exposure to e-waste was associated with slow childhood growthand cognitive development. Similar studies in India (Wang *et al.*, 2011; Khanam *et al.,* 2019; Tseng *et al.,* 2019) established that damage to central nervous and gastric systems were health risks

associated with lead and cadmium. Related studies in Latin America (Magalini *et al.,* 2015; Lethbridge, 2017) revealed that residents, especially children, near disposal sites were at risk of weak immune system, coma and weak endocrine system due to exposure to e-waste. Heavy metals are emitted during recycling, incineration and open burning of e-waste. Thus, heavy metals are released as a result of burning and dismantling of e-waste. Toxins such as dioxins are released into the air thereby polluting the air. The seepage of heavy metals into the soil causes groundwater pollution on illegal disposal sites. Thus, toxins in e-waste reach humans as a result of contaminated water and air.

Table 2.3: E-waste components and environmental hazards (Source: Joon *et al*., 2017)

E-waste	**Environmental hazards**
CRTs (used in TVs and computer monitors)	Cadmium, lead, barium, nickel leaching into the ground water
Plastic from printers, keyboards and monitors	Emissions of halogenated compounds, heavy metals, flame retards
Computer wires/cables	Hydrocarbon ashes released into air, water and soil (open burning)
Batteries	Cadmium, lead, lithium and mercury depending upon the types of batteries
Solder (circuit boards, monitors)	Lead being released in the environment

Studies in Africa, for example in Uganda (Wasswa and Schluep, 2008), in Tanzania (Blaser and Schluep, 2012), in Ghana (Van Niekerk and Weghmann, 2019) and in South Africa (Mangizvo and Mapindu, 2013; Ncube *et al.*, 2017) established that exposure to e-waste resulted in damage to the urogenital system and kidney problems. Health effects of e-waste are illustrated in Table 2.4. In Gweru, Zimbabwe, Jerie (2016) reported high risks of kidney and liver damages due to cadmium from e-waste. The quantity and type of heavy metals emitted varies significantly based upon the content of waste. Findings above suggest that illegal municipal solid waste

disposal is detrimental to public health, as evidenced by various health risks. To reduce related health problems, e-waste should be disposed of properly as the case in Europe (WHO, 2015).

Table 2.4: E-waste and health effects (Source: Kiddee *et al*., 2013)

Constituent	**Health effects**
Beryllium	Lung cancer and lung damage
Mercury	Lung damage, nausea, vomiting and skin irritation
Cadmium	Pulmonary, kidneys and bone structure damage
Barium	Muscle weakness and damage to heart and liver
Lead	Damage to central nervous system and kidneys, still births and miscarriages and muscle pain
Polyvinyl chlorides	Dioxins produced on burning are endocrine disrupters
Arsenic	Skin and lung cancer
Nickle	Asthma, skin damage and lung diseases

Tables 2.3 and 2.4 show that different e-wastes have different environmental hazards with diverse health effects. The nature of e-waste, which can vary with location, determines health risks. Having discussed MSWM and e-waste, the next task is to consider MSWM and respiratory problems.

2.4.4 Respiratory problems

Studies indicate that municipal solid waste illegal disposal was associated with respiratory problems (UNEP, 2013; Mahler *et al.,* 2016). Respiratory problems are a result of emissions from burning plastic and rubber. Studies on MSWM and health in India, for example in Chennai (Kandasamy, 2013) and in Kalimpong (Khati, 2015), revealed that uncontrolled burning of solid waste resulted in breathing difficulties among solid waste workers. Uncontrolled burning of plastic releases volatile organic compounds such as nitrogen oxides and sulphur oxides. Jayakrishnan *et al.* (2013)

pointed out that at least one quarter of formal waste workers in Mumbai experienced respiratory problems. Similar studies in Kelantan, Malaysia (Aminuddin and Rahman, 2015), in Canada (World Health Organization, 2011) and in Rio de Janeiro, Brazil (Mahler *et al.,* 2016) reported that asthma and bronchitis were among respiratory risks affecting waste pickers. In Jamaica, above 700 people visited hospital because of respiratory difficulties caused by volatile organic compounds emissions from burning plastic and rubber at River City Dump in 2015(Office of the Public Defender, 2016).

The majority of residents in South Africa were suffering from respiratory diseases as a result of nearby illegal disposal sites (Njeleka, 2010). UNEP (2013) noted that dump sites fires were a cause for concern in Sudan due to increased respiratory risks among residents and waste workers. Gwisai *et al.* (2015) highlighted that respiratory problems were common in Lobatse, Botswana, as a result of municipal solid waste illegal disposal. In a related study, waste workers in Alexandria City, Egypt were at risk of respiratory problems as a result of dump sites smoke (Madian and El-Wahed, 2018).

In Zimbabwe, Jerie (2016) concluded that there were respiratory risks in Gweru due to burning of MSW. From the above information, it can be deduced that both developing and developed countries are at risk of respiratory problems as a result of illegal solid waste disposal since Canada, which is a developed country, was one of the nations affected. However, the majority of those affected are in developing countries. The extent of respiratory risks depends on how solid waste is dealt with at disposal sites and nearness of residents to dump sites. In developing countries, open burning is common, thereby producing a lot of smoke, worsening respiratory problems, while open burning is rare in developed countries, resulting in limited respiratory risks.

Residents close to dump sites are at more risk than those living away from the dump sites. The present study sought to determine whether respiratory risks experienced in other urban areas also apply to Masvingo City.

2.4.5 Injury risks

Municipal solid waste can contain sharp objects, thereby increasing injury risks to waste pickers (Lethbridge, 2017; Ncube *et al.,* 2017). The chances of risk are increased by lack of awareness and absence of safety clothes among waste handlers (Gizaw *et al.,* 2014; Yadi, 2018). Literature in Seri Kembangan, Malaysia (Mohammed and Latif, 2014) and in Latin America (Lethbridge, 2017; Cruvinel *et al.,* 2019) shows that informal waste workers were at risk of injury from sharp material within mixed residential waste on illegal disposal sites. In a related study in New York City, Newman (2016) found out that waste management workers were at higher risk of injury than mine workers.

Studiesin Sudan (UNEP, 2013; Yadi, 2018), in South Africa (Nkosi, 2014; Ncube *et al.,* 2017), in Dakar, Senegal (African Population and Research Center, 2016), and in Alexandria, Egypt (Madian and El-Wahed, 2018) revealed that broken bottle and needles were among sharp objects which increased the risk of injuries on waste pickers. Similarly, Gizaw *et al.* (2014) states that more than half of waste workers in Gondar town, Ethiopia experienced cuts as result of sharp objects within solid waste. Scavenging animals such as cattle can attack waste pickers, thereby posing risk of injury for waste collectors. Butu and Mshelia (2014) noted that waste collectors in Kano, Nigeria were at risk of injury from scavenging animals at dump sites (Figure 2.6).

Figure 2.6: People and animals scavenging MSW at a dump site, Kano (Source: Butu and Mshelia, 2014)

Lack of personal protective equipment (PPE) increased the probability of cuts on waste workers on disposal sites in Chitungwiza and Bindura, Zimbabwe (TARSC, 2010; Chikombe, 2017). Thus, municipal solid waste workers, especially informal in developing countries, are the most affected as a result of lack of awareness and PPE. Therefore, the risks can be reduced by improving their awareness and providing protective clothing. Having covered injury risks, MSWM and ergonomic hazards will be presented in the next section.

2.4.6 Ergonomic hazards

Lifting of municipal solid waste is associated with pain on different parts of the body as a result of awkward posture and repetitive movement (Mohammed and Latif, 2014; Jerie, 2016). In studies on MSWM conducted in Seri Kembangan and Kelantan, Malaysia, Mohammed and Latif (2014), and Aminuddin and Rahman (2015) reported back and joint pains as ergonomic risks faced by refuse collectors. Similarly, Zolnikov *et al.* (2018) established that searching for recyclable materials on illegal disposal sites resulted in back pains among formal and informal waste collectors in Brazil. Earlier, Aboll-Elwaya *et al.* (2012) noted that pain on shoulder and back affected waste collectors due to lifting of waste loads in Mansoura, Egypt. Figure 2.7 shows waste collectors at risk of musculoskeletal injuries as a result of moving heavy containers.

Figure 2.7: Risk of musculoskeletal injuries as refuse collectors manually move heavy container (Source: Mohammed and Latif, 2014)

In Zimbabwe, council employees in Gweru and Bindura were found to be at high risk of back, joint and wrist pain as a result of waste loads lifting, as noted by Jerie (2016) and Chikombe (2017). The need to meet targets within a short period of time causes waste pickers to overload themselves with material. Basing on the above observations, it can be concluded that improper disposal of MSW is a disaster for human health as it is associated with various health problems. According to Ross (2013) and UNEP (2015), protecting public health is one of the objectives of waste management. By causing health problems, improper disposal is not enhancing the goal. Assessing health risks associated with MSW illegal disposal in Masvingo City was one of the objectives. Constraints encountered by stakeholders in municipal solid waste managementare discussed in the next section.

2.5 CONSTRAINTS OF MUNICIPAL SOLID WASTE MANAGEMENT

Municipal solid waste management is not sustainable in most urban areas worldwide due to various challenges encountered (Saikia and Nath, 2015; Amasuomo and Baird, 2016; Mohammed and Eyasu, 2017). According to Ogwueleka (2009), Abila and Kantola (2013), and Di Bella and Vaccari (2014), challenges encountered by stakeholders in MSWM can be divided into infrastructure and equipment, political and administrative, human resources and financial resources. In the next section infrastructure and equipment challenges are presented.

2.5.1 Infrastructure and equipment

Inefficient municipal solid waste management can be a result of infrastructure and equipment challenges as noted by Osei (2014) and Dout *et al.* (2017). Lack of vehicles and receptacles were infrastructure and equipment challenges discussed. Lack of vehicles will be discussed below.

2.5.1.1 Lack of vehicles

Vehicles are needed to carry generated waste from homes, offices, institutions, shops, industries and municipal services to treatment centres, disposal sites and for use at landfills (Jerie and Nyanzou 2014). Studies in Kumasi, Ghana (Osei, 2014), in Somaliland (Dibella and Vaccari, 2014) and in Nigeria (Amasuomo and Baird, 2016) revealed that lack of refuse vehicles due to unavailability of spare parts militated against municipal solid waste management. Studies conducted in Zimbabwe, for example in Harare (Jerie and Nyanzou, 2014) and in Chinhoyi (Musademba *et al.,* 2011) established that MSWM was not effective because of limited vehicles to carry solid waste. In a related study in Zimbabwe, Mangundu *et al.* (2013) stated that MSWM was not meeting requirements because less than 30 % of the required 120 trucks were

in use in Harare. Five years later, Mandevere and Jerie (2018) noted that the number of refuse vehicles in Harare was inadequate. Furthermore, Mudzengerere and Chigweya (2012) highlighted that limited refuse collection vehicles in Bulawayo, Zimbabwe was hindering waste management. The above studies indicate that lack of refuse collection vehicles is a challenge leading to poor municipal solid waste management. Collection frequency can be reduced, resulting in illegal disposal. Lack of receptacles as a constraint will be presented in the next section.

2.5.1.2 Lack of receptacles

Receptacles are essential in municipal solid waste management for waste generators to store generated waste for a short period before collection by responsible authorities (Ross, 2013; Vucijak *et al.,* 2016). Two functional elements of MSWM (storage and collection) of solid waste are very difficult in the absence of receptacles (Dout *et al.,* 2017). Studies conducted on MSWM and challenges encountered in Nigeria (Abila and Kantola, 2013), in Ghana (Osei, 2014; Dout *et al.,* 2017) and in South Africa (Gumbi, 2015; Kubanza and Simatele, 2019) highlighted that shortage of bins was hindering municipal solid waste management. In Zimbabwe, studies in Bulawayo (Mudzengerere and Chigweya, 2012) and in Mutare (Mafume *et al.,* 2016) established that shortage of receptacles derailed MSWM. Basing on the information above, lack of bins is a constraint encountered by stakeholders in MSWM in developing countries. Having presented shortage of receptacles, lack of equipment for separation of solid waste will be highlighted in the next section.

2.5.1.3 Lack of equipment for separation

Separation of solid waste is key for municipal solid waste management (Bogoro, 2018). Vaidya (2014) revealed that lack of equipment derailed the separation of solid

waste at source in India. Related regional studies in South Africa (Gumbi, 2015), in Kigali, Rwanda (Nishimwe *et al.,* 2016) in Kampala, Uganda and Nairobi, Kenya (Kabera *et al.,* 2019) revealed that scarcity of equipment resulted in lack of separation. Nishimwe *et al.* (2016) further indicated that households could not afford colour-coded bags in Kigali because a lot of money was required. Findings from studies conducted in the local context, Zimbabwe, for example in Harare (Mangundu *et al.,* 2013) and in Bulawayo (Sithumele and Mkumbuzi, 2019) concurred with what was revealed by Vaidya (2014), Nishimwe *et al.* (2016) and Kabera *et al.* (2019) as they also showed that shortage of separation containers hindered separation at source. Basing on the preceding findings, it can be deduced that separation of solid waste should be implemented to make MSWM sustainable and that to enable separation, necessary equipment should be available. The present study sought to determine whether the discussed infrastructure challenges also apply to Masvingo. Having discussed infrastructure and equipment challenges, political and administrative constraints will be presented in the next section.

2.5.2 Political and administrative

The way institutions are run determines their efficiency in terms of municipal solid waste management (Dladla *et al.,* 2016). Poor implementation of strategies can lead to improper municipal solid waste management (Ziraba *et al.,* 2016). Muchangos *et al.* (2015) noted that for any waste management system to be efficient, a suitable waste management policy should be in place, implying that waste management policy is key for MSWM. Inadequate implementation, corruption, lack of political will and lack of cooperation and community participation were political and administrative challenges discussed.

2.5.2.1Inadequate implementation

Lack of implementation of MSWM programmes, such as composting and recycling, can hinder municipal solid waste management. Sigh and Satija (2015) revealed that poor MSWM was a result of inadequate implementation of waste management programmes. Similarly, studies carried out in Nigeria (Abila and Kantola, 2013; Amasuomo and Baird, 2016) and in Ghana (Osei, 2014) established that MSWM was inefficient due to lack of implementation of planned municipal solid waste management programmes. Thus, inadequate implementation of proposed waste management programmes is a challenge faced by municipal solid waste management stakeholders. To improve MSWM, proposed waste management programmes should be well implemented. Weak enforcement was discussed in the next section.

2.5.2.3 Weak enforcement

Ineffective enforcement of laws can result in poor MSWM in urban areas. According to Abila and Kantola (2013), poor MSWM legislation in Nigeria was hindering efficient management of MSW. Similarly, studies in Egypt (Ibrahim and Mohamed, 2016), in Senegal (Beri, 2018), in Zambia (Mwanza *et al.*, 2018), in Rwanda (Kabera, 2019) and in Sudan (Mier and Zhou, 2020) revealed that poor enforcement was derailing municipal solid waste management. According to Mier and Zhou (2020), municipal solid waste management in Juba, Sudan was ineffective because responsible authorities were unable to enforce present policies and regulations. Inability to enforce regulations was a result of lack of political will and insufficient number of workers. Corruption and lack of political will are discussed in the next section.

2.5.2.4 Corruption and lack of political will

Inconsistency and unwillingness to perform for political reasons can militate against

effective MSWM (Bour, 2019). According to UNEP (2015), political commitment is essential in low-income countries and the African Union has urged African cities to promote recycling to the extent that by 2023 more than 49 % of generated waste will be recycled. Similarly, political will is essential for MSWM to be a success (United Nations Human Settlements Programme, 2015; Solomon, 2018; World Bank, 2018). Studies conducted in Bahamas, Guyana and Trinidad and Tibago (Riquelme*et al.,* 2016) established that corruption was hindering effective management of MSW. In Nepal, Pokhrel and Viraraghavan (2005) noted that lack of political will was derailing waste management. Related literature in South Africa (Nthuli, 2020) revealed corruption at Msunduzi's landfill where recycling companies paid in order be served by landfill officials. Similarly, Otchere *et al.* (2014) and Adipah (2019) found out that MSWM was not efficient in Kumasi and Accra, Ghana due to lack of political will. Adipah (2019) indicates that both national and local governments had low level of commitment to waste management. Sithumule and Mkumbuzi (2019) found out that in Bulawayo, Zimbabwe, clashes between Environmental Management Agency officials and Bulawayo City Council, due to difference in political ideology, was a challenge. The mayor lacked political will in relation to MSWM. These studies indicate that corruption and lack of political will can derail the management of MSW. The present study sought to establish whether residents and key informants in Masvingo share similar sentiments.

2.5.2.5 Lack of cooperation and community participation

Stakeholder inclusion and cooperation are crucial for any waste management programme to succeed (Kumar *et al.,* 2019). Literature in China (Chung and Lo, 2008) and in Lebanon (Abbas *et al.,* 2017) showed that municipal solid waste management was ineffective as a result of lack of cooperation and community participation.

Similarly, studies conducted in Tanzania (Kasala, 2014; Chengula *et al.,* 2015) and in South Africa (Gumbi, 2015; Van Niekerk and Weghmann, 2019) found out that, as in countries such as China and Lebanon, limited cooperation and participation was a challenge derailing MSWM. Chengula *et al.* (2015) stated that waste generators did not want to pay for refuse collection. In Zimbabwe, studies conducted revealed similar results. For example, Jerie and Nyanzou (2014) established that lack of cooperation was a challenge in Harare. Similarly, residents in Gwanda, Zimbabwe, had a negative attitude towards municipal solid waste management (Mathe and Phiri, 2015). Lack of cooperation and community participation was due to lack of awareness among waste generators and mismanagement by local authorities. The above information implies that without cooperation and community participation, it is very difficult, if not impossible, to achieve waste management goals. To improve MSWM, cooperation must be promoted and the community should be actively involved.

2.5.3 Human resources

Municipal solid waste management can be hindered by human resource challenges (Mmereki *et al.,* 2016; Dout *et al.,* 2017). Challenges discussed included lack of awareness, lack of manpower as well as lack of cooperation and community participation. Below is a discussion on lack of awareness.

2.5.3.1 Lack of awareness

The level of awareness of stakeholders, which depends on level of education, determines the extent to which waste management programmes succeed (Di Bella and Vaccari, 2014; Yoada *et al.,* 2014). Studies in China, (Chung and Lo, 2008) concluded that MSWM was inefficient due to lack of awareness among waste management administrators. Chung and Lo (2008) further indicate that about 40 % of

authorities involved in waste management lacked information on waste management hierarchy. In a related study in Poland, Macias and Piniarski (2016) found out that lack of environmental awareness led to improper municipal solid waste management.

Studies in Lagos, Nigeria (Abila and Kantola, 2013), in Somaliland (Di Bella and Vaccari, 2014), in Ethiopia (Kassie, 2016) and in Bawku, Ghana (Dout *et al.,* 2017) corroborate findings in Poland, as they show that inadequate information on municipal solid waste was a challenge encountered by stakeholders in municipal solid waste management. Di Bella and Vaccari (2014) further observed that limited awareness on negative effects of poor waste management was dominant among waste generators. Basing on this information, it can be concluded that limited environmental awareness is a constraint hindering management of MSW worldwide.

2.5.3.2 Lack of manpower

Municipal solid workers with necessary skills are needed for MSWM programmes to be implemented (Jerie, 2014). Some local authorities in developing countries lack the capacity to employ adequate MSWM manpower due to lack of financial resources. Sufficient manpower can enhance frequent collection of solid waste and enforcement of waste management laws, thereby deterring illegal MSW disposal. Studies in India (Sigh and Satija, 2015) and in Lebanon (Abbas *et al.,* 2017) revealed that lack of manpower was a challenge encountered in MSWM. Findings from related studies in Tanzania (Chengula *et al.,* 2015), in Addis Abbaba, Ethiopia (Mohammed and Eyasu, 2017) and in South Africa (Kubanza and Simatele, 2019; Van Niekerk and Weghmann, 2019) established that shortage of manpower was hindering the management of solid waste. The above information indicates that lack of manpower was one of the challenges disabling urban authorities from achieving solid waste management goals.

2.5.4 Financial challenges

Financial resources are needed to implement waste management programmes. Lack of money and fuel were financial challenges discussed.

2.5.4.1Shortage of money

Low-income countries are associated with poor municipal solid waste management as a result of scarcity of funds, while MSWM in high-income countries is usually effective due to availability of funds (Hoornweg and Bhada-Tata, 2012). Mian *et al.* (2010) reported that municipal solid waste management in Mymensingh municipal area, Bangladesh, was poor as a result of limited money for waste management. In a study conducted in India, Rana *et al.* (2014) revealed that municipal solid waste management in Indian cities was ineffective because financial resources were lacking. Studies in Nigeria (Ogwueleka, 2009), in Cameroon (Ndum, 2013), in Ghana (Osei, 2014; Dout *et al.,* 2017; Bour, 2019), in Tunisia (Chaabane *et al.,* 2019), in South Africa (Kubanza and Simatele, 2019), in Juba, Sudan (Mier and Zhou, 2020) and in Zambia (Shambo *et al.,* 2020) established that inadequate finance militated against MSWM. Shambo *et al.* (2020) indicate that lack of money made it difficult for local authorities to achieve set waste management goals and the situation was worsened by the inability of waste generators to pay refuse fees.

In relation to local studies in Zimbabwe, Mudzengerere and Chigweya (2012) and Jerie and Nyanzou (2014) found out that management of municipal solid waste in Bulawayo and Harare, respectively, was pathetic due to lack of money. In Zimbabwe, budgets of local authorities are approved by the Minister of Local Government, who belongs to the ruling party. Most local authorities are run by a different political party. It is very

difficult for these budgets to be approved due to lack of political will. Basing on the preceding findings, one can conclude that MSWM, especially in developing countries, is inefficient due to shortage of money.

2.5.4.2 Shortage of fuel

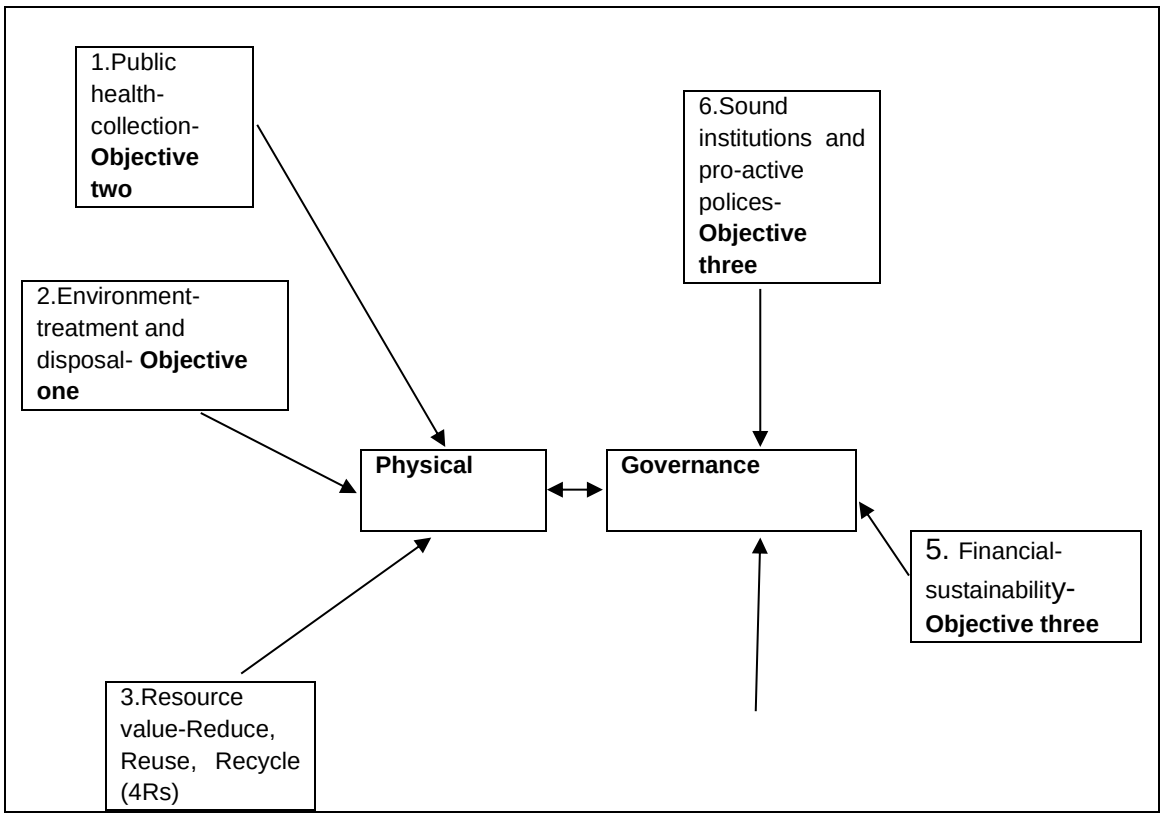
Fuel is needed for refuse collection vehicles and other machinery to function. Without fuel, management of municipal solid waste is very difficult, if not impossible. Saifullah and Islam (2016) noted that relying on vehicles which have been in use for many years and lack of maintenance increase fuel consumption. Lack of maintenance has created fuel shortages in Dhaka, Bangladesh, thereby hindering municipal solid waste management (Saifullah and Islam, 2016). In a study on sustainable solid waste management in Cameroon, Ndum (2013) highlighted that MSWM was ineffective as a result of lack of fuel emanating from lack of resources to purchase fuel on the market. Similarly, fuel shortages in Harare, Zimbabwe due to shortage of foreign currency to import the precious liquid were militating against municipal solid waste management (Chikobvu and Makarati, 2011). Therefore, scarcity of fuel derails MSWM. The present study sought to examine constraints encountered by municipal solid waste management stakeholders in Masvingo City. Having discussed constraints encountered by MSWM stakeholders elsewhere, theoretical framework of the study will be presented in the next section.

2.6THEORETICAL FRAMEWORK FOR MSWM

A theoretical framework can be defined as a foundation for research based on formal theory (Grant and Osanloo, 2014; Kivunja, 2018). Thus, theoretical framework is crucial for any research. Integrated sustainable waste management (ISWM) model

was used as the point of reference for the current study. In relation to solid waste management, Van de Klundert and Anschutz (2001) present a model that represents components of sustainable solid waste management. The research problem for the current study was rampant illegal municipal solid waste disposal and the aim was to evaluate this illegal disposal in Masvingo City, so the model was suitable as the theoretical framework that the researcher used to analyse data in this research. The model is illustrated in Figure 2.8.

The integrated sustainable waste management model enables holistic management of waste (Guerrero *et al.,* 2013; Amugsi *et al*., 2016). As illustrated in Figure 2.8, ISWM is the benchmark for all waste management systems involving three essential components (Hoornwerg and Bhada-Tata, 2012; UNEP, 2015; Yukalang *et al.,* 2018). The three components are elements, stakeholders and aspects. Elements of the integrated sustainable waste management model are processes involved in solid waste management and one of them is collection. The processes are represented by numbers 1-3 in Figure 2.8. These SWM processes were used by the researcher to evaluate health and environmental risks. Stakeholders (number 4 on Figure 2.8) are those that have an interest or roles that are individuals, local authorities, NGOs, community-based organisations and the donor community. In the current study, the level of stakeholder involvement was used to determine constraints faced in waste management. Aspects of the ISWM are policies and impact, for example technical, financial, environmental, social and political (Mwangi and Thuo, 2014; UNEP, 2015). Aspects (numbers 5 and 6 in Figure 2.8) were used to evaluate constraints encountered by stakeholders in MSWM. To achieve sustainability, all components of the ISWM model must be taken care of at the same time (Abbas *et al.*, 2017).


1.Public health-collection- **Objective two**
6.Sound institutions and pro-active polices- **Objective three**
2.Environment-treatment and disposal- **Objective one**
Physical
Governance
5. Financial-sustainability- **Objective three**
3.Resource value-Reduce, Reuse, Recycle (4Rs)

	4.Inclusivity-user and provider-**Objective three**	

Figure 2.8: Theoretical framework for evaluating municipal solid waste illegal disposal (Source: Van de Klundert and Anschutz, 2001)

Waste management hierarchy (Figure 2.9) is a crucial component of the ISWM model as it promotes the 4Rs (Jibril *et al*., 2012; Taiwo *et al.,* 2016). Waste management hierarchy is a waste management tool which can be used for policy formulation and is the foundation of present municipal solid waste management since it provides preferred options in the management of waste (Jibril *et al.*, 2012; World Bank, 2012). According to the waste management hierarchy (WMH), the most preferred option is reduction, while the least preferred is disposal. Waste management hierarchy was successfully implemented in Europe and Hong Kong (Amugsi *et al.*, 2016). Financial constraints hinder implementation of waste management hierarchy in low-income countries (Jibril *et al.,* 2012). The ISWM model was promoted to cater for waste management challenges in poor countries (Hoornwerg and Bhada-Tata, 2012; Marshall and Farahbakhsh, 2013). That is, it was designed to reduce environmental deterioration and to protect public health and safety from the rapid increase in MSW (UNEP, 2015; Amugsi *et al.*, 2016) and this was the main reason why the model was used in this study. In the current study, the ISWM model was used to formulate objectives, explain results and to design a sustainable municipal solid waste management model for Masvingo City. Elements 1 and 2 of ISWM were used to formulate objectives on health and environmental risks respectively while stakeholders (4) and aspects (5 and 6) were used to formulate the objective on constraints.

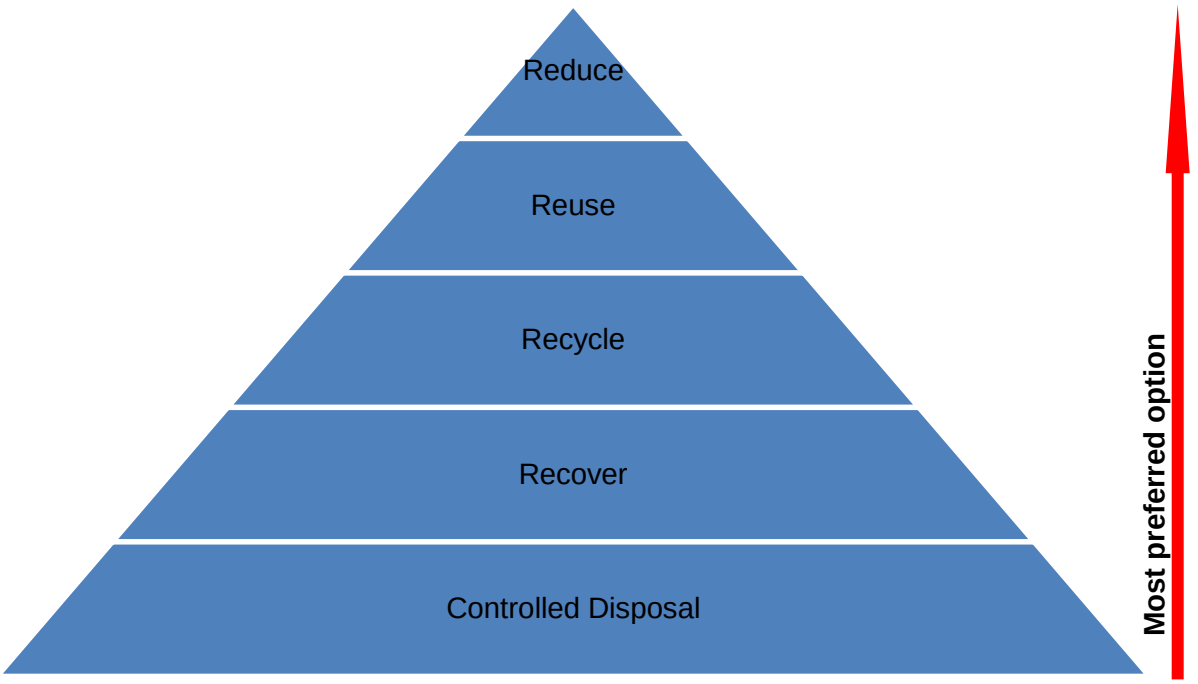


Figure 2.9: Waste management hierarchy (Source, Hoornweg and Bhada-Tata, 2012)

2.7 APPLICABILITY OF THE MODEL TOTHE PRESENT STUDY

The integrated sustainable waste management model is relevant to the present study. Element 1 of the ISWM is concerned with promoting public health as indicated in Figure 2.8. The second objective of the current study was to assess health risks of municipal solid waste illegal disposal, as alluded to in Chapter One. This indicates that the second objective was linked to element 1 of the ISWM. Protecting the environment is the main concern of element 2 of the ISWM as shown in Figure 2.8. Determining environmental risks of municipal solid waste illegal disposal was the first objective of the current study, implying that there was a link between element 2 of ISWM and the first objective of the current study. Thus, elements were used to assess health risks and determine environmental risks. In addition, stakeholders (4) and aspects (5 and 6) were linked to the third objective of the present study, which was to examine constraints encountered by stakeholders in municipal solid waste management. The level of stakeholder involvement, sustainability of financial resources and

effectiveness of institutions were used to examine constraints faced by stakeholders in municipal solid waste management.

2.8 CHAPTER SUMMARY

Literature related to research objectives was reviewed. The chapter discussed terms and concepts associated with MSWM. Pollution, reduced aesthetic value, fires and floods were highlighted as environmental risks of MSW disposal. Waterborne diseases, vectors, respiratory, injury and ergonomic health risks of MSW disposal were discussed. Constraints faced by MSWM stakeholders in different parts of the world were also discussed. ISWM was explained as the theoretical framework for this study. The next chapter comprises research design and methodology.

3 RESEARCH DESIGN AND METHODOLOGY

3.1 INTRODUCTION

The current study sought to evaluate municipal solid waste illegal disposal in Masvingo City, Zimbabwe, with a view to developing a sustainable waste management model. Having presented related literature on MSWM and environmental risks, MSWM and health risks and constraints encountered by MSWM stakeholders in the previous chapter, the present chapter outlines the research philosophy, research design, sampling techniques, data sources and collection techniques, issue of trustworthiness, ethical considerations, pilot study, data analyses and interpretation. Figure 3.1 shows the research process that was followed in the present study. In this study, the diagrammatic representation of the research process (Figure 3.1) is regarded as the research onion. Research onion shows worldview, approach to theory development, methodological choice, data collection and analysis of a given study. The base of each research onion depends on how the world is viewed as illustrated in Figure 3.1. Because of various world views, research onions also vary, implying that a research onion of a study based on positivism is different from a research onion whose base is interpretivism. In addition, a study based on pragmatism has a unique research onion.

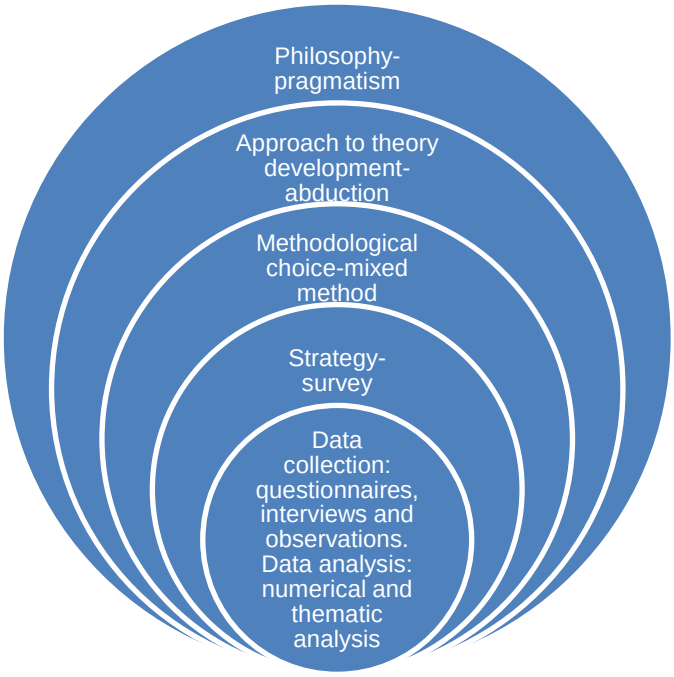


Figure 3.1: Research onion (Source, Saunders *et al*., 2007)

The research philosophy that informed the present study will be presented in the next section.

3.2 RESEARCH PHILOSOPHY

Research philosophy can be defined as how people view the world (Saunders *et al*., 2007; Creswell, 2013). Philosophy is also known as paradigm. The methodology used in each research depends on the research philosophy (Grix, 2004; Creswell, 2014). Figure 3.1 illustrates the link between research philosophy and methodology. Historically, the two dominant philosophies have been positivism and interpretivism (Bryman, 2001; Grix, 2004; Creswell, 2014). According to positivism, there is one true reality; knowledge is about measurable facts, the researcher is objective and research starts with theory and moves to data (Saunders *et al*., 2007; Creswell, 2014. Contrary to positivism, interpretivism regards reality as socially constructed, researcher is subjective and research moves from data to theory (Denzin and Lincolin, 2018;

Bloomberg and Volpe, 2019).

The two historical philosophies mentioned in the preceding paragraph represent two extreme positions; with positivism being aligned with quantitative research and interpretivism being associated with qualitative research. Considering that the current study applied both quantitative and qualitative methods, a philosophy that combines the two philosophies, namely pragmatism, was found appropriate. According to pragmatism, reality is regarded as a practical consequence of ideas, knowledge enables successful action, and research is value-driven (Saunders *et al.,* 2007; Bloomberg and Volpe, 2019). Pragmatism occupies middle ground and its approach to theory development is abduction (Saunders *et al*., 2007; Doyle *et al.*, 2009). Abduction entails reasoning from specific to general (data to theory) and from general to specific (moving from theory to data). Thus, abduction involves moving back and forth. Pragmatism enables use of multiple data collection tools, collection of different forms of data and use of triangulation, as noted by Saunders *et al*. (2007) and Creswell (2014). In the present study, a questionnaire was used to collect both quantitative and qualitative data, on environmental risks and constraints, from residents, while an interview was used to collect qualitative data on health risks, environmental risks and constraints from council employees, EMA officials and informal waste workers. Furthermore, observation was used to collect qualitative data on environmental risks. Collection of both quantitative and qualitative data in the current study enabled the use of both deductive (theory to data) and inductive (data to theory) approaches. Research design will be presented in the following section.

3.3 RESEARCH DESIGN

A research design can be defined as the structure of a research (Tashakkori and Teddie, 2010; Creswell, 2014). Thus, a research design is a plan of action to be used to answer research questions. There are three types of research designs depending on philosophy (Creswell and Piano Clark, 2007; Tashakkori and Teddie, 2010; Creswell, 2014). The three designs are:

i. Quantitative, which is based on positivism and involves a deductive approach towards research;
ii. Qualitative, which is based on interpretivism worldview and involves an inductive approach; and
iii. Mixed methods design, which is based on pragmatism and involves abductive approach towards research (Creswell, 2013; Wium and Louw, 2018).

Saunders *et al.* (2007) and Bloomberg and Volpe (2019) indicated that the mixed method approach is associated with pragmatism theory. The mixed methods approach was adopted in this study since pragmatism was the worldview used as the research philosophy, as indicated in Figure 3.1. The mixed methods approach involves combining quantitative and qualitative approaches, with the intention of having a better understanding of the research problem than when using each approach separately (Caruth, 2013; Rahman, 2016; Creamer, 2018). In this study, both quantitative and qualitative approaches were adopted to get a holistic picture of municipal solid waste in Masvingo City. The mixed methods approach offered a more complete understanding of the potential hazards of municipal solid waste illegal disposal in Masvingo City when than using either qualitative or quantitative alone. Quantitative

and qualitative approaches complement each other (Creswell, 2014; Berman, 2017). Use of both approaches in the present study enabled the researcher to gain complementary views about environmental risks and constraints from residents (questionnaire) and from waste management workers (semi-structured interviews).

Qualitative data are used to explain numbers, whereas numerical data adds more precision to qualitative data (Rahman, 2016; Berman, 2017). In this study, qualitative data described and interpreted attitudes, opinions and perceptions of municipal solid waste management officials and officials from the Environmental Management Agency, while quantitative data were used to give precision to the same, on environmental risks and constraints of solid waste management in Masvingo.

There are six mixed method models, namely:

i. Concurrent triangulation, which involves simultaneous data collection giving equal priority to each approach;
ii. Concurrent nested, which involves simultaneous data collection but giving priority to one approach;
iii. Concurrent transformative, involving the use of a theoretical perspective reflected in the purpose;
iv. Sequential explanatory, involving collection and analysis of quantitative data followed by collection and analysis of qualitative data;
v. Sequential exploratory, which involves collection and analysis of qualitative data then collection and analysis of quantitative data; and,
vi. Sequential transformative, involving collection and analysis of either quantitative or qualitative data first (Creswell, 2009; Wium and Louw, 2018).

The current study employed concurrent triangulation. The concurrent triangulation design involves collection and analysis of both quantitative and qualitative data at the same time and then combining them for complete understanding. In the current study, the concurrent triangulation design was employed because it enabled addressing of similar questions and concepts in both the quantitative and the qualitative strands. Using a questionnaire, respondents were asked questions on environmental risks and constraints encountered. Similar questions were asked council employees, EMA officials and informal waste workers. Tashakkori and Teddie (2010) and Terrel (2012) found out that concurrent triangulation corroborates findings. In the present study, data from key informants (interviews) corroborates data from residents (questionnaires). Thus, the concurrent triangulation design was used to validate and confirm findings within the current study. The quantitative approach will be presented in the next section.

3.3.1 The quantitative approach

The quantitative approach enables gathering of data from a large number of participants and varied scenarios (Majoko, 2013; Creswell, 2014). Since this study collected data from a relatively large sample (394 participants) and from different settings (from high, medium and low-density suburbs), the quantitative approach was found appropriate. Furthermore, a quantitative approach uses numbers to describe phenomena (Fetters *et al.*, 2013; Creswell, 2014; Daniel, 2016; Santos *et al.*, 2017). In this study, numbers obtained through structured questionnaires were used to describe opinions, attitudes and perceptions of respondents on environmental risks of municipal solid waste illegal disposal and constraints encountered. A Likert scale was used on close-ended questions. In addition, Yauch and Steudel (2003) and Johnson and Onwuegbuzie (2004) stated that one of the advantages of the quantitative

approach is its quick administration, evaluation and tabulation of responses within a short period of time. In this study, it was easy to administer the questionnaires and to tabulate responses. The qualitative approach will be discussed in the next section.

3.3.2 The qualitative approach

The qualitative research approach is a subjective approach employed to describe life experiences and give them a meaning (Leedy and Ormrod, 2013; Agyepong, 2014). Perceptions and experiences of participants with regard to environmental and health risks of municipal solid waste illegal disposal and constraints were assessed in the current work.

The qualitative approach enables the collection of comprehensive descriptions which provide a basis for analysis (De Vaus, 2014; Leedy and Ormrod, 2014). Use of semi-structured interviews in this study enabled the collection of detailed information on attitudes, perceptions and opinions of council employees, EMA officials and informal waste workers on risks of municipal solid waste illegal disposal. Moreover, the qualitative approach was adopted because of its flexibility. As Adhabi and Anozie (2017) stated, the qualitative approach facilitates flexibility. In this study, semi-structured interviews were used to adjust order as well as wording of questions, as the situation demanded. In addition, the qualitative approach studies people in their natural settings where they experienced the problem under study (Creswell, 2009; Gibson and Brown, 2009; Denzin and Lincoln, 2011). Since the qualitative approach involves interpretation, the approach was adopted because it involved experiences of council employees, EMA officials and informal waste workers on municipal solid waste management. From the interviews, it was possible to establish attitudes, experiences and beliefs of formal waste workers, informal waste workers, health officials and EMA

officials on MSWM. In the next section, survey strategy will be discussed.

3.4 SURVEY STRATEGY

The survey is a technique used to gather data from a sample and it aims at establishing opinions and attitudes of respondents (Check and Schutt, 2012; Avedian, 2014). In the current study, survey was used to gather opinions and attitudes of residents, council employees, EMA officials and informal waste collectors on environmental risks associated with MSW illegal disposal and challenges faced by stakeholders in MSWM. The survey used was cross-sectional. The cross-sectional survey can be defined as an observational research used to analyse data of variables collected at one given point in time across a sample population (Levin, 2006; Zangirolami-Raimundo *et al.,* 2018). Thus, data are collected within a short period of time. Needing less time and being cheap are the benefits of cross-sectional survey (Setia, 2016; Zangirolami-Raimundo *et al.,* 2018). The cross-sectional study enabled the collection of information on environmental risks, health risks and on constraints to solid waste management within a short period of time.

3.5 STUDY AREA

The study area in Masvingo City is shown in Figure 3.2. Masvingo City is located in the southern part of Zimbabwe ($20^{0}4^{l}28^{ll}$S and $30^{0}49^{l}58^{ll}$E). It is 288km north of Beitbridge, 290km east of Bulawayo and is 292km south of Harare. Masvingo is 1098 metres above sea level. In terms of climate, its annual rainfall is 615mm and the average temperature is between 17.5 and 20˚C. The geology of Masvingo City is made up of resistant (strong) and non-resistant (weak) metamorphic rocks implying

moderate chances of groundwater pollution from solid waste leachate. In 2012, Masvingo had a total population of 87 886 (Zimbabwe National Statistics Agency, 2012). Currently, the city has a population of 100 000 (Masvingo City Council, 2019) indicating a growth rate of about 1.3 % per annum. This growth rate has implications on municipal solid waste management because an increase in urban population is associated with an increase in MSW generation rate, which makes it difficult for local authorities to collect and dispose waste sustainably (Emelumadu *et al.,* 2016; Makarichi *et al.,* 2018). Given the high unemployment rate in Masvingo City, the majority of waste generators fail to pay rates. Thus, a rapid increase in urban population has a negative impact on MSWM.

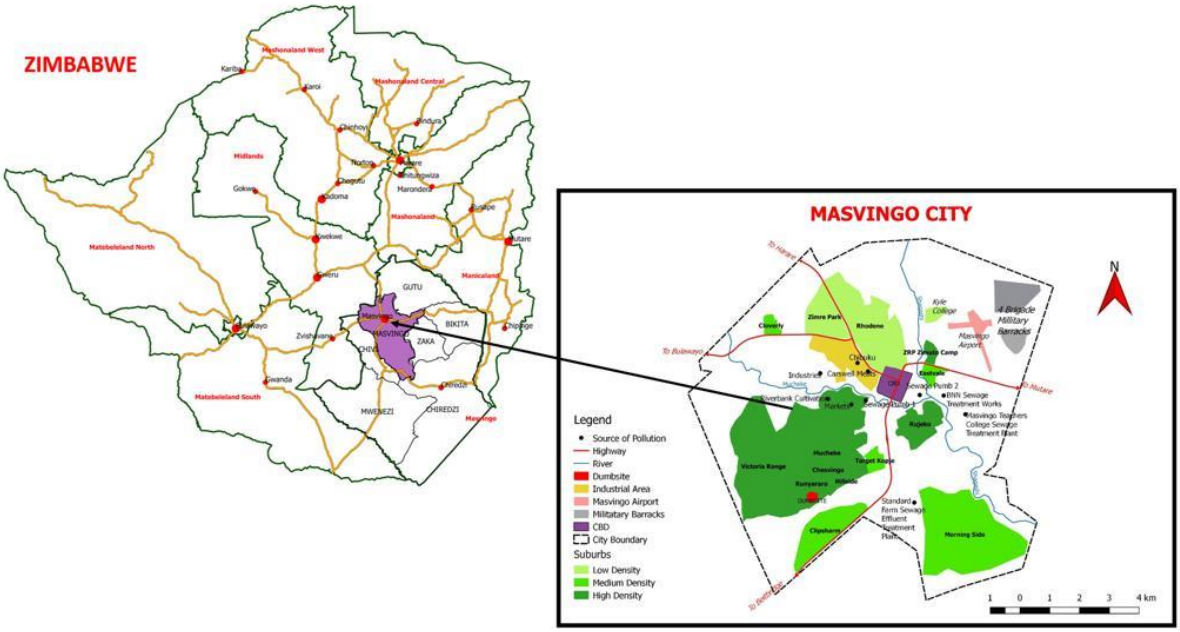


Figure 3.2: Masvingo City map and relative location of Masvingo City in Zimbabwe (Source: Masvingo City Council, 2019)

3.6 DELIMITATIONS OF THE STUDY

The study was carried out in Masvingo City. The area of study included high-density, medium-density and low-density suburbs. Mucheke, Rujeko, Runyararo, Hillside, and

Chesvingo are the high-density suburbs in Masvingo. Target Kopje, Cloverly, Morningside, Clipsham and Eastvale are medium-density suburbs, while Rhodene and Zimre Park are the low-density suburbs in Masvingo, as shown in Figure 3.2. The focus of the study was on environmental risks, health risks associated with MSW illegal disposal, and constraints faced by stakeholders in MSW management in Masvingo City. Having covered delimitations of the study, population and sampling techniques will be presented in the next section.

3.7 STUDY POPULATION AND SAMPLING TECHNIQUES

Population can be defined as the likely observations of a given random variable from which a sample is drawn and has similar characteristics (Etikan, *et al.*, 2016; Asiamah *et al.,* 2017). The population in this study was all the residents in the City of Masvingo. The total number of households in Masvingo was 14374 (Masvingo City Council, 2019). The heads of selected households were participants. Households were stratified into high-density, medium-density and low-density suburbs. The number of households in each layer was used to determine the actual number to be included in the sample as shown in Table 3.1. Waste workers were also stratified into formal and informal.

Table 3.1: Number of households in Masvingo (Source: Masvingo City Council, 2019)

Suburb	Number of households	Actual number involved in sample
High-density	12980	354
Medium-density	615	16
Low-density	779	24
Total	14374	394

The researcher then used Cochran's 1963 formula to determine sample size.

$$n=\frac{Z^2pq}{d^2}$$

n is desired sample size (when population is > 10 000),

z is standard normal deviate at 95 percent confidence interval which is set at 1.96,

p is estimated proportion of an attribute that is present in a population. In this case it was municipal solid waste collection efficiency for Masvingo City which is 40 % (0.4).

q is 1-p. In this case it is 1-0.4=0.6

d is degree of accuracy desired = 0.05

$$n=\frac{(1.96)^2(0.4)(0.6)}{(0.05)^2}$$

$$n=\frac{3.8416\times0.24}{0.0025} = 368.79= 369$$

The calculated sample size was 369. Non-response rate of 10 % was expected, so the required sample size was increased with 10 % of the calculated sample size. This was in line with Getahun *et al.*'s (2012) recommendation that where a 10 % non-response rate is expected, the sample size should be increased by 10 % of the calculated sample size. The required sample size was 406. Out of 406, three hundred and ninety-four were heads of households, while 12 were key informants. House numbers of each stratum were picked randomly. Stratified random sampling captures diversity of strata, thereby producing a representative sample (Etikan and Bala, 2017). In view of this, the researcher employed stratified random sampling to select

respondents as the procedure enabled capturing the diversity of suburbs. Three hundred and fifty-four households were from high-density suburbs, while 16 households were from medium-density and 24 from low-density suburbs.

Purposive sampling procedure was used to select eight key informants, namely, the City Council Director of waste management, three council waste collection workers, two officials from the Environmental Management Agency (EMA), because they had knowledge on environmental effects of MSW illegal disposal. One Environmental Health Technician and another official from the Health Department were also purposively selected from the City Council because they had enough knowledge on health risks. Given the importance of focusing on participants who are well informed with the phenomenon of interest, purposive sampling, which enhances collection of data of high quality (Etikan *et al.,* 2016; Etikan and Bala, 2017), was employed in this study to collect data from people who were knowledgeable about management of municipal solid waste in Masvingo City.

Convenience and snowball sampling were used to select four informal waste pickers who were aware of environmental effects of MSW illegal disposal. One dump site was visited and one informal waste worker present was selected. Snowballing then assisted since the informal waste picker selected identified where else others could be found and three other informal waste pickers were selected using this sampling method. Convenience and snowball sampling techniques are affordable and applicable where the researcher does not know all the prospective research participants (Etikan and Bala, 2017). In light of this, the researcher used convenience and snowball sampling to collect data from informal waste workers, most of who he

did not know. Data sources and collection techniques will be presented in the next section.

3.8 DATA SOURCES AND COLLECTION TECHNIQUES

Data sources and collection strategy used in the study are discussed in this section.

3.8.1 Data collection strategy

Both quantitative and qualitative data were collected simultaneously because, as (Terrel, 2012) stated, concurrent data collection gives equal priority to both strategies. Concurrent data collection was possible since a research team was used (Doyle *et al.*, 2009).In this study, four research assistants were used to assist in data collection. Simultaneous data collection enables the capture of different dimensions of the same phenomenon within a short space of time compared to sequential (Tashekkori and Teddlie, 2010), hence it was employed. The views of participants on environmental risks and constraints were captured through the use of questionnaires and interviews with council employees, EMA officials and informal waste workers on environmental risks and constraints encountered.

3.8.2 Primary data collection techniques

This section deals with primary data collection techniques. Questionnaires, interviews and observation were used to collect primary data. These are discussed in this section.

3.8.2.1 Questionnaires

Both close-ended and open-ended questions on risks of MSWD on environment and challenges encountered were asked. The questionnaire was divided into three

sections. Section A was on demographic information. Section B had three questions on environmental risks, while section C had three questions on constraints and one question on what should be done by stakeholders to improve MSWM. Participants completed questionnaires. Table 3.2 illustrates objectives, questions linked to the objectives and references from which questions were derived.

The Likert type of scale was used on closed-ended questions. According to Vanderstoep and Johnson (2009), the Likert scale can be applied to establish extent of agreement or disagreement with questions. In the present study, a score of '5' was given for a very positive feeling "strongly agree", while score '1' was given for a very negative feeling "strongly disagree". Enabling collection of data from many respondents and ease of analysis are some of the advantages of questionnaires (Gray, 2004; Murth and Bhojana, 2008). In the present study, the use of a questionnaire enabled collection of data on environmental risks and constraints encountered by stakeholders from a large sample (394 respondents). In addition, data collected through close-ended questions were easy to analyse and to compare.

Table 3.2: Objectives and related questions

Objective	Questions	References
To determine environmental risks of MSW illegal disposal in Masvingo	1. Indicate the extent to which you agree that each of the following (table, appendix one) is an environmental risk. 2. List any other environmental risks of MSW illegal disposal not in the table. 3. From the environmental risks listed, which once do you regard as main 4?	Achankeng (2004) Baabereyir (2009)
To examine constraints faced by stakeholders in MSWM in Masvingo	1. Indicate the extent to which you agree that each of the following (table, appendix one) is a constraint faced by stakeholders in MSWM in Masvingo. 2. List other constraints not in the table. 3. From constraints listed, which ones do you regard as the main 4?	Human (2005) Agyepong (2014) Omar (2018)

Furthermore, use of a questionnaire with both close-ended and open-ended questions enables collection of both quantitative and qualitative data as noted by Zohrabi (2013) and Kabir (2017). In the present study, it was possible to collect both numerical and text data regarding environmental risks and constraints encountered from one instrument because the questionnaire had both close-ended and open-ended questions. However, a questionnaire has the problem of low response rate (Zohrabi, 2013). To cater for low response rate, effective follow up was employed.

Appointments were made with the respondents and they were requested to sign consent forms before the administration of questionnaires. Questionnaires were administered in person to 394 heads of households at their (participants') houses. Respondents were informed that information was to be treated with confidentiality and they were not supposed to write their names on questionnaires so as to remain anonymous. The participants were told that participation was voluntary and they could withdraw from the study without any obligations, as indicated on consent form (Appendix ten). Soon after completion, the questionnaires were collected and numbers were assigned to them.

3.8.2.2 Interviews and personal observations

Semi-structured interviews were used to collect information on risks of MSW illegal disposal on health and environment and the constraints of MSWM in Masvingo, from 12 key informants. The key informants were the city council Director of Waste Management, three council waste collection workers, city council Environmental Health Technician, another official from city council Health Department, two officials from the Environmental Management Agency (EMA) and four informal waste collection workers. Semi-structured interviews are more flexible (Adhabi and Anozie, 2017). In the present study, questions on environmental and health risks and on constraints encountered were modified during conversations. Interviewees signed consent forms and appointments were made before interviewing the key informants at their workplaces. Each interview lasted between 15 and 30 minutes. Codes were assigned to interviewees, to ensure anonymity. The interviews were face-to-face and notes were written down since the interviewees refused to be recorded. Where interviewees were not able to express themselves in English, their mother tongue was used to clarify their

responses to questions asked, in keeping with Muller's (2015) suggestion on the need to use the mother tongue where a respondent is not comfortable in English. Data from semi-structured interviews were compared with data from heads of households.

Personal observations were done in high, medium and low-density suburbs on dump sites, water sources, bins and air, with the help of an observation check list. Observations on presence of vectors, pollutants in water bodies and air were done. Pictures were taken and are presented in Chapter Four. The key informants, organisations and reasons for interview will be presented in Table 3.3.

Table 3.3: Key informants, organisations and reasons for interview

Organisation	**Interviewee**	**Reason for interview**
Environmental Management Agency	Information and publicity officer Environmental quality officer	Environmental risks Constraints faced
Masvingo City Council	Environmental health technician Health official	Health risks Constraints encountered
	Director waste management formal waste handlers	Environmental risks Constraints encountered
None	Informal waste handlers	Environmental risks Constraints encountered

3.8.3 Secondary data sources

Secondary data sources such as municipal publications, policy documents, municipal by laws and local newspapers were reviewed before, during and after collecting primary data. This was done to collect qualitative and quantitative data on environmental and health risks of MSW illegal disposal. Secondary data sources,

nature of data collected and objectives addressed are presented in Table 3.4.

Table 3.4: Secondary data sources

Data source	Nature of data collected	Objective addressed
Policy documents	Qualitative	Environmental risks
Municipality publications	Qualitative	Challenges encountered in MSWM Environmental risks Health risks
Local newspapers	Qualitative	Environmental risks Health risks Challenges encountered in MSWM

3.9 TRAINING OF RESEARCH ASSISTANTS

Four research assistants were conveniently selected from secondary schools in Masvingo City. The selected assistants were holders of a Bachelor of Science degree in Geography and Environmental Studies. They were geography teachers and had some knowledge of environmental management. Assistants were trained to ensure reliability of study results. Training involved explaining purpose of research and research assistants' ethical responsibilities.How to sample and administer tools was also explained to the assistants. Research assistants filled in a confidential form committing themselves to collecting data from participants ethically and professionally. To determine whether they had grasped the research skills, assistants participated in a pilot study. Participating in the pilot study helped research assistants to familiarise with research tools and procedures.

3.10 PILOT STUDY

A pilot study can be defined as a study carried out before the main study in order to test the feasibility of instruments (Beebe, 2007; Doody and Doody, 2015). Questionnaires and interview schedules were pretested using 30 respondents comprising 17 females and 13 males, who were not involved in the final study. Convenience sampling was used to select participants for the pilot study. The instruments were on risks of MSWD on health and environment. They were also on constraints encountered. Permission to carry out the pilot and main study was granted by Masvingo City Council (Appendix seven).In the present study, questions were examined for sequence and clarity, in line with Cohen *et al.'s* (2011) suggestion on pilot studies. The pilot study is important because it offers an opportunity for verifying whether instructions, order of questions and time allocated are appropriate (Roopa and Rani, 2012; Creswell, 2012). Having presented the pilot study, the next task is to present validity and reliability of data.

3.11 VALIDITY AND RELIABILITY OF DATA

Issues of validity and reliability were crucial in the present study since quantitative researches are expected to be reliable and valid. Quantitative research was part of the study since mixed methods was employed.

3.11.1 Validity

Burns and Grove (2005), Zohrabi (2013) and Taherdoost (2016) defined validity as the extent to which an instrument measures what it is intended to measure. Expert review of the questionnaire ensured validity. People knowledgeable on municipal solid waste

management, including the supervisor, made essential comments on the questionnaire to ensure that items reflected objectives of the study. In addition, pilot testing of instruments was used to achieve validity. Anomalies on instruments (questionnaire and interview schedule) were corrected before data collection in the main study. Participant validation was also used to achieve validity. Research evidence was taken back to the participants to confirm whether information was captured accurately, as recommended by Zohrabi (2013). Reliability will be presented below.

3.11.2 Reliability

Reliability entails extent of consistency of results (Polit *et al*., 2001; Bowling, 2009; Ncube, 2013). McMillan and Schumacher (2010) noted that having a reliable instrument is essential to reduce influence of unrelated variables in the terms intended for measurement. Pilot study, as discussed earlier, was used to achieve reliability. According to Cohen *et al.* (2011), reliability can be achieved by testing of research instruments before the main study. In the present study, the questionnaire and interview schedule were pre-tested during pilot study. Having highlighted validity and reliability of data, trustworthiness of data will be presented in the next section.

3.12 TRUSTWORTHINESS OF DATA

Trustworthiness can be defined as accuracy and adequacy of the study (Holloway and Wheeler, 2002; Padgett, 2008). Trustworthiness of the study was determined by dependability, credibility, transferability and confirmability, as suggested by Denzin and Lincoln (2018).

3.12.1 Dependability

Research is regarded as dependable when another researcher can clearly follow procedures used by the researcher and potentially arrive at a similar or comparable conclusion (Cohen *et al.,* 2011). Triangulation of research tools and participants was used to achieve dependability. Shenton (2004) and Khaldi (2017) defined triangulation as involving collection of data from different sources using different tools. In the current study, the semi-structured interview technique was used to collect qualitative data on environmental risks and constraints encountered from key informants, while a questionnaire with open-ended questions was used to collect the same from residents. In addition, a detailed explanation of the research process ensured dependability. Shenton (2004) indicates that detailed description of research methods is one way of achieving dependability. In the present study, the research design, data collection and data analysis procedures were explained in detail thereby enabling other researchers to obtain similar results. Furthermore, member checks were employed. Data and tentative interpretations were taken back to the participants from whom they were derived and asked the respondents if the results were plausible and the participants confirmed. Credibility is discussed in the next sub section.

3.12.2 Credibility

Credibility can be defined as the confidence placed in the truth of study findings (Holloway and Wheeler, 2002). To ensure credibility, questionnaires and interview schedule were pre-tested to check for anomalies which were corrected before final data collection. This was in harmony with Hassan *et al.* (2006) and Fraser *et al.* (2018), who noted pre-testing of instruments as a way to achieve credibility. Triangulation can achieve credibility (Leedy and Ormrod, 2013; Liamputtong, 2013; Mohadhan, 2017).

The mixed methods approach was used in the present study to cross-check the findings. Both questionnaires and interview schedules were used to collect data. Colleagues who were knowledgeable on municipal solid waste management and not directly involved in the study were asked to review questionnaires, interview schedules and notes written during data collection so as to achieve credibility. Purposeful selection of council employees and EMA officials as key informants also achieved credibility of the study because they were knowledgeable on environmental and health risks associated with MSWM.

3.12.3 Confirmability

Confirmability refers to the degree to which outcomes of a study are influenced by participants (Shenton, 2004). It is the degree to which results can be confirmed by others. In the present study, triangulation, as alluded to earlier, was employed to reduce bias. Detailed explanation of the research methodology was also used to achieve confirmability.

3.12.4Transferability

Shenton (2004) defined transferability as the degree to which results of a qualitative study can be applied to other settings. In the present study, a detailed description of the research methods and settings was provided. According to Shenton (2004), description of the settings in detail can achieve transferability. Interview guides, questionnaires and observation checklist were pilot-tested with respondents who had characteristics similar to those of the sample studied. Pilot testing helped the researcher to check the clarity of items and instructions. The respondents were allowed to comment and the comments were considered and modifications made before the main study. Data analysis and interpretation will be presented in the next

section.

3.13 DATA ANALYSIS AND INTERPRETATION

The researcher used triangulation of data analyses procedures because the data were both qualitative and quantitative. Triangulation of data analyses means using at least two methods of data analyses within the same study (Hussein, 2009; Daniel, 2016). The advantage of triangulation of data analysis is that it promotes validity (Ndanu and Syombua, 2015; Daniel, 2016). Figure 3.3 below illustrates triangulation data analysis.

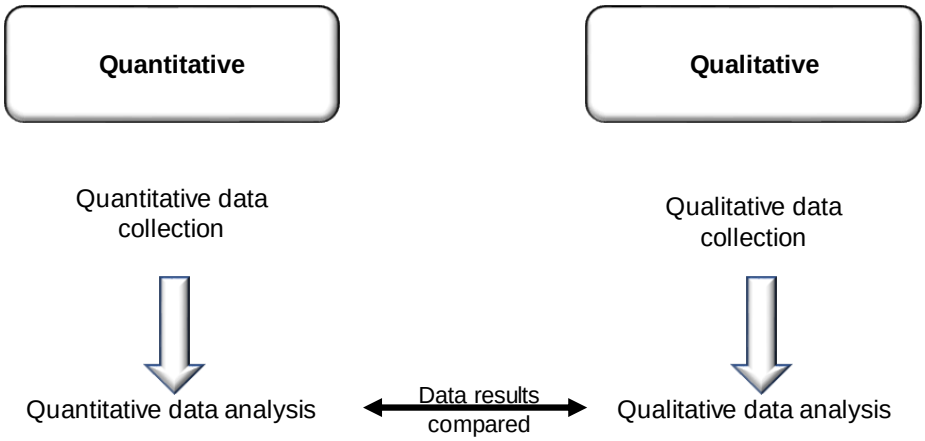


Figure 3.3: Triangulation data analysis (Source: Terrel, 2012)

Questionnaire data were coded using Microsoft Excel software and basic numerical analysis was used, in which data from questionnaires were assigned numerical values. Entries in the categories “Agree” and “Strongly agree” were combined into a single score during data analysis. The same was applied to the entries “Disagree” and “Strongly disagree”. Tables with number of times (frequency) a question was answered were drawn. Findings of the research were presented through the use of tables, bar graphs and pie charts, and the significance of each illustration was briefly

explained.

Thematic coding approach was used for qualitative data (Alsaawi, 2014; Plow *et al.*, 2017). According to Gibson and Brown (2009) and Ibrahim (2012), thematic analysis involves analysing data according to commonalities, relationships and differences across data sets. Thematic analysis was used because it is flexible (Jugder, 2016; Maguire and Delahunt, 2017). Qualitative data collected through semi-structured interviews with council employees, EMA officials, informal waste workers and from open-ended questions on questionnaires completed by residents were presented and analysed narratively in systematic themes derived from research questions highlighted in Chapter One. Recorded notes written during interviews by the researcher and by one of the research assistants were used as transcripts, since the interviews were not recorded. Themes were identified after initial codes were generated and then there was integration and interpretation (Maguire and Delahunt, 2017; Salleh *et al.,* 2017). Analysed quantitative and qualitative data were integrated during the interpretation phase, as illustrated on Figure 3.3. Ethical considerations will be presented in the next section.

3.14 ETHICAL CONSIDERATIONS

Research ethics constitute beliefs about what is right or wrong and, thus, give researchers the guidelines on how to conduct research. This implies that research ethics provide standards guiding researchers on how to conduct research in a morally acceptable manner. According to Punch (2004), all social research involves collecting data from people, so involves social issues. Confidentiality and anonymity, informed consent, permission and protection from harm were ethical issues addressed. Below

is a presentation on confidentiality and anonymity.

3.14.1 Confidentiality and anonymity

Confidentiality and anonymity imply keeping secret information about participants (Denzin and Lincoln, 2005; Mugenda, 2011). The purpose of the study was explained to participants. Participants were assured of the confidentiality, privacy and anonymity of the information obtained. They were told not to write their names on questionnaires. Participants were assured that they had the right to decide when, where, to whom and to what extent their attitudes, beliefs and behaviour would be revealed as recommended by Singleton and Straights (2010). According to Henning (2004), participants will participate freely when they know that their privacy and sensitivity will be protected and are aware of what will happen with information after it has been recorded. The statement implies that confidentiality and anonymity are crucial for any research. Only the researcher and one research assistant were present during interviews.

3.14.2 Informed consent

Informed consent can be defined as a process through which participants knowingly and voluntarily agree and authorise their participation in a study (Tanya, 2014; Akaranga and Makau, 2016). Informed consent was obtained from respondents before collecting data. The following information was included in the consent form:

i. Purpose of the study: Respondents were given information on purpose of the study. Aim and objectives were provided.

ii. Potential benefits: The researcher highlighted potential beneficiaries and how they were to benefit to motivate potential respondents to participate.

iii. Withdrawal clause: Participants were informed that they were free to

withdraw from the study at any time and without giving a reason.

iv. Anonymity and confidentiality clause: Respondents were assured that any identifying information obtained in the study was to remain confidential and to be disclosed only with participant's permission.

v. Researcher's and supervisor's contact information: Contact details of the researcher were provided for respondents to be informed of the final research findings. In case of concerns about the study, supervisor's contact details were provided.

Henning (2004) advised that respondents should be allowed to choose to participate or not in the research after receiving full information about possible benefits for the participants. In line with this, the researcher provided potential benefits (Appendices nine and ten). Those willing to participate in the study signed consent forms (Liamputtong, 2013; Agyepong, 2014). The researcher did not force anyone to participate in the study. Permission as an ethical issue will be presented in the next section.

3.14.3 Permission

The ethical clearance certificate was applied for and was obtained from the CAES Health Research Ethics Committee before collecting any data from Masvingo City (ethical clearance no; 2019/CAES/008 Appendix eleven). Prior to entering the research sites, permission was sought and granted from Masvingo Municipality (Appendix seven) and Environmental Management Agency (Appendix eight) through application letters on which ethics approval was attached. Permission from individual respondents was obtained through consent forms. Protection from harm will be presented in the next section.

3.14.4 Protection from harm

Ethical issues are crucial in research, as they protect participants from potential dangers. According to David and Sutton (2004) and Robson (2011), protecting participants from harm is crucial in any research. Irritation and invasion of privacy are some of the harms in research. Privacy, confidentiality and anonymity were maintained, thereby avoiding psychological harm. This implies that respondents were not exposed to any sort of harm in the present study.

3.15 CHAPTER SUMMARY

Chapter Three highlighted pragmatism as the research philosophy and mixed methods as the research design. Stratified random, purposive, convenience and snowball sampling techniques employed. Furthermore, concurrent data collection and triangulation data analysis were employed. A questionnaire with both close and open-ended questions, semi-structured interviews and personal observations were used for data collection. Validity and reliability of quantitative data were discussed. Dependability, credibility, transferability and confirmability were highlighted as criteria for trustworthiness of qualitative data, while confidentiality and anonymity, informed consent, permission and protection from harm were ethical issues discussed. Results and discussion will be presented in the next chapter.

4 RESULTS AND DISCUSSION

4.1 INTRODUCTION

This study was aimed at evaluating municipal solid waste illegal disposal in Masvingo City, Zimbabwe; with a view to developing a sustainable municipal solid waste management model. In the previous chapter the research methodology was discussed. The findings of the study are presented and discussed in this chapter. The research findings are discussed under the following themes derived from research questions outlined in Chapter One: environmental risks associated with municipal solid waste illegal disposal in Masvingo City; health risks associated with municipal solid waste illegal disposal in Masvingo; and constraints encountered by in Masvingo City in MSWM. Data generated from participants pooled from residents' questionnaires are presented and analysed first, then complemented by data from interviews with officials and other stakeholders (City Council employees, EMA officials and informal waste workers). It was essential to present pilot study findings before findings of the main study.

4.2 PILOT FINDINGS

The pilot survey conducted involved 30 respondents. The questionnaires and interview guides were used as tools and techniques for data collection respectively. The sample pilot grid is illustrated in Table 4.1.The majority of respondents (57 %) were females as shown in the table.

Table4.1: Sample pilot grid (N=30)

Gender	Age	Percentage (%)
Male	18-33	13
	34-49	23
	50+	7
Female	18-33	17
	34-49	30
	50+	10
Male		43
Female		57
Grand total		100

Findings from the pilot study revealed that the instruments (questionnaire and interview schedules) had anomalies. Two words used on the questionnaire, namely 'risk' and 'constraint', were not clear to some of the pilot study participants. The word 'risk' was replaced with the word 'problem', while 'constraint' was replaced with 'challenge'. It was also observed that one of the interview schedules was not good enough in terms of order of questions and it was adjusted. The adjustment of anomalies ensured validity (Hassan *et al.,* 2006; Fraser *et al.,* 2018). In addition, 76 % of the distributed questionnaires were returned, implying the possibility of bad response rate in the main study. So, effective follow-up was planned to promote high response rate. Environmental risks will be presented in the next sub section.

4.2.1 Environmental risks

The pilot findings on environmental risks are illustrated in Table 4.2. From Table 4.2, at least 70 % of respondents agreed that surface water, groundwater, land, air, soil contamination, loss of urban beauty, flooding and fire were the environmental risks in Masvingo City. Ninety five percent agreed that air pollution was a risk, 94 % were in agreement with surface water pollution, 92 % agreed that loss of urban beauty was a

risk, while 70 % agreed that groundwater pollution was an environmental risk.

Table 4.2: Environmental risks

Environmental risks	Respondents (%)		
	Agree	Not sure	Disagree
Surface water pollution	94	5	1
Ground water pollution	90	8	2
Land pollution	70	20	10
Air pollution	95	2	3
Soil contamination	87	7	6
Loss of urban beauty	92	3	5
Flooding	86	4	10
Fire	89	5	6

4.2.2 Health risks

The results from interviews indicated that malaria, skin problems and injuries were health risks in Masvingo City. Having presented pilot study findings on health risks, constraints will be presented in the next section.

4.2.3 Constraints

4.2.3.1 Financial challenges encountered by stakeholders

The financial challenges are presented in Table 4.3. The majority of respondents (60 %) noted lack of money as shown in Table 4.3. Thus, lack of money was the main financial challenge.

Table.4.3: Financial challenges

Constraint	Respondents (%)
Lack of money	60
Lack of fuel	35

4.2.3.2Political and administration challenges

The highest number of respondents (46 %) indicated corruption, while the least

number (10 %) noted poor priorities as illustrated in Table 4.4. Therefore, corruption was a political challenge.

Table.4.4: Political challenges

Constraint	Respondents (%)
Corruption	46
Lack of political will	22
Lack of implementation	30
Poor policies and priorities	10

4.2.3.3 Infrastructure and equipment challenges

Most of the respondents (58 %) noted lack of vehicles as a challenge while, 15 % highlighted lack of spare parts as indicated in Table 4.5. Lack of vehicles was the main challenge.

Table 4.5: Infrastructure and equipment challenges

Constraint	Respondents (%)
Lack of spare parts	15
Lack of vehicles	58
Lack of bins	20
Lack of equipment for separation	22

4.2.3.4Human resources

The majority of respondents (57 %) noted inadequate environmental education, while lowest number of respondents (11 %) indicated lack of motivation, implying that inadequate environmental education was the main human resource challenge as illustrated in Table 4.6.

Table 4.6: Human resources challenges

Constraint	Respondents (%)
Lack of personnel	21
Lack of motivation (poor working conditions)	11
Lack of cooperation and community participation	28
Inadequate environmental education	57

4.3 MAIN STUDY

In this study, 394 questionnaires were administered and 360 were returned, indicating a response rate of 91 %, which was above the usual expected, as noted by Fincham (2008) and Fosnacht *et al.* (2013). Follow-up was used to achieve a high response rate. The respondents were reminded to complete distributed questionnaires. A high response rate could imply a quality study as noted by Brtnikova *et al. (*2018). The findings of the current study were based on responses of 360 residents who completed questionnaires and 12 key informants who were interviewed. Microsoft excel was used to analyse responses from questionnaires. Below is a discussion on the demographic characteristics of respondents.

4.4 DEMOGRAPHICS

4.4.1 Gender of questionnaire respondents

There were more male respondents (61 %) than female (39 %) amongst the 360 participants (Figure 4.1). The domination by males was expected, as Masvingo City has more households headed by males compared to females. Furthermore, waste sites are not socially friendly hence males brave such harsh environments (Mangizvo, 2008; Makwara, 2011).

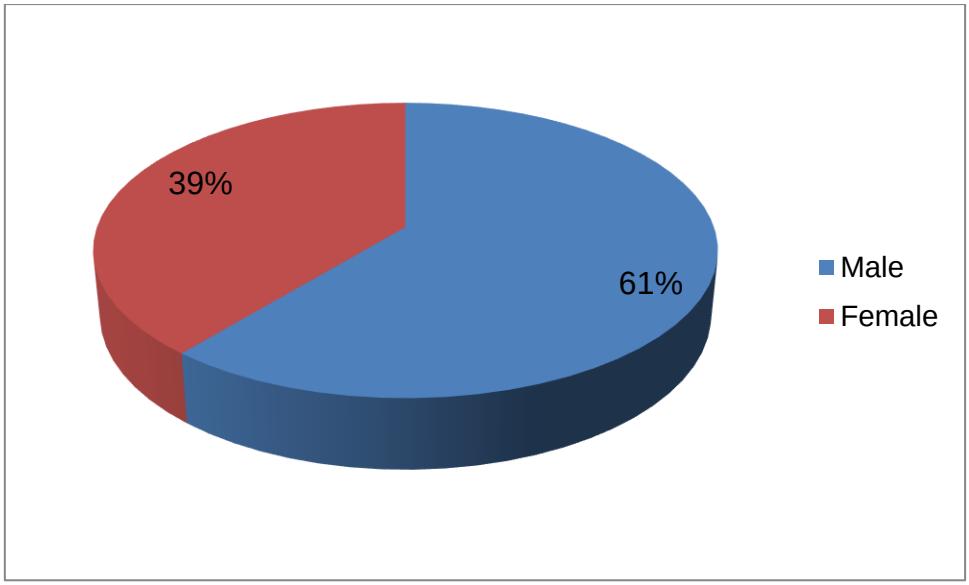


Figure 4.1: Gender composition of respondents

4.4.2 Age of respondents

The age-group 35-49 had the highest number of respondents (24 %), followed by 25-34 which had (21 %) and 63+ had the least number of respondents (6 %) as illustrated in Figure 4.2. The results imply that young people are more mobile than old people, hence they dominate urban areas as a result of rural-urban migration, as noted by Zaiceva (2014), Flahaux and De Haas (2016) and International Organisation for Migration (2020). The dominance of young people has implications on waste composition. Many diapers were observed within solid waste on illegal dumps because of the dominant younger people in Masvingo City, as they are the child-bearing age-group. Environmental awareness campaigns should be directed to these young people so as to improve waste management. The diapers have a negative impact on the environment, as the majority of them are non-biodegradable. In a related study in Tanzania, Omar (2018) noted that the majority of respondents (informal waste collectors) were young people who had enough energy needed for waste collection.

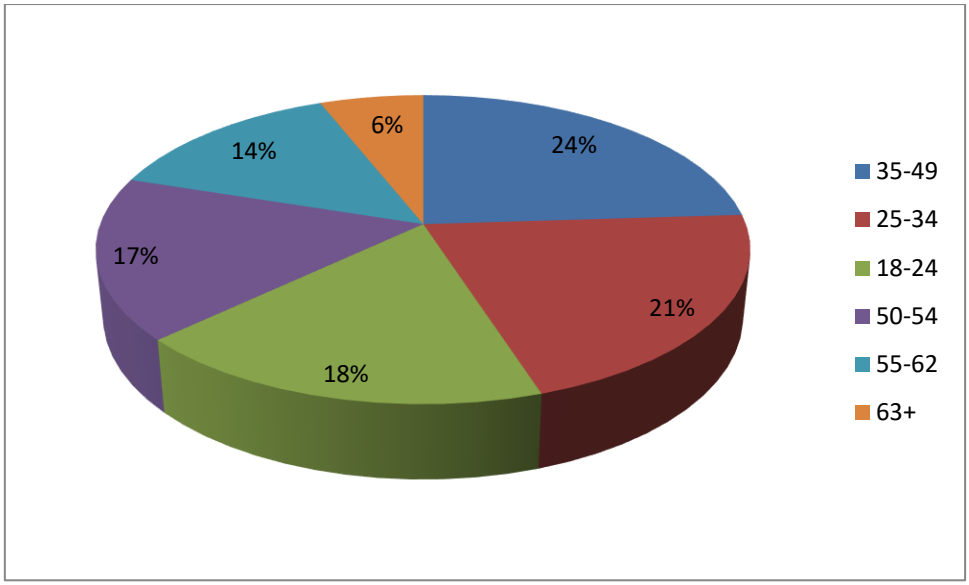


Figure 4.2: Age of respondents

4.4.3 Education level of respondents

The levels of education, in ascending order, were as follows:

i. Primary;

ii. Secondary;

iii. Certificate/Diploma; and

iv. Degree.

Most (96 %) of the respondents had at least secondary education, while only (4 %) had primary education as their highest level of education (Figure 4.3). This is expected because of the high literacy rate in Zimbabwe, which was reported to be at 98 % in 2017 (Economic Commission for Africa, 2017). A high literacy rate is good for Masvingo City's waste management in the sense that educated people are more likely to participate in development programmes, as noted by Goyder *et al.* (2002). In this case they would participate in waste management programmes. These educated people are more likely to appreciate the implementation of waste management policies and practices, thereby improving waste handling. The general level of education of municipal solid waste stakeholders in other urban areas is above 75 % due to a high

literacy rate, as noted by Ndum (2013) and Maluleke (2014).

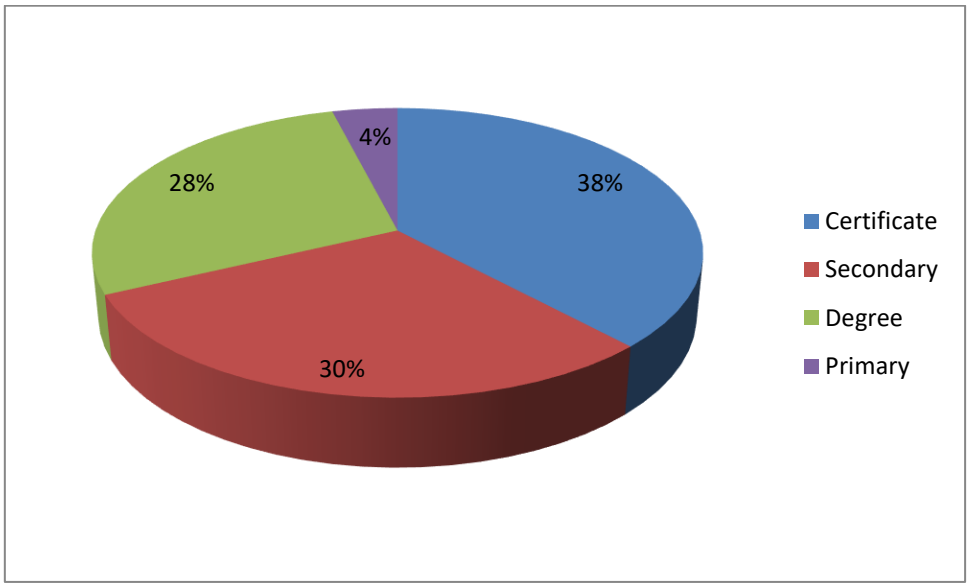


Figure 4.3: Highest education level of respondents

4.4.4 Distribution of response rate by affluence

More affluent people had the highest response rate, while less affluent people had the lowest response rate, as shown in Figure 4.4. More affluent people are willing to participate in programmes (Moore and Tamai, 2002; Hoornweg and Bhada-Tata, 2012). The results imply that municipal solid waste collection is better where affluent people live than where less affluent people reside, meaning that illegal disposal is more common where less affluent people live than where more affluent reside. Environmental and health risks are more common in high-density than low-density suburbs.

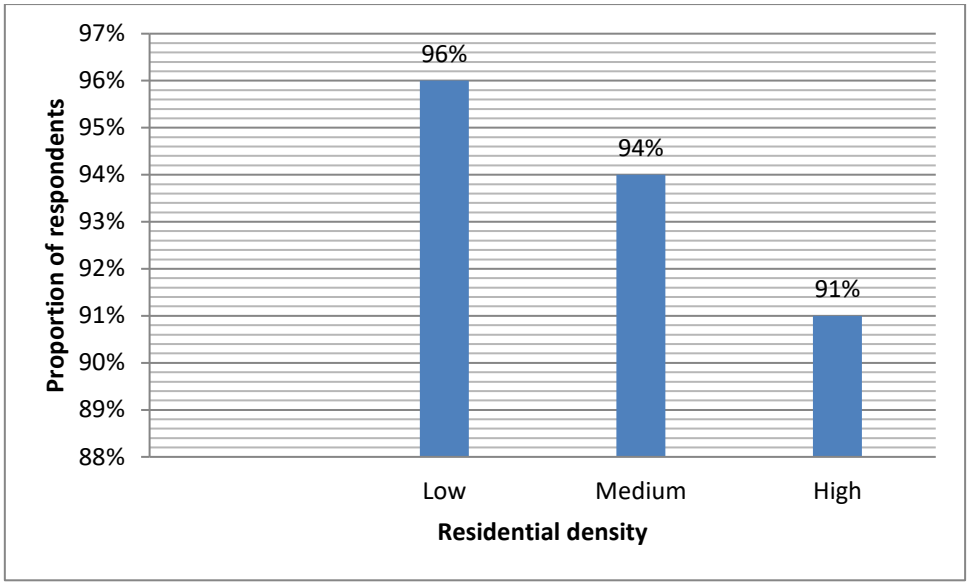


Figure 4.4: Response rates with affluence

For clarity, identity codes for interviewees were presented before results. The codes are shown in Table.4.7.

Table.4.7: Interviewee codes

Respondent (Interviewee)	Identity code
First formal waste worker	Interviewee One
Second formal waste worker	Interviewee Two
Third formal waste worker	Interviewee Three
Fourth formal waste worker	Interviewee Four
First EMA official	Interviewee Five
Second EMA official	Interviewee Six
First informal waste worker	Interviewee Seven
Second informal waste worker	Interviewee Eight
Third informal waste worker	Interviewee Nine
Fourth informal waste worker	Interviewee Ten
First health official	Interviewee Eleven
Second health official	Interviewee Twelve

4.5 ENVIRONMENTAL RISKS

The first sub-question outlined in Chapter One focused on determining environmental risks associated with municipal solid waste illegal disposal in Masvingo City. Data to address this question were collected through both respondents' questionnaires and

key informant interviews. Respondents indicated their views on surface water pollution, ground water pollution, land pollution, air pollution, soil contamination, loss of urban beauty, floods and fire as environmental risks as illustrated in Figure 4.5.

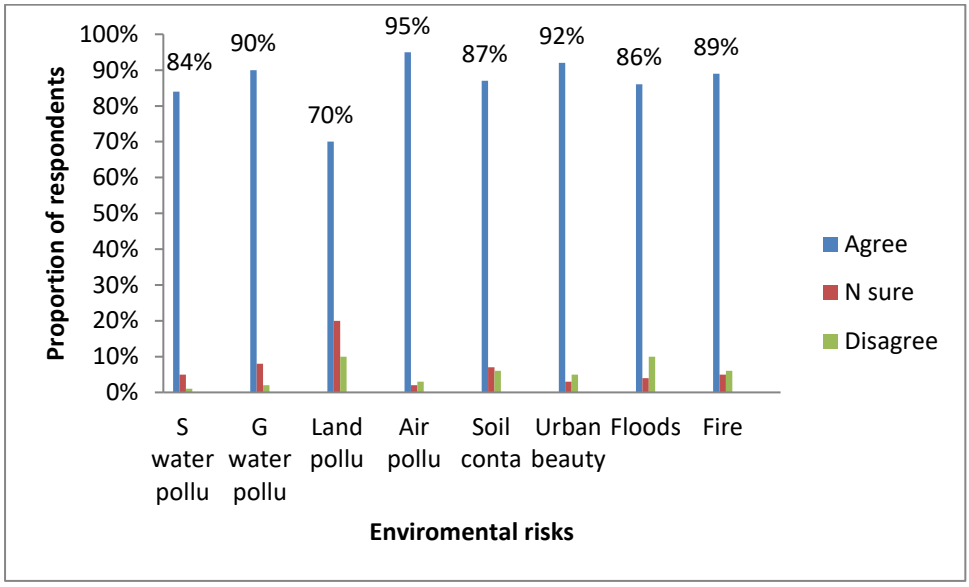


Figure 4.5: Environmental risks (G stands for ground; N for not; S for surface; conta for contamination and pollu for pollution.)

4.5.1 Surface water pollution

The majority of respondents (99 %) agreed that surface water pollution was associated with illegal municipal solid waste disposal, as illustrated in Figure 4.5. Thus, surface water pollution was an environmental risk in Masvingo. Interview results also noted surface water pollution as an environmental risk. Interviewees One, Three and Four highlighted surface water pollution. For example, interviewee one revealed that:

> "Water in streams is not clean because a lot of solid waste is disposed of in these streams" (Excerpt from interview, Masvingo City, 2019).

Observation results corroborate questionnaire and interview results. Solid waste in water sources was observed as illustrated in Figure 4.6.

Figure 4.6: Municipal solid waste in water source

Secondary data obtained from the Environmental Management Agency records also revealed that surface water pollution was an environmental risk associated with municipal solid waste illegal disposal in Masvingo City. Thus, the current study found out that surface water pollution was an environmental risk associated with unlawful disposal of municipal solid waste in Masvingo City. The study corroborates what was observed in other urban areas. For example, studies in China (Zhou *et al.,* 2017), in India (Saikia and Nath, 2015; Alam *et al.,* 2020), in Tanzania (Kasala, 2014), in Nigeria (Babayemi and Daud, 2009) and in Harare, Zimbabwe (Jerie and Nyanzou, 2014), where leachate from disposal sites and solid waste disposed of illegally on the land polluted surface water. Pollution of surface water can increase water treatment costs for the city council and water shortages in the city. The main source of water for Masvingo City is Lake Mutirikwi, into which polluted Mucheke River flows.

4.5.2 Land pollution

All the participants (100 %) were in agreement with the statement that land pollution was an environmental problem linked to MSW illegal disposal (Figure 4.5).

Interviewees Two and Five shared similar sentiments on land pollution. Interviewee Five revealed that:

> "Infrequent collection of generated solid waste has resulted in illegal disposal thereby making the land dirty" (Excerpt from interview, Masvingo City, 2019).

This finding on land pollution is consistent with observations made in India (Saikia and Nath, 2015; Dhere and Barkele, 2016; Alam *et al.,* 2020), in China (Zhou *et al.,* 2017), in Tanzania (Kasala, 2014) and in Nigeria (Butu and Mshelia, 2014), that poor municipal solid waste management was associated with pollution of the land. Pollution of the land implies negative impact on microorganisms and vegetation. To reduce land pollution, MSW should be managed in a manner friendly to the environment. MSWM should not result in negative environmental impact such as land pollution.

4.5.3 Air pollution

In agreement with the statement that air pollution was associated with MSWM, were most of the participants (96%) as shown on Figure 4.5. The finding indicates that illegal MSW disposal in Masvingo City had the potential to cause air pollution. Interviewees Five and Six also highlighted air pollution as an environmental risk. For example, Interviewee Five revealed that:

> "Smoke is now common in the air due to uncontrolled burning of solid waste on illegal dumps" (Excerpt from interview, Masvingo City, 2019).

Similarly, Interviewee Six commented that:

> "Air has been degraded as a result of improper burning of solid waste on unlawful dumpsites by waste generators and waste pickers" (Excerpt from interview, Masvingo City, 2019).

The finding on air pollution is in harmony with literature in India (Vilas, 2015), in Kenya (Muniafu and Otiato, 2010) and in Ethiopia (World Bank, 2012), which show that

uncontrolled burning of municipal solid waste on illegal dumps resulted in a lot of smoke in air. Incineration should be used as it is associated with less air pollution, as noted by Alam and Ahmade (2013) and Atalia *et al.,* (2015). However, the problem is that it requires a lot of capital, which most developing countries cannot afford (Khaza and Bhada-Tata, 2018). The findings of the present study on MSWM and environmental pollution are in line with the ISWM model which informed the present study, which states that improper solid waste management affects the environment negatively and to protect the environment, solid waste should be treated and disposed of in accordance with the by-law of a particular area. To reduce pollution, solid waste must be disposed of properly as suggested by the ISWM model.

4.5.4 Loss of urban beauty

Figure 4.5 shows that the majority of respondents (97 %) agreed that loss of aesthetic value was a risk associated with illegal MSW disposal. This implies that loss of urban beauty was an environmental problem associated with unlawful MSW disposal in Masvingo. Interviewee Four noted that the City had lost its beauty. Questionnaire and interview results on urban beauty were in harmony with observation results. It was observed that solid waste illegally disposed on the ground reduced aesthetic value of Masvingo City as shown in Figure 4.7. The market value of residential houses near illegal disposal sites was lower than that of those away from the disposal sites as revealed by Masvingo City records. The market value of properties near illegal disposal sites in Mucheke and Rujeko suburbs was about four percent lower than those away from illegal disposal sites.

Figure 4.7: Solid waste on the ground reducing aesthetic value

The finding is in line with findings from previous studies conducted in Pakistan (Eljaz *et al.,* 2010; Mohsin and Chinyama, 2016) and in India (Khati, 2015; Balasubramania, 2018) which established that improper disposal of MSW negatively affected urban beauty. Furthermore, the finding on MSWM and aesthetic value concurs with literature in Nigeria (Ogedengbe and Oyedele, 2006; Wekeko and Uruesheyi, 2014), in South Africa (Mangizvo and Mapindu, 2012) and in Uganda (Kinobe, 2015), which noted that illegal disposal of MSW results in loss of urban beauty which, in turn, reduces property values. The finding of the current study on MSWM and aesthetic value is in harmony with the ISWM model which informed the study. Both the ISWM and the current study noted that unlawful disposal of MSW is associated with loss of urban beauty. Loss of aesthetic value is a negative effect.

4.5.5 Flooding

The majority of participants (95 %) agreed that flooding was a risk associated with MSW illegal disposal (Figure 4.5). The implication was that flooding was an

environmental risk associated with poor municipal solid waste disposal in Masvingo City. Interview results corroborate questionnaire results. Interviewee Three stated that:

> "Human life is under threat from flooding during the rainy season as a result of Illegal solid waste disposal in drains" (Excerpt from interview, Masvingo City, 2019)

Similarly, Interviewee Six revealed that:

"Floods are now common in Masvingo due to municipal solid waste disposed in illegal areas" (Excerpt from interview, Masvingo City, 2019).

Solid waste was observed in and around drains during data collection as illustrated in Figure 4.8.

Figure 4.8: Solid waste in and around drains

There is some reasonable probability that during heavy rainfall episodes, localised flooding may occur due to disposal of MSW in drains and this concurs with observations in Mexico (Lamond *et al.,* 2012), in India (Rana *et al.,* 2015), in Ghana (Boadi and Kuitumen, 2003; Yoada *et al.,* 2014), in Nigeria (Butu and Mshelia, 2014; Ojo, 2014), in the Democratic Republic of Congo (African Population and Research Center, 2016) and in Tanzania (Chengula, 2015; Vann Niekerk and Weighmann, 2019), that unlawful municipal solid waste disposal blocks drains and other waterways,

resulting in floods in urban areas.

4.5.6 Fire

Figure 4.5 illustrates that the majority of respondents (97 %) were in agreement with the fact that fire was a risk. The finding of the current study that fire was an environmental risk caused by illegal municipal solid waste disposal is consistent with studies conducted in Bangladesh (Das *et al.,* 2014), in India (National Aeronautics and Space Administration, 2016; Times of India, 2017), in Jamaica (Duncan, 2018), in Jordan (Aljaradin and Persson, 2012), in Nigeria (Aderemi and Falade, 2012) and in Harare, Zimbabwe (Kharlamova, 2016), which revealed that fire was a result of flammable gases like methane produced by anaerobic decomposition and informal waste collectors who start fires when recovering recyclable materials on illegal disposal sites.

4.5.7 Dominance of environmental risks

Findings on participants' responses on dominance of environmental risks are presented in Figure 4.9.

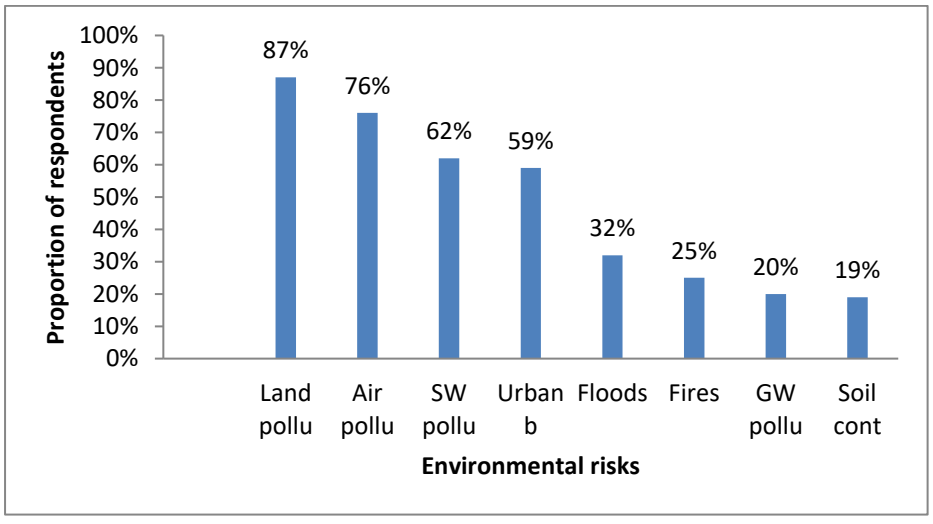


Figure 4.9: Dominance of environmental risks (b stands for beauty, cont for contamination, GW for groundwater and pollu for pollution.)

The highest number of participants (87 %) indicated land pollution. The second highest (76 %) noted air pollution, while the third highest (62 %) indicated surface water pollution and the fourth highest (59 %) noted loss of urban beauty, as shown in Figure 4.9. Figure 4.9 also shows that soil contamination had the lowest percentage (19 %), while ground water pollution had the second lowest (20 %). The findings imply that land pollution, air pollution, surface water pollution and loss of urban beauty were the dominant environmental risks associated with illegal municipal solid waste disposal. On the other hand, soil contamination and groundwater pollution were the least environmental risks among residents. Questionnaire results (from residents) on environmental risks were in harmony with interview results. In relation to dominance of environmental risks, Interviewee Six stated that:

> "The most dominant environmental risks are air pollution, land pollution, surface water pollution and loss of aesthetic value" (Excerpt from interview, Masvingo City, 2019).

4.6 HEALTH RISKS

The second sub-question highlighted in Chapter One focused on assessing health risks associated with illegal MSW disposal in Masvingo City. Data on health risks were collected using the interview schedule and observation check list. Interviewees composed of two Masvingo City Council health workers. The following is a presentation on interviewee responses on waterborne diseases.

4.6.1 Waterborne diseases

Responding to a question on waterborne diseases, Interviewee eleven noted that:

> “Cases of cholera have increased with increasing urban population due to increased MSW which is usually disposed illegally” (Excerpt from interview, Masvingo City, 2019).

Interviewee Twelve also noted cholera as a health risk of municipal solid waste management and had this to say:

> “Illegal disposal as a result of infrequent MSW collection has enhanced the likelihood of cholera in the City. The situation is being worsened by the rapid increase in urban population” (Excerpt from interview, Masvingo, City, 2019).

The finding of the current study on waterborne diseases is consistent with findings from studies conducted in Laguna, Philippines (Atienza, 2004), in Kaye, Burkina Faso (Kafando *et al.,* 2013), in Juba, Sudan (Karija *et al.,* 2013), in Ghana (Ashitey, 2014), in Tanzania (Palfreman, 2014; Chengula *et al.,* 2015, and in Harare, Zimbabwe (Federation of Red Cross and Red Crescent, 2010; Saungweme, 2012), that poor collection and improper disposal of municipal solid waste create conditions for outbreaks of disease like cholera when the faecal material in such disposal areas provide conducive environment for bacteria growth. Surface runoff from illegal disposal sites may cause contamination of water sources as noted by Osei *et al*. (2010). Contaminated water that is used without adequate treatment increase the risk of cholera. Many illegal disposal sites were observed in Masvingo City and there was probability of cholera in the city as indicated by interviewees eleven and twelve. The probability of cholera was high during the rainy season due to run off and stagnation of water leading to exposure to *Vibrio cholerae*. The finding on MSWM and waterborne diseases is also in harmony with the ISWM model which states that infrequent collection and illegal disposal of municipal solid waste can cause diseases. To solve the problem of waterborne diseases, generated solid waste should be collected

regularly and disposed of properly. The findings on municipal solid waste management and vector borne diseases are discussed next.

4.6.2 Vectorborne diseases

Responding to a question on vectors, Interviewee Twelve remarked that:

> "Mosquitoes have increased in Masvingo as illegal disposal sites act as breeding grounds and this has increased cases of malaria" (Excerpt from interview, Masvingo City, 2019).

Interviewee Eleven also shared similar sentiments. The interviewee said:

> "Unlawful disposal of MSW has resulted in stagnant water and containers within solid waste trap water during the rainy season thereby promoting favourable conditions for mosquitoes to breed" (Excerpt from interview, Masvingo City, 2019).

From responses above, it can be deduced that malaria was a vectorborne disease associated with municipal solid waste illegal disposal in Masvingo City. In Masvingo City, malaria is seasonal since rainfall is received during the summer season, while studies in Butwal, Nepal (Panta, 2013) and in Ghana (Yoada *et al.,* 2014; Doke *et al.,* 2017) concluded that malaria cases were common all year, as rainfall is received all year. Illegally disposed MSW in drainage channels only promote stagnation of water, enhancing the breeding of mosquitoes when it is rainy. The finding supports literature and observations in Latin America (Lethbridge, 2017), in Uganda (Kinobe, 2015), and Sudan (Yadi, 2018), that show that if MSW is poorly handled, it can promote breeding of mosquitoes thereby increasing cases of malaria. Thus, to reduce the risk of malaria, MSW should be collected frequently and disposed of in ways expected by law and the ISWM model which promotes sustainability. The finding on MSWM and vectorborne diseases is, on the other hand, inconsistent with findings from studies carried out in

the Caribbean (Requeleme *et al.,* 2016) and in Jigawa, Nigeria (Mansur, 2015), which showed that besides malaria, improper municipal solid waste disposal was associated with yellow fever and plague. This could be due to different climatic conditions.

4.6.3 Respiratory risks

In response to a question on respiratory risks, interviewee eleven noted that:

> "There is bad odour from illegal waste disposal sites and that those who burn solid waste often experience breathing difficulties and coughing" (Excerpt from interview, Masvingo City, 2019).

Interviewee Twelve's response to respiratory risks was in harmony with Interviewee Eleven's. The interviewee stated:

> "The health of waste workers, especially informal, who work on illegal disposal sites, is under threat from dustand smoke. They often experience coughing" (Excerpt from interview, Masvingo City, 2019).

The information above implies that breathing difficulties and coughing were respiratory risks associated with MSW illegal disposal in Masvingo. These findings of the present study corroborate findings from studies in India (Jayakrishnan, 2013; Kandasany, 2013), in Malaysia (Aminuddin and Rahman, 2015) and in Brazil (Mahler *et al.,* 2016), which concluded that municipal solid waste workers and residents living near dump sites were at risk of breathing problems and coughing due smoke from burning solid waste. However, there is a variation with findings in Malaysia and Brazil. Besides breathing problems and coughing, Aminuddin and Rahman (2015) and Mahler *et al.* (2016) noted that asthma and bronchitis were also respiratory risks in Malaysia and Brazil, respectively. This could be due to variation in waste composition. According to the ISWM model which informed the present study, MSW must be disposed of appropriately so that it does not cause health problems. Thus, to reduce health risks

associated with MSWM, solid waste should be handled properly. Below is a discussion on health risks associated with heavy metals and e-waste.

4.6.4 Heavy metals and e-waste

Interviewee Eleven stated that:

> "Skin rush and kidney problems were a result of illegal disposal of e-waste" (Excerpt from interview, Masvingo City, 2019)

Similarly, Interviewee Twelve noted dermatitis and kidney complications as risks associated with e-waste. Information from both interviewees implies that skinand kidney problems were the health risks linked to heavy metal and e-waste in Masvingo City. The study findings concur with findings from previous studies conducted in South Africa (Mangizvo and Mapindu, 2013; Ncube *et al.,* 2017) and in Gweru, Zimbabwe (Jerie, 2016), which showed that improper management of heavy metals and e-waste caused skin problems and damage to kidneys. However, the finding of the present study on heavy metals and e-waste is inconsistent with literature in China (Shamim *et al.,* 2015) and in India (Khanam *et al.,* 2019; Tseng *et al.,* 2019) which suggest that besides causing skin and kidney problems, illegal disposal of heavy metals and e-waste also caused slow cognitive development and childhood growth in China, while in India it caused damage to the central nervous system and gastric system. The differences in health risks associated with heavy metals and e-waste could be due to differences in the nature of heavy waste.

4.6.5 Ergonomic problems

Health officials were asked a question on MSWM and ergonomic risks.

Interviewee Eleven revealed that:

> “Those who work on illegal disposal sites complained of painful joints and low back pains” (Excerpt from interview, Masvingo City, 2019).

Related to this, Interviewee Twelve noted upper back pain and painful joints. These results suggest that painful joints, low back and upper back pains were ergonomic problems affecting informal waste pickers on illegal disposal sites in Masvingo City. The finding of the current study on ergonomic risks is in harmony with findings from studies conducted in Kelantan, Malaysia (Mohammed and Latif, 2014; Aminudin and Rahman, 2015), in Brazil (Zolnikov *et al.,* 2018) in Egypt (Aboll-Elwaya *et al.,* 2012) and in Gweru and Bindura, Zimbabwe (Jerie, 2016; Chitombe, 2017), which highlighted that carrying of waste loads resulted in ergonomic problems like back and joint pains. According to the ISWM model, management of solid waste should not cause health problems. Municipal solid waste management should promote public health. That is, it should not be associated with health risks. By causing health problems in Masvingo, MSWM was not sustainable. MSW disposal and injury risks will be discussed in the next section.

4.6.6 Injury risks

Responding to a question on injury risks, Interviewee Twelve stated that:

> “A lot of waste workers and children on unlawful waste disposal sites experience cuts as a result of sharp objects like glass and scrap zinc” (Excerpt from interview, Masvingo City, 2019).

Interviewee Eleven’s response was in harmony with Interviewee Twelve’s. In response to MSWM and injury risks, Interviewee Eleven noted that:

> “Municipal solid waste workers on unlawful disposal sites, mainly informal, complain of injuries from broken glass and metal nails and the problem is worsened by lack of protective clothing like safety shoes and gloves (Excerpt

from interview, Masvingo City, 2019).

Responses above indicate that that cuts were an injury risk associated with municipal solid waste illegal disposal in Masvingo City. Broken glass was also observed within illegal waste dumps during data collection as illustrated in Figure 4.10. Broken glass is a sharp object; hence it increases the risk of cuts.

Figure 4.10: Broken glass within waste dump

The finding of the current study on MSWM and injury risks concurs with findings from studies carried out in Seri-Kembangan, Malaysia (Mohammed and Latif, 2014) in Latin America (Leithbridge, 2017; Cruvinel *et al.,* 2019), in South Africa (Nkosi, 2014; Ncube *et al.,* 2017) and in Sudan (UNEP, 2013; Yadi, 2018), that municipal solid workers and those playing on dump sites experienced cuts from sharp objects. The above finding of the current study is in line with the ISWM model which informed the present study, which states that generated solid waste should be collected regularly and disposed properly to prevent negative effects on public health. By causing injuries, MSW disposal in Masvingo was not promoting public health. To reduce injury risks, MSW should be collected frequently and disposed of in a sustainable manner as required by the ISWM model. Following is a discussion on constraints encountered by MSWM stakeholders in Masvingo.

4.7 CONSTRAINTS

The third sub-research question was centred on examining constraints encountered by stakeholders in MSWM. Participants' responses and responses of council employees, EMA officials and informal waste workers will be presented. Availability of financial resources will be presented in the next section.

4.7.1 Financial resources

Responding to a question on availability of financial resources, a significant proportion of respondents noted lack of fuel (47 %), while (45 %) highlighted lack of money as financial challenges, as illustrated in Table 4.8.

Table 4.8: Financial challenges encountered by stakeholders

Constraint	Respondents (%)
Lack of money	45
Lack of fuel	47

The information in Table 4.8 implies that lack of fuel and money were the financial challenges faced by stakeholders in MSWM in the City of Masvingo. Interviewees Seven, Nine and Ten indicated lack of money as a challenge. For example, interviewee nine commented that:

> "Municipality lacks money to implement its programmes" (Excerpt from interview, Masvingo City, 2019).

Lack of money in the study area was due to the economic meltdown being experienced in Zimbabwe. Masvingo City records indicated that revenue collection had been poor as a result of economic hardships and limited financial resources were channelled towards waste management thereby corroborating interviewee Nine's views. This finding of the current study supports literature in India (Rana *et al.,* 2014), in Nigeria

(Ogwueleka, 2009), in Cameroon (Ndum, 2013), in Ghana (Dout *et al.,* 2017; Bour, 2019), in South Africa (Kubanza and Simatele, 2019) and in Bulawayo, Zimbabwe (Mudzengerere and Chigweya, 2012), which revealed that lack of money was militating against refuse management in the stated areas. Studies conducted in Cameroon (Ndum, 2013) and in Harare, Zimbabwe (Chikobvu and Makarati, 2011) revealed that management of solid waste was poor as a result of fuel shortages. The integrated sustainable waste management model, which is the theoretical framework for the present study, states that lack of financial sustainability results in poor waste management. Lack of money and fuel shortages in Masvingo City is a sign of absence of financial sustainability. Thus, the findings of the present study on financial challenges are in line with the ISWM which informed the current study. Infrastructure and equipment challenges will be discussed next.

4.7.2 Infrastructure and equipment

The highest number of respondents (51 %) noted lack of vehicles while the least number (15 %) highlighted lack of spare parts as illustrated in Table 4.9.

Table 4.9: Infrastructure and equipment challenges

Constraint	Respondents (%)
Lack of spare parts	15
Lack of vehicles	51
Lack of bins	49
Lack of equipment for separation	50

4.7.2.1 Lack of vehicles

In response to a question on availability of vehicles, the majority of respondents (51%) noted it as a challenge as shown in Table 4.9. This implies that shortage of refuse vehicles was a challenge encountered by stakeholders in MSWM in Masvingo City.

Interviewee Eleven noted that:

> "Management of MSW in this city is very difficult due to limited refuse collection vehicles because at the moment only two out of five vehicles are in use" (Excerpt from interview, Masvingo City, 2019).

In other urban areas, the same constraint was noted. For example, in Nigeria (Amasoumo and Baird, 2016), in Kumasi, Ghana (Osei, 2014), in Somaliland (Di Bella and Vacarri, 2014) and in Harare, Zimbabwe (Mangundu *et al.,* 2013), where it was found out that efficient management of municipal solid waste was not possible due to a limited number of vehicles. Lack of refuse collection vehicles in Masvingo implies infrequent collection of generated solid waste, thereby promoting illegal disposal. Illegal disposal has environmental and health risks.

4.7.2.2 Lack of equipment for separation

Responding to a question on availability of equipment for separation, a significant proportion of respondents (50 %), as illustrated in Table 4.9, indicated that it was a challenge, implying that it was a constraint encountered by MSWM stakeholders in Masvingo. Interview results concur with questionnaire results. Interviewees Two and Eight noted that separation of municipal solid waste was very difficult due to lack of equipment. Interviewee Eight said:

> "Some waste generators want to separate waste but they cannot due to the fact that equipment needed is not available" (Excerpt from interview, Masvingo City, 2019).

The finding on availability of equipment for separation is in harmony with what was observed in India (Vaidya, 2014), in Kampala, Uganda, in Nairobi, Kenya (Kabera *et al.,* 2019), in Kigali, Rwanda (Nishimwe *et al.,* 2016) and in South Africa (Gumbi,

2015), that separation of solid waste at source was very difficult due to lack of equipment. Separation is a key element of sustainable waste management. According to Ogwueleka (2009) and De Medina Salas *et al.* (2020), separation is important because it makes it possible for recycling, reuse and composting of solid waste.

4.7.2.3 Lack of bins

Reacting to a question on availability of receptacles, a significant proportion of respondents (49 %) noted lack of bins as a challenge in Masvingo, as indicated in Table 4.9. The result implies that lack of receptacles was a challenge militating against proper municipal solid waste management in Masvingo City. Related studies revealed the same. In Nigeria, lack of bins was derailing municipal solid waste management (Abila and Kantola, 2013). According to Osei (2014) and Dout *et al.* (2017), scarcity of receptacles was a challenge in Ghana. Gumbi (2015) and Kubanza and Simatele (2019) noted that solid waste management in South Africa was not efficient as a result of a limited number of receptacles. In a related study in Mutare, Zimbabwe, Mafume *et al.* (2016) also revealed that lack of receptacles was an obstacle for waste management. Storage and collection of solid waste is very difficult, if not impossible, without receptacles. Lack of these two functional elements of municipal solid waste management promotes illegal disposal which, in turn, increases environmental and health risks.

4.7.3 Political and administrative

Participants' responses on political and administrative challenges are presented in Table 4.10.

Table4.10: Political and administrative challenges

Constraint	Respondents (%)
Corruption	50
Lack of political will	49
Lack of implementation	30
Poor policies and priorities	10

The highest number of respondents (50 %) noted corruption as a challenge, while the least number (10 %) indicated poor policies and priorities. Corruption will be discussed in the next section.

4.7.3.1 Corruption

Table 4.10 shows that a large number of respondents (50 %) cited corruption as a challenge. The high percentage indicates that corruption was a challenge hindering efficient municipal solid waste management in Masvingo. Interviewees also noted corruption as a challenge in Masvingo City. Interviewee Ten reported that MSWM officials in Masvingo City usually implement programmes which yield personal gains. According to the Mirror (2018), law enforcement officials were not punishing those involved in illegal disposal due to bribes. This finding was in line with what was established elsewhere. In the Bahamas and in Guyana, Riquelme *et al.* (2016) noted that municipal solid waste management was not effective as a result of nepotism. Nthuli (2020) reported that dumpsite corruption was militating against municipal solid waste management in South Africa. Sustainable waste management programmes may not be implemented, while unsustainable programmes may be implemented due to favouritism and this is not good for waste management.

4.7.3.2 Lack of political will

Lack of political will was noted as a constraint by a significant proportion of respondents (49 %), as indicated in Table 4.10. The significant proportion implies that lack of political will was a challenge encountered by stakeholders in MSWM in

Masvingo City. In a related study in Nepal, Pokhrel and Viraraghavan (2005) pointed out that lack of political commitment resulted in less attention being given to environmental management, resulting in poor MSWM. Similarly, Otchere (2014) established that MSWM in Kumasi, Ghana, was ineffective due to limited political will. In Bulawayo, Zimbabwe, Sithumule and Mkumbuzi (2019) reported that clash of interests between City Council and EMA officials was a challenge. According to the ISWM model, sound institutions are needed for effective waste management. Corruption and lack of political will in Masvingo are evidence of unsound institutions. This is an indication that findings of the current study on political and administrative challenges are in line with the ISWM model, in that institutions in Masvingo were not sound, which resulted in poor municipal solid waste management. Human resources challenges are discussed in the next section.

4.7.4 Human resources

Human resources-related challenges were illustrated in Table4.11. The majority of participants (66 %) mentioned inadequate environmental education as a challenge, while lack of motivation was noted by the least number of respondents (15 %).

Table4.11: Human resources

Constraint	Respondents (%)
Lack of personnel	17
Lack of motivation (poor working conditions)	15
Lack of cooperation and community participation	52
Inadequate environmental education	66

4.7.4.1 Inadequate environmental education

The majority of respondents (66 %) noted inadequate environmental education as a constraint as shown in Table 4.11. The finding indicates that limited environmental education was a challenge encountered by stakeholders in MSWM in Masvingo City.

Interview results were in harmony with questionnaire results. For example, Interviewee Five stated that:

> "Lack of awareness due to limited environmental education is limiting progress in municipal solid waste management" (Excerpt from interview, Masvingo City, 2019).

The finding was in harmony with the study conducted in China, Chung and Lo (2008) established that less than half of waste management administrators were aware of waste hierarchy, and in Poland (Macias and Piniarski, 2016) noted that low level of environmental awareness was hindering MSWM. Similarly, studies in Lagos, Nigeria, (Abila and Kantola, 2013), in Ethiopia (Kassie, 2016) and in Bawku, Ghana (Dout *et al.,* 2017) revealed that limited environmental education was a challenge. Level of environmental education can determine level of participation in waste management programmes (Goyder *et al*., 2002).Responses on level of cooperation and community participation will be discussed in the next section.

4.7.4.2 Lack of cooperation and community participation

Responding to a question on level of cooperation and community participation, a significant proportion of respondents (52 %) highlighted lack of cooperation and community participation as a challenge (Table 4.11). Interviewee Three remarked that:

> "Municipal solid waste management is hindered by limited cooperation and participation of the public" (Excerpt from interview, Masvingo City, 2019).

The finding supports literature in China (Chung and Lo, 2008), in Lebanon (Abbas *et al.,* 2017), in Tanzania (Kasala, 2014; Chengula *et al.,* 2015), in South Africa (Gumbi, 2015; Van Niekerk and Weghmann, 2019) and in Gwanda, Zimbabwe (Mathe and Phiri, 2015), which pointed out that limited cooperation and community involvement was derailing MSWM. The finding of the present study on human resources is in line

with the ISWM. The integrated sustainable waste management model states that limited inclusivity of user and provider is detrimental to sustainable waste management. Community represents users. Limited community participation in Masvingo is an indication of limited inclusivity and is one of the reasons why MSWM is inefficient.

4.8 POSSIBLE SOLUTIONS

Respondents were asked to provide possible solutions for various stakeholders involved in MSWM and the following were suggested.

4.8.1 Solutions for city council

A significant proportion of participants (50 %) noted regular collection, 48 % highlighted provision of receptacles and (47 %) indicated awareness as illustrated in Table 4. 12.

Table 4.12: Proposed solutions for city council

Possible solution	Respondents (%)
Collect waste regularly	50
Service all areas	2
Provision of receptacles	48
Promote awareness campaigns	47
Provide suitable equipment for separation	5
Integrated waste management	7
Right priorities	2
Introduce heavy fines	21
Stakeholder involvement	4
Recycling	10

The above results imply that regular collection, provision of receptacles and promoting awareness campaigns were the popularly suggested solutions for the city council. Residents were aware that it was the duty of the local authority to provide receptacles, educate stakeholders and collect waste frequently to reduce risks on the environment

and health. For the council, interviewees One, Five and Eleven suggested that enough bins and adequate equipment for separation must be provided and composting should be promoted.

4.8.2 Possible solutions for residents

In reaction to a question on how they would improve MSWM in Masvingo, respondents suggested various solutions which are illustrated in

Table 4.13.

Table 4.13: Possible solutions for residents

Possible solution	Respondents (%)
Educating each other	29
Placing waste in appropriate receptacles	71
Reuse and recycle	9
Reporting illegal disposal	6
Clean their surroundings	4
Cooperation	25
Take part in clean up campaigns	17
Environmental health clubs	1

Pay rates in time	4

Table 4.13 shows that the largest number of respondents (71 %) indicated placing of waste in suitable receptacles, the second highest (29 %) noted educating each other and the third highest (25 %) highlighted cooperation, while the least number of residents (one percent) indicated environmental health clubs. Thus, common possible solutions for residents were placing waste in appropriate receptacles, educating each other, and cooperation. Residents appreciated that they have an important role in waste management and that waste should be placed in bins. Residents should place waste in bins and pay for refuse collection, as suggested by interviewees Four and Six.

4.8.3 Possible solutions for vendors

Possible solutions suggested by residents for vendors are shown in Figure 4.11.

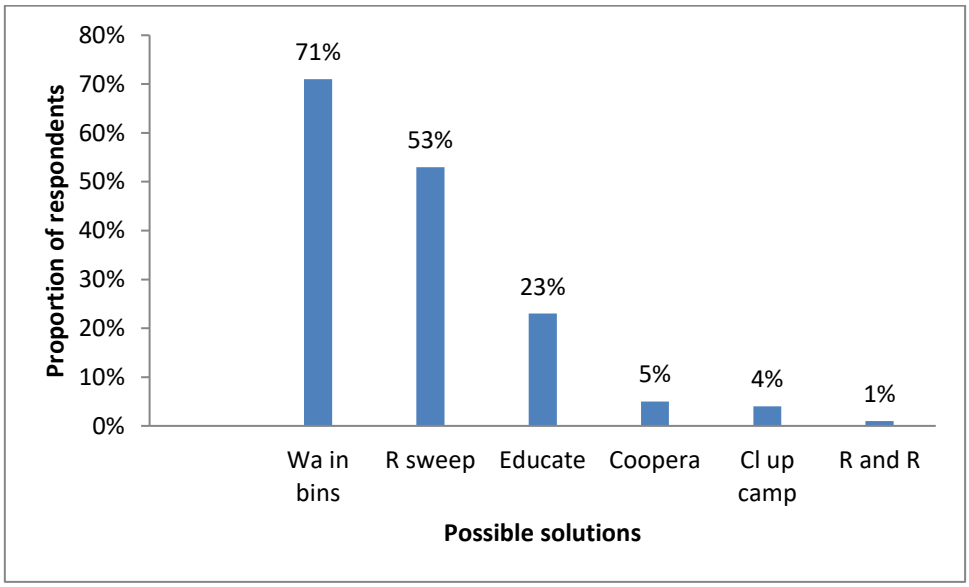


Figure 4.11: Possible solutions for vendors (Wa stands for waste; R sweep for Regular sweeping; Coopera for Cooperation; Cl up camp for Clean up campaigns; Rand R for Reuse and Recyling)

The majority of respondents(71 %) highlighted placing of waste in bins, regular sweeping was indicated by the second highest number of participants (53 %) and reuse and recycling were noted by the lowest number of respondents(one percent). Hence, placing waste in bins and regular sweeping were common solutions among those suggested for vendors by residents, as shown in Figure 4.11. Having presented and analysed suggested solutions for vendors, below are possible solutions for visitors.

4.8.4 Possible solutions for visitors

Responses of participants on possible solutions for visitors are illustrated in Figure 4.12. In response to a question on possible measures for visitors to improve MSWM in the City, 79% of respondents noted placing of waste in bins, while four percent stated participation in clean up campaigns, as indicated in Figure 4.12.

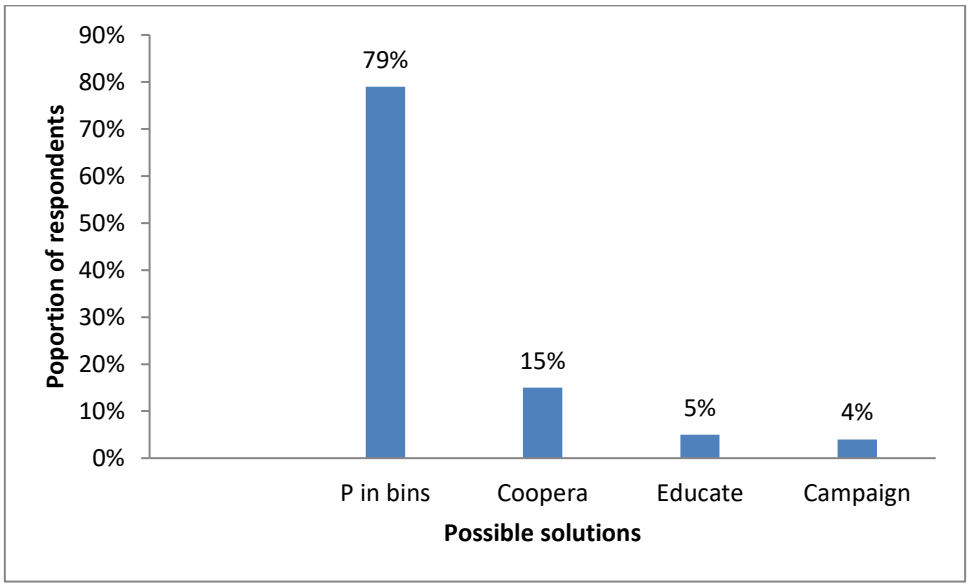


Figure 4.12: Possible solutions for visitors (Coopera stands for Cooperation and P in bins for Placing waste in bins)

As shown in Figure 4.12, placing of waste in bins was the most popular suggested

solution.

4.8.5 Possible solutions for non-governmental organisations (NGOs)

Possible solutions for NGOs are shown in Table 4.14.

Table 4.14: Possible solutions for NGOs

Possible solution	Respondents (%)
Assist financially	57
Promote waste separation	4
Promote integrated waste management	2
Educate waste generators on waste hierarchy	46
Donate bins	44
Provision of waste vehicles	2
Spearhead clean up campaigns	3

From Table 4.14, a significant proportion of respondents (57 %) indicated financial assistance. The second highest number of participants (46 %) noted education, while 44 % of respondents cited provision of receptacles. Provision of waste collection vehicles and promotion of integrated waste management had the lowest proportion of participants(two percent). The findings imply that residents were aware of the importance of NGOs in waste management. For municipal solid waste management to improve, NGOs should assist the council financially, provide bins for waste generators and educate all stakeholders according to interviewees Two, Three and Eleven. Suggested possible solutions were used to develop a waste management model and to make recommendations.

4.9 CHAPTER SUMMARY

This chapter revealed various environmental and health risks. Constraints encountered by stakeholders in municipal solid waste management in Masvingo City were also highlighted.

5 CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

The study sought to evaluate municipal solid waste illegal disposal in Masvingo City, Zimbabwe, with a view to developing a sustainable waste management model. The previous chapter presented and analysed research findings. The findings were then discussed in the context of related literature reviewed in Chapter Two. This chapter presents the summary of findings of the study on each objective. The chapter then presents the conclusions of the study and recommendations for the improvement of municipal solid waste management in Masvingo. This chapter further presents a proposed model for sustainable municipal solid waste management for Masvingo City. Matters requiring further research are also included.

5.2 SUMMARY OF FINDINGS

5.2.1 Sub-question 1: Environmental risks

The current study revealed that land was polluted as a result of illegal disposal of generated municipal solid waste. Heaps of solid waste were common even near residential areas. It also emerged that the air, surface water and ground water were made dirty. The present study also found out that flooding and fire were environmental risks in Masvingo. The most common environmental risks were land pollution, air pollution, surface water pollution and loss of urban beauty.

5.2.2 Sub-question 2: Health risks

Cholera was established as a waterborne disease in Masvingo City due to illegal disposal of MSW. The current study also revealed that malaria was a vectorborne risk

in Masvingo as a result of illegal disposal of MSW which provided breeding grounds for mosquitoes. Furthermore, the current study found out that coughing and breathing difficulties were respiratory risks in Masvingo. In addition, back pains and painful joints were ergonomic risks, while cuts were injury risks associated with municipal solid waste illegal disposal in Masvingo.

5.2.3 Sub-question 3: Constraints

The current study found out that lack of money and fuel shortages were financial resources challenges in Masvingo City. In addition, the present study established that lack of vehicles, lack of bins and lack of equipment for separation were infrastructure and equipment-related constraints. In terms of political and administrative constraints, the current study found out that corruption and lack of political will were MSWM challenges in Masvingo. The current study also revealed that lack of cooperation and community participation and inadequate environmental education were human resources challenges in Masvingo City.

5.3 CONCLUSIONS

The study sought to evaluate municipal solid waste illegal disposal in Masvingo City, Zimbabwe. On the basis of findings of this study, the following conclusions were reached:

5.3.1 Environmental risks

Municipal solid waste illegal disposal was associated with various environmental risks. Dominant environmental risks were surface water pollution, land pollution, air pollution and loss of urban beauty, implying that municipal solid waste management in Masvingo was not promoting Sustainable Development Goal 6 of clean water and

sanitation.

5.3.2 Health risks

Basing on findings of the study, it can be concluded that a variety of health risks were associated with municipal solid waste illegal disposal in Masvingo. Cholera, malaria and skin problems were the main risks in Masvingo. Thus, management of municipal solid waste in Masvingo was not fulfilling Sustainable Development Goal 3 of good health and well-being.

5.3.3 Constraints

From findings of the study, it can be concluded that MSWM stakeholders in Masvingo City encountered various challenges. The main challenges were inadequate environmental education, lack of cooperation and community participation, lack of money, lack of refuse vehicles and lack of political will, thereby not promoting Sustainable Development Goal 11 of sustainable cities and communities.

5.4 RECOMMENDATIONS

Basing on research findings and literature, the following recommendations were made for Masvingo City to achieve sustainable MSWM:

1. *Municipal solid waste management policy*: Presently, the legislation is fragmented. Municipal solid waste management services would be effective if there was a clear and concise mandatory policy and legislation supported by an Act of Parliament that spell out the expectations and roles of the stakeholders in the implementation of solid waste programmes. Wilson *et al.* (2006) noted that policy towards informal waste recycling was repressive in most developing countries. In relation to this, waste management in low-income

countries was inefficient as a result of weak waste management policies and regulations (Chanza *et al.,* 2017). There is, therefore, need for extensive consultation among MSWM stakeholders which include Ministry of Environment, Tourism and Hospitality Industry, Ministry of Health and Child Care, local authorities, captains of industries, residents, informal waste workers and NGOs to come up with an effective waste management policy. This is in line with residents, EMA officials and informal waste workers' suggestions that community involvement among stakeholders would enhance the effectiveness of MSWM. The policy may spell out the role of each stakeholder, resource allocation, training of stakeholders and assessment procedures, among other important aspects.

2. *Involvement of all stakeholders in MSWM:* Local authority, individuals, NGOs, private sector, community-based organisations and donor communities need to be involved in MSWM. Recognising the importance of the private sector in waste management cannot be overestimated. Lack of cooperation and community participation was noted as one of the main constraints leading to poor municipal solid waste management in Masvingo City. This is an indication that inclusivity, which is one of the key components of the theoretical framework (ISWM), was not adequately embraced. To promote good municipal solid waste management, there is need to promote inclusivity.

3. *Adequate and regular education campaigns for all stakeholders to promote positive attitude and effective cooperation and community participation:* Inadequate environmental education was one of the main constraints leading

to poor municipal solid waste management in Masvingo. If stakeholders are made aware of, for example, environmental and health risks associated with illegal disposal of municipal solid waste, it would change their attitude positively and this would be good for waste management. Masvingo City Council, in partnership with Environmental Management Agency and NGOs, needs to carry out the education campaigns.

4. *Provision of suitable waste receptacles including colour coded waste bins for all waste generators by local authority, NGOs and donor agencies:* Availability of suitable receptacles would reduce littering and promote separation at source. Lack of bins and equipment for separation were noted by respondents as challenges hindering MSWM. Separation at source is crucial for recycling, composting and reuse of solid waste. The 4Rs are a key component of the integrated sustainable waste management, which is the theoretical framework of this study. If the 4Rs are promoted because of separation at source, sustained municipal solid waste management would be achieved and this would reduce environmental and health risks of municipal solid waste management.

5. *Masvingo City Council in conjunction with NGOs and Donor Communities need to provide incentives for those who practice recycling, composting and reuse to reduce the quantity of solid waste collected for disposal.* Recycling, composting and reuse are a crucial component of the integrated sustainable waste management (Figure 2.6) and of the proposed framework for sustainable municipal solid management (Figure 5.2). Motivation for recycling, composting

and reuse would lead to reduced illegal disposal which would result in sustainable waste management in Masvingo City. Environmental and health risks would be reduced as a result of sustainable municipal solid waste management.

6. *Regular collection of solid waste from all areas*: Only 40 % of municipal solid waste generated in Masvingo was collected (Chanza *et al.*, 2017; Newsday, 2017). According to the integrated sustainable waste management, collection of solid waste should promote public health. Illegal disposal was caused by infrequent collection. By collecting solid waste frequently from all waste generators, illegal disposal would be reduced. This would reduce environmental and health risks associated with municipal solid waste management.

7. *Use of sanitary landfill*: Masvingo City Council could use sanitary landfill as main disposal site. Proper solid waste disposal is crucial for the protection of the environment and public health, according to the theoretical framework (ISWM) of this study. Sanitary landfills should be the final disposal site as suggested by the conceptual MSWM model designed for Masvingo City by the researcher (Figure 5.2). Sanitary landfills are friendly to the environment and protect public health. If sanitary landfills would be used in Masvingo, it means the disposal would be sustainable.

5.5 PROPOSED FRAMEWORK FOR MSWM

The findings from the study, literature on waste management models, Environmental

Management Act and municipal by-laws were used to come up with the model. This model was inspired by the integrated sustainable waste management model, which was the theoretical framework of the current study. According to some of the interviewees, municipal solid waste in Masvingo had a significant proportion of organic matter (50 %) and recyclables (more than 30 %) as illustrated on Figure 5.1. This implied that for a model to be sustainable, composting and recycling were to be key components.

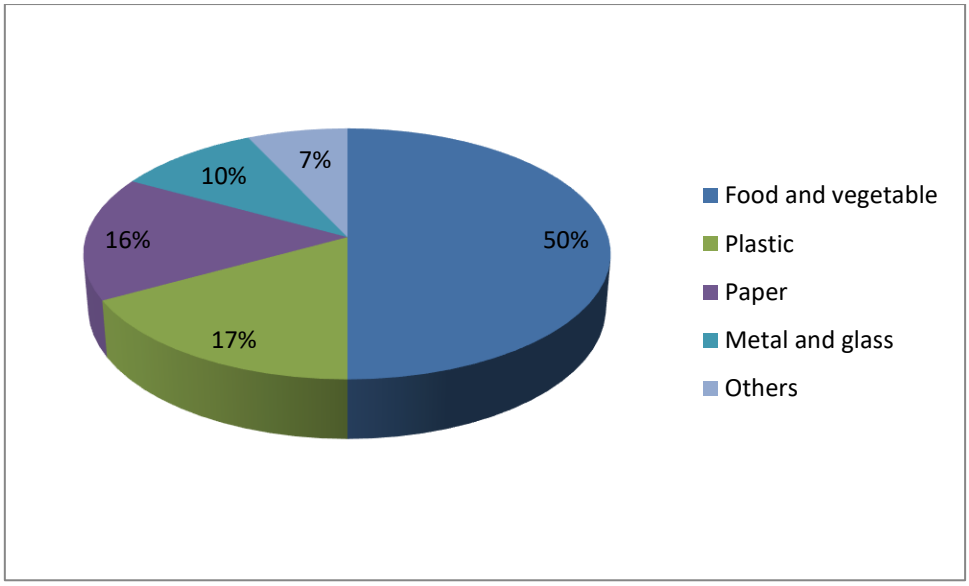


Figure 5.1: Masvingo City's MSW composition

Waste composition is important as it determines waste management methods (Mwanza and Phiri, 2013). Thus, in the present study, Masvingo City waste composition was used to propose a sustainable municipal solid waste management model for Masvingo City. Municipal solid waste management framework involves five key interventions, namely:

i. Environmental education;

ii. Separation at source;

iii. Regular refuse collection;

iv. Composting, recycling and reuse; and,

v. Sanitary land filling.

5.5.1 Environmental education

The current study established that lack of environmental education was a challenge encountered by MSWM stakeholders in Masvingo City. Reviewed literature also revealed the same. To reduce environmental and health risks associated with MSWM, stakeholders should be educated on municipal solid waste management. MCC, NGOs, Great Zimbabwe University, Masvingo Teachers' College, Masvingo Polytechnic College and EMA should educate waste generators, formal waste workers, informal waste workers on MSWM. Environmental awareness promotes a positive attitude towards waste management. Open burning and dumping would be reduced as a result of awareness, thereby reducing environmental and health risks. All waste generators should pay a monthly refuse fees. Charging of a service fee is common in other cities for example, US $ 1.10 is charged per household by Accra Municipality (Bour, 2019). Although interviewees one and four suggested a minimum fee of $2, there is a need for in-depth feasibility study to determine a minimum affordable amount that would keep refuse collection viable while not overburdening the city population. Furthermore, an effective variable and fixed costing model should be considered where, below a specific tonnage there is a fixed cost, above which there will be an additional cost proportional to the weight of the waste.

5.5.2 Separation at source

Separation at source is key since it enables recycling, composting and reuse, as illustrated on Figure 5.2. This reduces the quantity of waste taken for final disposal

(Saikia and Nath, 2015). Both questionnaire and interview results highlighted lack of separation at source as a challenge hindering MSWM in Masvingo. Interviewees suggested provision of equipment for separation as possible solution for the city council and NGOs, implying that provision of equipment for separation at source should be part of the proposed sustainable MSWM for Masvingo. To enhance separation, the local authority, with the assistance from NGOs (CARE International and Plan International) and donor communities (World Bank and International Monetary Fund) as shown in Figure 5.2 should:

i. provide waste generators with different receptacles for different waste components;
ii. educate waste generators on the importance of separation at source;
iii. avail incentives for those who separate; and,
iv. use collection vehicles which accommodate separated waste.

Literature in Latin America reveals that separation at source is efficient only if suitable conditions are appropriate. For example, De Madina *et al.* (2020) concluded that separation at source was a success in Teocelo, Varacruz in Mexico because there was adequate community involvement and environmental awareness. Thus, for separation at source to be a success in Masvingo City, all stakeholders should be actively involved. Separated solid waste must be transported to suitable destinations. For example, in partnership with NGOs and donor agencies, the local authority should carry recyclables and sell them to recycling companies in the city and carry organic waste for composting centres.

5.5.3 Regular refuse collection

Filling up of bins can be a result of infrequent collection of waste, leading to illegal disposal (Amoah and Kosoe, 2014; Emelumadu *et al.,* 2016; Chanza *et al.,* 2017). In relation to this, the integrated sustainable waste management states that infrequent collection of waste is bad for public health. The above information implies that irregular refuse collection is not sustainable because it results in illegal disposal which is associated with various environmental and health risks as alluded to under discussion of results. In conjunction with NGOs, MCC should notify waste generators on collection days and waste generators should avail bins on scheduled days and time. This means that there should be effective communication among MSWM stakeholders. Frequent collection of MSW reduces illegal disposal of waste, thereby protecting public health and the environment.

5.5.4 Composting, recycling and reuse

Composting, recycling and reuse are key concepts of the waste management hierarchy (World Bank, 2012; Taiwo *et al.,* 2016). Residents should practice composting at their homes, with assistance from council officials and NGOs, so that they can get cheap organic fertilisers. Organic fertilisers from composting sites away from residents should be sold to different stakeholders, including residents, at affordable prices. Selling of organic fertilisers, recyclable material and refuse fee collection would boost financial resources for the local authority.

The researcher included composting as part of the model (Figure 5.2) because a large percentage of the solid waste in Masvingo was organic (Figure 5.1). To cater for high proportion of recyclables (Figure 5.1), recycling should be part of the model. Residents should especially reuse plastic matter, for example plastic bags for shopping and plastic containers for storing water, sugar and salt. The benefit would be that money

used for buying water containers and plastic bags would be reduced, as indicated in Figure 5.1. Composting, recycling and reuse have been recommended elsewhere to improve waste management, for example in Harare, Zimbabwe (Mangundu *et al.,* 2013).

5.5.5 Sanitary landfill

Rejects of composting and waste which cannot be recycled and reused should be taken to a sanitary landfill (Mwanza and Phiri, 2013; Saikia and Nath, 2015). Masvingo City Council, in conjunction with NGOs, EMA and donor agencies should make use of a sanitary landfill. According to Cuartal *et al.* (2017) and Vaverkova *et al.* (2018), a landfill should be located on suitable ground and its base should be impermeable. In addition, MCC, with assistance from NGOs and EMA, should collect landfill gas and leachate regularly. Furthermore, sustainability can be achieved by daily compaction and covering of solid waste, as noted by Chadar and Kerti (2017).

These interventions would reduce environmental and health risks, thereby promoting sustainable waste handling, as illustrated in **Error! Reference source not found.**.

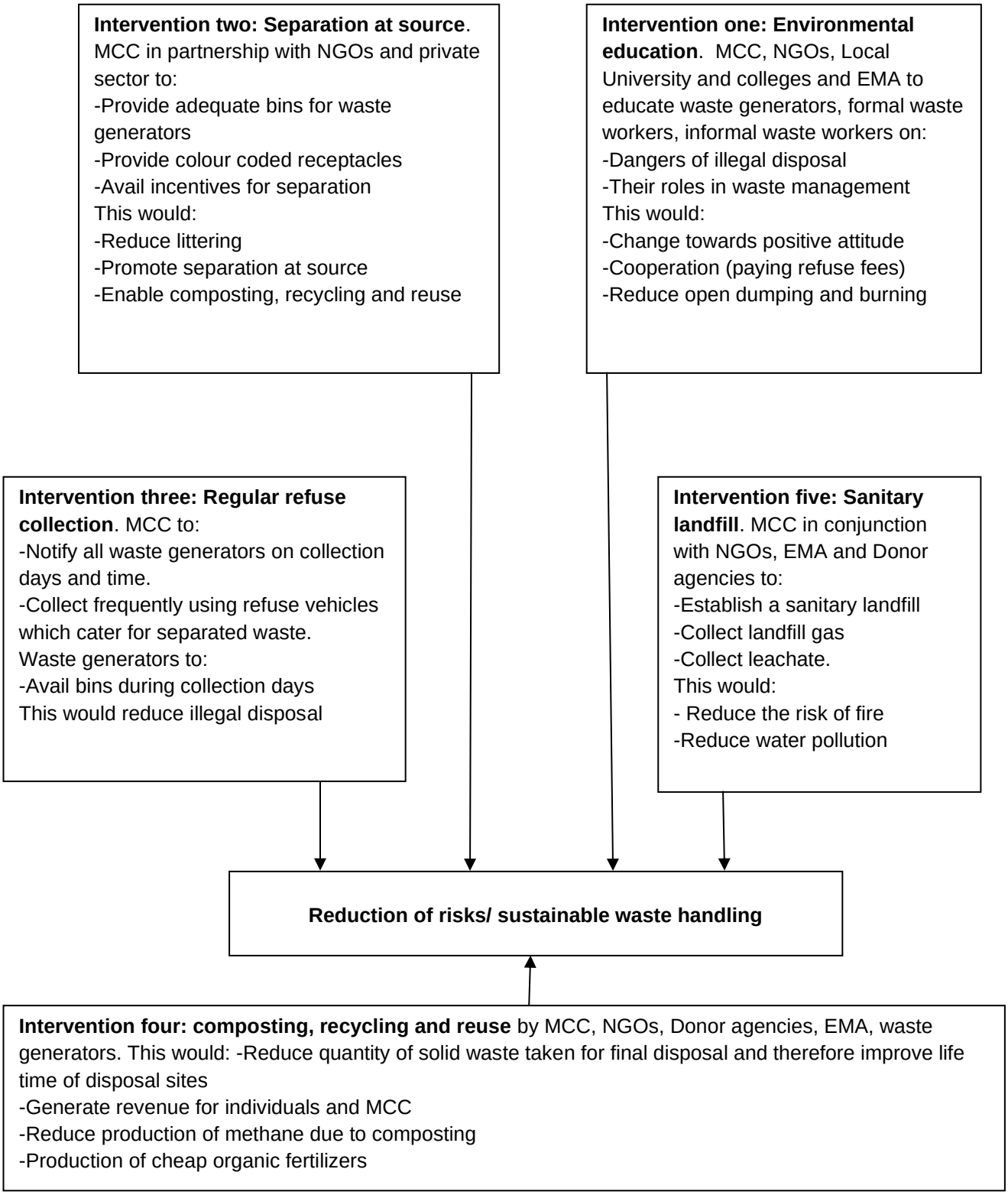


Figure 5.2: Framework for MSWM

6 FUTURE STUDIES

Further studies on the following aspects will need to be conducted:

i. An evaluation of the impact of MSW illegal disposal on surrounding rural areas. Pollution has no boundaries. It is possible for surrounding rural areas to be affected by pollution in a nearby urban area.

ii. The impact of liquid waste disposal on environment and health. This would give the city a holistic approach to waste management.

iii. Factors determining refuse collection fees.

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APPENDICES

APPENDIX ONE: QUESTIONNAIRE FOR RESIDENTS

My name is Amato Chireshe. I am carrying out a research titled '**Evaluation of municipal solid waste illegal disposal in the city of Masvingo, Zimbabwe: Towards a sustainable waste management model** for the Doctor of Philosophy Degree in Environmental Management with University of South Africa (UNISA). I kindly ask you to assist by completing this questionnaire. The research findings have the potential to benefit residents, local authority, Ministry of Environment, Tourism and Hospitality Industry, Ministry of Health and Child Care and Non-Governmental Organisations.

The information will be treated with confidentiality and you do not have to write your name on the questionnaire to remain anonymous. The information will be used only for academic purposes. Participation in this study is voluntary and you can withdraw from the study without any obligations. Thank you for understanding and agreeing to participate.

SECTION A: Background information

Please tick the appropriate and applicable box.

1. Gender Male ☐

Female ☐

2. Age 18-24 ☐

25-34 ☐

35-49 ☐

50-54 ☐

55-62 ☐

63+ ☐

3. Highest level of education

Primary ☐

Secondary ☐

Certificate/Diploma ☐

Degree ☐

4. Suburb----------

SECTION B: Environmental risks of municipal solid waste illegal disposal

5. Indicate the extent to which you agree that each of the following is an environmental risk (problem) of municipal solid waste illegal disposal Masvingo City. Please tick appropriate space.

ENVIRONMENTAL	RESPONSE

RISK	Strongly agree	Agree	Not sure	Disagree	Strongly disagree
Surface water contamination					
Ground water contamination					
Land pollution					
Air pollution					
Death of vegetation					
Soil contamination					
Flooding					
Loss of urban beauty					
Fire					

6. List any other environmental risks of municipal solid waste illegal disposal not in the table above.

---

7. From environmental risks listed above, which ones can you regard as the main 4?

SECTION C: Constraints encountered by stakeholders in municipal solid waste management in Masvingo City

8. Indicate the extent to which you agree that each of the following is a constraint to municipal solid waste management in Masvingo City.

CONSTRAINT	RESPONSE				
	Strongly agree	Agree	Not sure	Disagree	Strongly disagree
Lack of cooperation and participation of the community					
Inadequate environmental education					

9. List other constraints encountered by stakeholders not included in the table above.

---

10. From the constraints listed above, which ones can you regard as the main 4?

---

11. What do you think should be done by each of the following stakeholders to improve municipal solid waste management in Masvingo?

a. City council

---

b. Residents

---

c. Vendors

---

d. Visitors

---

e. Non-governmental organisations (NGOs)

APPENDIX TWO: INTERVIEW GUIDE FOR FORMAL WASTE MANAGEMENT

WORKERS

1. Can you describe your job in relation to municipal solid waste management?
2. Are there any environmental risks of municipal solid waste illegal disposal?
3. From the risks, which do you consider as the popular?
4. Which constraints are faced by people involved in municipal solid waste management?
5. In your opinion, what should be done to improve MSWM in Masvingo?

APPENDIX THREE: INTERVIEW GUIDE FOR INFORMAL WASTE WORKERS

1. Can you describe your job in relation to municipal solid waste management?
2. Which are the environmental problems of municipal solid waste illegal disposal?
3. From the problems, which do you consider as the popular?
4. Which constraints do you face in municipal solid waste management?
5. In your opinion, what should be done to improve municipal solid waste management in Masvingo?

APPENDIX FOUR: INTERVIEW GUIDE FOR HEALTH PRACTITIONERS

1. Can you describe the composition of MSW in Masvingo?

2. Which are the waterbornediseases associated with municipal solid waste illegal disposal in Masvingo City?

3. Are there any respiratory risks associated with municipal solid waste illegal disposal in Masvingo City?

4. Which are the injury risks associated with municipal solid waste illegal disposal in Masvingo?

5. Are there vectorbornediseasesassociated with municipal solid waste illegal disposal in Masvingo City?

6. Which are the ergonomic risks associated with municipal solid waste illegal disposal in Masvingo?

7. From the health problems listed, which ones can you regard as top 4 in order of severity?

8. Which constraints are encountered by people involved in municipal solid waste management?

9. In your opinion, what should be done to improve municipal solid waste management in Masvingo City?

APPENDIX FIVE: INTERVIEW GUIDE FOR EMA OFFICIALS

1. Can you describe your job in relation to municipal solid waste management?
2. Can you describe composition of MSW in Masvingo?
3. Which are the environmental risks of municipal solid waste illegal disposal?
4. Which are the challenges faced by stakeholders in MSWM?
5. In your opinion, what should be done to improve municipal solid waste management in Masvingo?

APPENDIX SIX: OBSERVATION CHECKLIST

Environmental effects	**Magnitude**			
	High	Moderate	Low	None
Municipal solid waste in water sources				
Smoke/dust in air				
Dark flowing water from bins and waste dumps				
Mosquitoes and coackroacheson waste dumps				
Rats in and around bins and waste dumps				
Domestic animals in and around dump sites				
Fly infested dump sites				

APPENDIX SEVEN: CITY COUNCIL PERMISSION LETTER

Rupare high school
Bag 557

Nyika

29 April 2019

The Town Clerk

Masvingo City Council

P.O Box 17

Masvingo

Dear Sir/Madam

RE: Request for permission to undertake a research in Masvingo City (Amato Chireshe. Ref number 2019/CAES/008)

Your permission is herewith requested to allow Amato Chireshe, a student in the PhD Environmental Management at the UNISA in the department of Environmental Sciences), to conduct academic research in your organisation. Amato Chireshe was granted ethical approval by the UNISA ethics committee as indicated on attached letter.

I am sure you are aware that any post graduate study involves completion of a Dissertation or Thesis. It is for this reason that I request your personal and professional

permission to partake my research in your departments within the city of Masvingo. My study is in municipal solid waste management and the title of my research thesis is **Evaluation of municipal solid waste illegal disposal in the city of Masvingo, Zimbabwe, with a view to develop a sustainable MSWM model.**

I will administer questionnaires to some residents, observe the surroundings, interview some members of your staff and review documents. Photographs will be taken on issues related to municipal solid waste disposal.

Your organisation participation in this study is very important to us. You may, however choose not to participate and you may also withdraw from the study at any time without any negative consequences. The results of the study will be used for academic purposes only and may be published in an academic journal. We will provide you with a summary of our findings on request.

Please contact my supervisor, Dr CA TOGO (catogo@gmail.com) if you have any questions or comments regarding the study. Please sign below to indicate your willingness to participate in the study.

Yours sincerely

Amato Chireshe

(UNISA-61647063)

Supervisor: Doctor CA TOGO

I, **Company representative**, herewith give my permission for the study to be

City Of Masvingo

+263 39 262431/4
Fax No + 263 39 262257

townclerkdept@masvingocity.gov.zw

All Communications Should Be
Addressed to
THE TOWN CLERK
P O Box 17
MASVINGO

Town Clerk's Office
City Council Offices
Civic Centre
Masvingo
Zimbabwe

Our Ref MM/rm/research

02 July 2019

Amato Chireshe
Rupare High School
Bag 557
Nyika

Dear Sir

RE: PERMISSION TO CARRY OUT RESEARCH ON EVALUATION OF MUNICIPAL SOLID WASTE ILLEGAL DISPOSAL TOWARDS A SUSTAINABLE WASTE DISPOSAL MODEL IN THE CITY OF MASVINGO, ZIMBABWE.

Reference is made to your letter dated 29 April 2019 requesting permission to undertake an academic research on ***"evaluation of Municipal Solid waste illegal disposal towards a sustainable waste disposal model in the City of Masvingo, Zimbabwe"*** in partial fulfillment of your PhD Environmental Management.

I am pleased to inform you that Masvingo City Council has granted you the permission to undertake your research. However your research findings shall not be for publication and ***you are also required to present a copy of your final project to the Town Clerk.***

May I take this opportunity to thank you for the interest you have shown in our organization and wish you well in your research.

Yours faithfully

V. Shonhai
Acting Chamber Secretary
Cc: file

CHAMBER SECRETARY
CITY OF MASVINGO
19 JUL 2019
P.O. BOX 17, MASVINGO
TEL : (039) 262431 - 4
FAX : (039) 262257

APPENDIX EIGHT: EMA PERMISSION LETTER

Rupare High School

Bag 557

Nyika

14 June 2019

The Provincial Environmental Manager

Environmental Management Agency

P.O 425

Masvingo

Dear Sir/Madam

RE: Request for permission to undertake a research in your organization in Masvingo City (Amato Chireshe. Ref number 2019/CAES/008; Contact number +263773529053)

Your permission is herewith requested to allow Amato Chireshe, a student in the PhD Environmental Management at the UNISA in the department of Environmental Sciences), to conduct academic research in your organisation. Amato Chireshe was granted ethical approval by the UNISA ethics committee as indicated on attached letter.

I am sure you are aware that any post graduate study involves completion of a Dissertation or Thesis. It is for this reason that I request your personal and professional

permission to partake my research in your departments within City of Masvingo. My study is in municipal solid waste management and the title of my research Thesis is **Evaluation of municipal solid waste illegal disposal in the city of Masvingo, Zimbabwe, with a view to develop a sustainable MSWM model.**

I will interview some of you staff members from the Environmental Management Agency (EMA), review documents and observe the surroundings. Photographs will be taken on issues related to municipal solid waste disposal.

Your organisation participation in this study is very important to us. You may, however choose not to participate and you may also withdraw from the study at any time without any negative consequences. The results of the study will be used for academic purposes only and may be published in an academic journal. We will provide you with a summary of our findings on request.

Please contact my supervisor, Dr CA TOGO (catogo@gmail.com) if you have any questions or comments regarding the study. Please sign below to indicate your willingness to participate in the study.

Yours sincerely

Amato Chireshe

(UNISA-61647063)

Supervisor: Doctor CA TOGO

Rupare High School

Bag 557

Nyika

0773529053

14 June 2019

The Provincial Environmental Manager

Environmental Management Agency

Masvingo

ENVIRONMENTAL MANAGEMENT AGENCY
MASVINGO PROVINCE
RECORDS
18 JUN 2019
P. O. BOX 425, MASVINGO
ZIMBABWE
TEL. (039) 262776 / 264056

Dear Sir/Madam

RE: Request for permission to undertake a research in your organization in Masvingo City (Amato Chireshe. Ref number 2019/CAES/008; Contact number +263773529053)

Your permission is herewith requested to allow Amato Chireshe, a student in the PhD Environmental Management at the UNISA in the department of Environmental Sciences), to conduct academic research in your organisation. Amato Chireshe was granted ethical approval by the UNISA ethics committee as indicated on attached letter.

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I will interview some of you staff members from the Environmental Management Agency (EMA), review documents and observe the surroundings. Photographs will be taken on issues related to municipal solid waste disposal.

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Please contact my supervisor, Dr CA TOGO (catogo@gmail.com) if you have any questions or comments regarding the study. Please sign below to indicate your willingness to participate in the study.

Yours sincerely

Supervisor: Doctor CA TOGO

Amato Chireshe

(UNISA-61647063)

I, **Company representative**, herewith give my permission for the study to be conducted in Masvingo city.

M. MUUSHA

MC

4/7/19

Signature **Date**

APPENDIX NINE: CONSENT FORM FOR INTERVIEWEES

Participant Information Sheet

Ethics Clearance reference number: 2019/CAES/008……

Research Permission reference number: ……

15/08/2019

Title: Evaluation of municipal solid waste illegal disposal inMasvingoCity, Zimbabwe: towards a sustainable solid waste management model

Dear Prospective participant,

You are invited to participate in a survey conducted by Amato Chireshe under the supervision of Dr CA Togo, a research supervisor in the Department of Agriculture and Environmental Sciences, towards a PhD in Environmental Management at the University of South Africa.

The survey has been designed to study the illegal municipal solid waste disposal in Masvingo city, Zimbabwe. You were selected to participate in this survey because you have important information on the municipal solid waste disposal. You will not be eligible to complete the survey if you are younger than 18 years or older than 75 years. By completing this survey, you agree that the information you provide may be used for research purposes, including dissemination through peer-reviewed publications and conference proceedings.

Purpose of the study

The purpose of this study is to evaluate illegal municipal solid waste disposal in high-density, medium- density and low-density suburbs in Masvingo city, Zimbabwe through questionnaires, face to face interviews, direct observations and document

review.

It is anticipated that the information we gain from this survey will help us to evaluate environmental and health risks of illegal municipal solid waste disposal. You will not receive any direct and immediate benefit from your participation as an individual. However, it is envisioned that the findings of this study will benefit residents who would be aware of health risks of municipal solid waste illegal disposal, The Ministry of health would be able to design strategies to reduce solid waste related risks and would also assist the Ministry of Environment, Tourism and Hospitality Industry in policy formulation and implementation. The aim of the study will be fulfilled through the following specific objectives which are to:

- determine environmental risks of MSW illegal disposal in Masvingo;
- assess health risks of municipal solid waste illegal disposal in Masvingo; and
- examine constraints faced by stakeholders in MSWM in Masvingo;

Why am I being invited to participate?

You have been chosen to participate in this study based on the fact that you are one of the key stakeholders in municipal solid waste management.

Can I withdraw from this study even after having agreed to participate?

Participating in this study is voluntary and you are under no obligation to consent to participation. If you do decide to take part, you will be given this information sheet to keep and be asked to sign a written consent form. You are free to withdraw at any time and without giving a reason. However, it will not be possible to withdraw after the interview.

What are the potential benefits of taking part in this study?

This study will benefit residents who would be aware of safety and health risks of municipal solid waste illegal disposal, The Ministry of Health and Child Care would be able to design strategies to reduce solid waste related risks and would also assist the Ministry of Environment, Tourism and Hospitality Industry in policy formulation and implementation.

Are there any negative consequences for me if I participate in the research project?

Participants could be exposed to invasion (privacy and anonymity).

The researcher will first seek informed consent from research participants and protect their anonymity and confidentiality.

Protecting anonymity and confidentiality: Any identifying information that is obtained in connection with this survey will remain confidential and will be disclosed only with your permission or as required by law.

Informed consent: The researcher will provide detailed information about the research project so that participants understand that they are taking part in research and what the research requires of them

Avoiding deceptive practices: The researcher will strive for honesty in this study. Participants should understand that they are taking part in research and what the research requires of them. The researcher will provide detailed information about the purpose of the research, expected duration and procedures.

How will the researcher(s) protect the security of data?

Hard copies of your answers will be stored by the researcher for a period of five years in a locked filing cabinet at the researcher's home for future research or academic purposes. Electronic information will be stored on a password protected computer. Future use of the stored data will be subject to further Research Ethics Review and approval if applicable. Hard copies will be shredded and electronic copies will be permanently deleted from the hard drive of the computer through the use of a relevant software programme.

Will I receive payment or any incentives for participating in this study?

There will be no any payment or reward offered financial. However, any costs incurred by the participant will be explained and justified in adherence with the principle of fair procedures (justice).

Has the study received ethics approval?

This study has received written approval from the Research Ethics Review Committee of the College of Agriculture and Environmental Sciences, Unisa. A copy of the approval letter can be obtained from the researcher if you so wish.

How will I be informed of the findings/results of the research?

If you would like to be informed of the final research findings, please contact Amato

Chireshe at **+263773529053** or email amatochi@gmail.com

Should you have concerns about the way in which the research has been conducted, you may contact Dr. Togo on **+27 82 3622 431**, or email catogo@gmail.com**.**You can also contact the chairperson of the Ethics Research Committee, Prof EL Kempen on +27 11 4712 241 or kempeel@unisa.ac.za. Alternatively, you can report any serious unethical behaviour at the University's Toll Free Hotline **0800 86 96.**

You are making a decision whether or not to participate. You are free to withdraw from the study at any time. Thank you for taking time to read this information sheet and for participating in this study.

Thank you

Amato Chireshe

CONSENT TO PARTICIPATE IN THIS STUDY

I, _____(participant name), confirm that the person asking my consent to take part in this research has told me about the nature, procedure, potential benefits and anticipated inconvenience of participation.

I have read (or had explained to me) and understood the study as explained in the information sheet.

I have had sufficient opportunity to ask questions and am prepared to participate in the study.

I understand that my participation is voluntary and that I am free to withdraw at any time without penalty.

I am aware that the findings of this study will be processed into a research report or conference proceedings, but that my participation will be kept confidential unless otherwise specified.

I agree to the recording of the interview.

I have received a signed copy of the informed consent agreement.

Participant Name &Surname…….. (pleaseprint)

Participant Signature……..Date……

Researcher's Name & Surname…… (please print)

Researcher's signature……..Date……

APPENDIX TEN: CONSENT FORM FOR RESIDENTS

Participant Information Sheet

Ethics Clearance reference number: 2019/CAES/008……

Research Permission reference number: ……

15/08/2019

Title: Evaluation of municipal solid waste illegal disposal in Masvingo city, Zimbabwe: towards a sustainable solid waste management model

Dear Prospective participant,

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Purpose of the study

The purpose of this study is to evaluate illegal municipal solid waste disposal in high-density, medium- density and low-density suburbs in Masvingo city, Zimbabwe through questionnaires, face to face interviews, direct observations and document review.

It is anticipated that the information we gain from this survey will help us to evaluate safety, environmental and health risks of illegal municipal solid waste disposal. You will not receive any direct and immediate benefit from your participation as an individual. However, it is envisioned that the findings of this study will benefit residents who would be aware of safety and health risks of municipal solid waste illegal disposal, The Ministry of health would be able to design strategies to reduce solid waste related risks and would also assist the Ministry of Environment, Tourism and Hospitality Industry in policy formulation and implementation. The aim of the study will be fulfilled through the following specific objectives which are to:

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- evaluate constraints faced by stakeholders in MSWM in Masvingo.

Why am I being invited to participate?

You have been chosen to participate in this study based on the fact that you are one of the key stakeholders in municipal solid waste management.

Can I withdraw from this study even after having agreed to participate?

Participating in this study is voluntary and you are under no obligation to consent to participation. If you do decide to take part, you will be given this information sheet to keep and be asked to sign a written consent form. You are free to withdraw at any time and without giving a reason. However, it will not be possible to withdraw after completing questionnaire.

What are the potential benefits of taking part in this study?

This study will benefit residents who would be aware of safety and health risks of municipal solid waste illegal disposal, The Ministry of Health and Child Care would be able to design strategies to reduce solid waste related risks and would also assist the Ministry of Environment, Tourism and Hospitality Industry in policy formulation and implementation.

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Participants could be exposed to invasion (privacy and anonymity)

The researcher will first seek informed consent from research participants and protect

their anonymity and confidentiality.

Protecting anonymity and confidentiality

Any identifying information that is obtained in connection with this survey will remain confidential and will be disclosed only with your permission or as required by law.

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How will the researcher(s) protect the security of data?

Hard copies of your answers will be stored by the researcher for a period of five years in a locked filing cabinet at the researcher's home for future research or academic purposes. Electronic information will be stored on a password protected computer. Future use of the stored data will be subject to further Research Ethics Review and approval if applicable. Hard copies will be shredded and electronic copies will be permanently deleted from the hard drive of the computer through the use of a relevant software programme.

Will I receive payment or any incentives for participating in this study?

There will be no any payment or reward offered financial. However, any costs incurred by the participant will be explained and justified in adherence with the principle of fair procedures (justice).

Has the study received ethics approval?

This study has received written approval from the Research Ethics Review Committee of the College of Agriculture and Environmental Sciences, Unisa. A copy of the approval letter can be obtained from the researcher if you so wish.

How will I be informed of the findings/results of the research?

If you would like to be informed of the final research findings, please contact Amato Chireshe at **+263773529053** or email amatochi@gmail.com

Should you have concerns about the way in which the research has been conducted, you may contact Dr. Togo on **+27 82 3622 431**, or email catogo@gmail.com**.**You can also contact the chairperson of the Ethics Research Committee, Prof EL Kempen on +27 11 4712 241 or kempeel@unisa.ac.za. Alternatively, you can report any serious unethical behaviour at the University's Toll Free Hotline **0800 86 96.**

You are making a decision whether or not to participate. You are free to withdraw from the study at any time. Thank you for taking time to read this information sheet and for participating in this study.

Thank you

Amato Chireshe

CONSENT TO PARTICIPATE IN THIS STUDY

I, _____(participant name), confirm that the person asking my consent to take part in this research has told me about the nature, procedure, potential benefits and anticipated inconvenience of participation.

I have read (or had explained to me) and understood the study as explained in the information sheet.

I have had sufficient opportunity to ask questions and am prepared to participate in the study.

I understand that my participation is voluntary and that I am free to withdraw at any time without penalty.

I am aware that the findings of this study will be processed into a research report or conference proceedings, but that my participation will be kept confidential unless otherwise specified.

I have received a signed copy of the informed consent agreement.

Participant Name &Surname…….. (pleaseprint)

Participant Signature……..Date…….

Researcher's Name & Surname…… (please print)

Researcher's signature……..Date…….

UNISA university of south africa

CAES HEALTH RESEARCH ETHICS COMMITTEE

Date: 15/03/2019

NHREC Registration # : REC-170616-051
REC Reference # : 2019/CAES/008
Name : Mr A Chireshe
Student #: 61647063

Dear Mr Chireshe

Decision: Ethics Approval from 14/03/2019 to 31/03/2020

Researcher(s): Mr A Chireshe
amatochi@gmail.com

Supervisor (s): Dr CA Togo
catogo@gmail.com; 082-362-2431

Working title of research:

Evaluation of municipal solid waste illegal disposal towards a sustainable waste disposal model in Masvingo City, Zimbabwe

Qualification: PhD Environmental Management

Thank you for the application for research ethics clearance by the CAES Health Research Ethics Committee for the above mentioned research. Ethics approval is granted for a one-year period. After one year the researcher is required to submit a progress report, upon which the ethics clearance may be renewed for another year.

Due date for progress report: 31 March 2020

Please note the points below for further action:

1. The researcher is advised to look at the chosen sampling technique and the sample size, as well as the base data to be used for stratification, as it is not clearly described.

*The **low risk application** was **reviewed** by the CAES Health Research Ethics Committee on 14 March 2019 in compliance with the Unisa Policy on Research Ethics and the Standard Operating Procedure on Research Ethics Risk Assessment.*

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The proposed research may now commence with the provisions that:

1. The researcher(s) will ensure that the research project adheres to the values and principles expressed in the UNISA Policy on Research Ethics.
2. Any adverse circumstance arising in the undertaking of the research project that is relevant to the ethicality of the study should be communicated in writing to the Committee.
3. The researcher(s) will conduct the study according to the methods and procedures set out in the approved application.
4. Any changes that can affect the study-related risks for the research participants, particularly in terms of assurances made with regards to the protection of participants' privacy and the confidentiality of the data, should be reported to the Committee in writing, accompanied by a progress report.
5. The researcher will ensure that the research project adheres to any applicable national legislation, professional codes of conduct, institutional guidelines and scientific standards relevant to the specific field of study. Adherence to the following South African legislation is important, if applicable: Protection of Personal Information Act, no 4 of 2013; Children's act no 38 of 2005 and the National Health Act, no 61 of 2003.
6. Only de-identified research data may be used for secondary research purposes in future on condition that the research objectives are similar to those of the original research. Secondary use of identifiable human research data require additional ethics clearance.
7. No field work activities may continue after the expiry date. Submission of a completed research ethics progress report will constitute an application for renewal of Ethics Research Committee approval.

Note:

*The reference number **2019/CAES/008** should be clearly indicated on all forms of communication with the intended research participants, as well as with the Committee.*

Yours sincerely,

Prof EL Kempen
Chair of CAES Health REC
E-mail: kempeel@unisa.ac.za
Tel: (011) 471-2241

Prof MJ Linington
Executive Dean : CAES
E-mail: lininmj@unisa.ac.za
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Zimbabwe

25 March 2021

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Cell: +263 772 978 970

TO WHOM IT MAY CONCERN

Re: Confirmation of Editing of Amato Chireshe's Doctoral Thesis

This is to certify that I, Prof. Rugare Mareva (National Identity Number 22-101 400 k 22), have edited Amato Chireshe's thesis, titled: Evaluation of municipal solid waste illegal disposal in Masvingo City, Zimbabwe: Towards a sustainable solid waste management model', to be submitted to the University of South Africa (UNISA). I am a holder of: a PhD (English) (University of Venda); M.Ed (English) (University of Zimbabwe); B.Ed (English) (University of Zimbabwe), and a Certificate in Education (English Major) (Gweru Teachers' College).

Thank you.

Prof. Rugare Mareva (PhD)