

**ASSESSMENT OF SOLID WASTE MANAGEMENT PRACTICES IN BOR TOWN,
SOUTH SUDAN**

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of the Award of a Master of Science Degree in Environmental Science of Egerton
University**

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DECLARATION AND RECOMMENDATIONS

Declaration

This thesis is my original work and has not been presented in this or any other university for the award of a degree.

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Recommendations

This thesis has been submitted with our approvals as supervisors for examination according to Egerton University regulations.

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DEDICATION

I would like to dedicate this thesis to my beloved wife, Daruka and my children, Acuei, Garang, Deng and Alek for their encouragement and support they gave me during my academic studies. Without them I could have not been able to accomplish this academic research work.

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ABSTRACT

In South Sudan like in many other developing countries, one to two thirds of the solid waste generated is not collected. There is a great problem in the household' management of solid wastes in the rapid growing town of Bor in South Sudan. This study sought to generate information on solid waste handling practices, which could provide appropriate data that can be used to come up with strategies for managing solid waste. The research focussed on 384 respondents in Bor Town in order to assess the types and sources of solid waste generated, determine knowledge levels, practices and attitudes of people toward solid waste management (SWM) as well as factors and challenges faced in SWM in Bor town. The research instruments were pilot tested to determine the reliability of the instrument in Juba town, Central Equatoria State. Descriptive statistics and Pearson correlation were used to analyse the data. This study found that the major types of solid wastes generated in Bor town include plastic (41%), organic waste (29%) and papers (15%) which were obtained from places of residence, commercial, agricultural fields, institutions and construction sites. Open dumping (62.4) and burning (34.7%) were the most popular method of solid waste disposal. This study recommends that since some of the solid waste generated can be recycled (metals, glass, plastic), efforts should be made to link up with agencies dealing with waste recycling. The government/municipal council should launch a widespread awareness campaign to deal with the negative perceptions and low knowledge of the community toward solid waste disposal methods. Government efforts to build more waste disposal sites in the study area should be supported and necessary budget allocated and also to ensure to improve road infrastructure in the area to support easier waste disposal.

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LIST OF ABBREVIATIONS AND ACRONYMS

AESSL	Agricultural Engineering Society of Sri Lanka
BMC	Bor Municipal Council
CBS	Central Bureau of Statistics
EPA	Environmental Protection Agency
GDP	Gross Domestic Product
HDI	Human Development Index
ISWA	International Solid Waste Association
LCC	Lusaka City Council
MSW	Municipal Solid Waste
MSWM	Municipal Solid Waste Management
NEMA	National Environmental Management Authority
NGO	Non Governmental Organizations
OECD	Organization for Economic Co-operation and Development
SWM	Solid Waste Management
UN	United Nations
UNCHS	United Nation Conference on Human Settlement
UNEP	United Nations Environmental Programme
UNPD	United Nation Populations Division
USEPA	United States Environmental Protection Association
WHO	World Health Organization

CHAPTER ONE

INTRODUCTION

1.1 Background information

According to Rushbrook and Pugh (1999), the term solid waste (SW) refers to municipal waste and can be categorized in seven groups. These are residential (household or domestic waste), commercial, institutional, street sweeping, construction and demolition, sanitation and industrial wastes. Municipal solid waste refers to solid wastes from houses, streets and public places, shops, offices and hospitals, which are often the responsibility of municipal or other governmental authorities of any country (Rush Brook and Pugh, 1999). Solid waste from industrial processes, are generally not considered municipal waste. However, solid waste from industrial processes should be taken into account when dealing with solid waste as they often end up in the municipal solid waste stream. The synonyms to solid waste are terms such as garbage, trash, refuse and rubbish (Zurbrugg, 2000).

Managing domestic, industrial and commercial waste has traditionally consisted of collection, followed by disposal (Soni, 2007). Depending upon the type of waste and the area, a level of processing may follow collection. This processing may be to reduce the hazard of the waste, recover material for recycling, produce energy from the waste, or reduce it in volume for more efficient disposal. The management of various types of solid waste over the years has been a difficult and challenging issue worldwide including South Sudan. Research reports elsewhere on waste management show that levels of knowledge, attitudes and practices have an influence on waste management (Brown, 1994; Ghosh, 2001; Palczynski, 2002).

Collection methods vary widely between different countries and regions. For example, in Australia most urban domestic households have a 240-litre bin that is emptied weekly by the local Council (Phase, *et al*, 2010). Many cities, especially those in less developed countries, do not have a formal waste-collection system in place. For example, solid waste disposal is a major problem in urban African towns, where more than half the population now lives. In urban areas, especially in the rapid urbanizing cities of the developing world, problems and issues of Municipal Solid Waste management (MSWM) are of immediate concern. This has been acknowledged by most governments, rapid population growth overwhelms the capacity of most municipal authorities to provide even the most basic services (Zurbrugg, 2000). Urban authorities have the responsibility to ensure safe, reliable and cost-effective removal and disposal of solid waste, which takes up a large proportion of available resources which are not adequate to cope with the magnitude of the problem

(NEMA, 2000). Unfortunately, public agents and urban authorities do not have adequate capacity to handle the increased solid waste mainly due to limited public budgets (NEMA, 2000).

In South Sudan like in many other developing countries, one to two thirds of the solid waste generated is not collected (Zerbock, 2003). As a result, the uncollected waste, which is often also mixed with human and animal excreta, is dumped indiscriminately in the streets and in drainage channels in Bor town.

1.2 Statement of the problem

There is a great problem in the household' management of solid wastes in the rapid growing city of Bor in South Sudan. The current population of the town is estimated at 221000 (UNMIS, 2010). In Bor town, domestic and municipal solid wastes are commonly found disposed of in open dumps, deposited in unoccupied land, water channels, and at the back of houses. The current practices of collecting, processing, and disposing of municipal solid wastes seem to be insufficient in the town. As a result of this, there is bad odour and the waste is likely to lead to water and air pollution. Such conditions have been associated with increased occurrences of diseases like diarrhea, malaria, cough and cholera in the town. However, there is little or no documented data concerning the current practices, attitudes and knowledge on solid waste management as well as challenges encountered in SWM in Bor that can be used in planning. There was need to document the current waste handling practices in order to provide a data base that can be used for planning in managing solid waste in Bor town.

1.3 Study objectives

1.3.1 Broad objective

To generate information on solid waste handling practices, which could provide appropriate data that can be used to come up with strategies for managing solid waste.

1.3.2 Specific objectives

1. To assess the types and sources of solid waste produced.
2. To determine knowledge levels, attitudes and practices (KAP) of the community toward solid waste.
3. To document solid waste disposal practices.
4. To assess factors and challenges related to solid waste management.
5. To assess the existing policy framework for solid waste management

1.3.3 Research questions

1. What are the types and sources of solid waste produced?

2. What are the knowledge levels and attitudes of the community toward solid wastes?
3. What are the solid waste disposal practices?
4. What are the factors and challenges related to solid waste management?
5. What are the existing policy frameworks for solid waste management?

1.4 Justification

There is evidence that Africa is littered with open dump sites and other inefficient means of waste disposal mechanisms and South Sudan is inclusive, For instance; incinerators with inappropriate air pollution control devices (NEMA, 1998). Diseases associated with improper solid waste management has led to some untimely human death which was estimated to be up to 20000 in a year (NEMA, 1998). Poor waste management has been noted to result to pollution of both surface and ground water through leachate draining and impairing the permeability of soil as well as blockage of drainage systems (NEMA, 1998).

This study was aimed at generating information that will contribute to the existing body of knowledge in the areas of solid waste management and particular in Bor town. It is hoped that the findings of this study will enlighten the policy makers, local leaders and local people about the causes of poor waste management and how it would be mitigated. These findings will assist in drafting appropriate policies regarding solid waste management and the government will be in position to initiate programs that will empower citizens and make them aware of the challenges of poor waste management. Moreover, the findings of this study will also provide future researchers and scholars with appropriate information regarding disposal methods of solid wastes.

1.5 Scope of the study

The study was conducted in Bor town, the capital of the Jonglei State. The research focussed on 384 respondents in Bor Town in order to assess the types and sources of solid waste generated, determine knowledge levels, attitudes and practices of people toward solid waste management as well as factors and challenges faced in SWM in Bor town. The study used both quantitative and qualitative types of data. Moreover, the researcher reviewed documents, reports and collected data from already existing literatures. The data collected was used to evaluate how the existing disposal methods had been effective and efficient in managing solid wastes.

1.6 Assumptions and limitations

- i. The data that was collected during the survey reflected the true status of the situations as at the time of the study.

- ii. The study also depended on the assumption that the respondents answered the survey questions correctly and truthfully as expected.
- iii. The study was limited by political instability since the country had been at war for more than twenty months which had made some areas inaccessible.
- iv. There was no documented existing policy on waste management in the state which has limited my survey in tackling my objective five on existing policies.

1.7 Definition of terms and operationalization of terms in the context of this study

Attitude- Refers to the positive and negative feeling of people toward waste management as well as any preconceived ideas that they may have towards it.

Integrated waste management- Defined IWM as the selection and application of appropriate techniques, technologies and management programmes to achieve specific waste management objectives and goals.

Knowledge- Refers to the community understanding of solid waste disposal methods, effects and diseases caused by poor solid waste disposal.

Municipal council- Refers to the authority responsible for waste management in the town.

Municipal waste- wastes generated from houses, streets and public places, shops, offices and hospitals.

Payam- Administrative area (Division).

Practice- Refers to the way in which people demonstrate their knowledge and attitude through their actions.

Solid waste (SW) - Refers to wastes generated from residential, commercial, institutions, constructions and agricultural fields.

Solid waste management (SWM) - Solid waste management encompasses collection, transportation and disposal of solid wastes.

Waste minimization- Refers to any source or recycling activity undertaken by those who generate the waste.

CHAPTER TWO

LITERATURE REVIEW

2.1 Overview on solid waste management

According to the UN estimates 2025, the world population will be 8 billion inhabitants, and around 2050, the total population will be around 9.5 billion, 50% more than the current one. 97% of this growth will be realized in Asia and Africa. The rising middle class in emerging countries will shape both the economic and the political landscape. Today, the total amount of waste generated annually worldwide (municipal, industrial, hazardous) is more than 4 billion tons (Veolia, 2009). Almost 45% of it is considered as municipal solid waste, while the rest is industrial waste, including hazardous one. It has been estimated By UN that globally, urban food waste is going to increase by 44% from 2005 to 2025. As a global measure of the expected impacts, if present waste management trends are maintained, land filled food waste is predicted to increase the landfill share of global anthropogenic emissions from 8 to 10% (Adhikari and Barrington, 2006).

In developing countries, millions of people are working in informal recycling activities making their living in difficult and risky conditions. On the other hand, their activities contribute to global recycling rates and create employment opportunities for marginalized populations. Recycling is one of the most important sectors in terms of employment creation and currently employs 12 million people in just three countries - Brazil, China and the United States. Overall, including the informal sector, the number of people working in recycling is estimated to be more than 20 millions (Medina, 2008). Waste management industry is one of the most dynamic ones on a global scale. With an annual turnover above 430 billion \$ and around 40 million workers (including informal recyclers), the industry covers a huge variety of operations for different waste streams and different phases of the waste life-cycle. It is considered that the industry will further grow, especially in developing countries, and recycling business will be the cornerstone of it. Based on different ways of assessment, it was estimated that the global population without access to Elementary Waste Management is more than 3.5 billion or more than 52% of the 2008 Earth's population (D-Waste, 2012). Per capita waste generation increases with both the development level and the income level of the country (Wilson *et al*; 2012).

2.2 Types and sources of solid wastes

Badran and Hagggar (2006) define municipal solid waste as a general term which encompasses all waste materials except hazardous waste, liquid waste and atmospheric emissions. Solid waste can be further subdivided into two general categories: residential and

commercial. The residential category refers to the waste that is designated as 'garbage'. The garbage class can be described as the waste that is gathered by the community services. The commercial category contains industrial and agricultural customers.

Phuc (2010) observed in the study that sought to characterize the amount and composition of solid waste in Vietnam that total wastes, food wastes and plastic wastes were the major types of wastes generated. This waste generation had a significant seasonal variation. Nagabooshnam (2011) also observed in a study on solid waste generation and composition in Gaborone, Botswana, noted that close to 50,000 tonnes of the annual amount of solid waste to landfill were paper, garden and wood waste, textile, food, metals, glass, electronic waste, plastics and fines.

Nabegu (2010), Nagabooshnam (2011) and Okot-Okumu (2012) noted that household wastes are often generated from several sources where variable human activities are encountered. They argued that most solid waste from developing countries are generated from households (55–80%), followed by commercial or market areas (10–30%) with varying quantities from streets, industries, institutions among others. Waste from these sources are highly heterogeneous in nature (Valkenburg *et al.*, 2008) and have variable physical characteristics depending on their sources; notably in their composition are food waste, yard waste, wood, plastics, papers, metals, leather, rubbers, inert materials, batteries, paint containers, textiles, construction and demolishing materials and many others which would be difficult to classify.

2.3 Segregation and disposal of solid waste

Segregation and sorting usually occurs under very unsafe and hazardous conditions and the effectiveness of segregation is relatively low as unorganized sector segregates only important discarded materials from waste stream which can guarantee them comparatively higher economic return in the recycling market (Kaushal *et al.*; 2012). Lack of segregation deprive proper scientific disposal of waste (Singhal and Pandey, 2000).

Gurtong (2015) conducted an assessment in Bor County following a request made by the Makuach Payam Land Authority and noted that the disposal of solid waste may create problems to the growth of population and development of Bor. The disposal of waste in open pits was found to have become a routine in places of Makuach Payam in Bor County. Hazardous semi-solid or solid matters, created by human or animal activities were not well disposed. Most of the solid wastes, like paper, plastic containers, bottles, cans, and even used iron sheet and electronic goods are non-biodegradable, which means they do not get broken down through inorganic or organic processes. Decaying wastes attract household pests and

result in urban areas becoming unhealthy, dirty, and unpleasant to reside in. Study by Gabriel (2015) noted that most households in major towns of South Sudan are not served by any waste collection and disposal service provider and therefore are forced to initiate their own way of managing their solid wastes.

Juca (2013) observed the following forms of treatment of municipal solid waste are implemented in Brazil: landfill, sorting and recycling; composting, anaerobic digesters waste to energy (WTE) plants-or waste-energy (REN), incineration with energy recovery, which will be chosen according to the type of waste, amount of waste processed and applications. Garang (2013) concluded that in South Sudan, just like most parts of the world, radio is deemed as the fastest, affordable and the best means of disseminating information to the dispersed heterogeneous population because it is flexible and it can cover a wide range of area.

2.4 Knowledge and perception on solid waste management

Waste management education is a critical and necessary element in the management of waste. Lack of knowledge brings about poor waste management practices. This was evident in Jurczark' (1997) study who observed that generally, generation of total municipal solid waste had significantly increased in Poland due to poor management of waste which in turn was attributed to lack of knowledge. According to Jurczark (1997) lack of knowledge by the tenants resulted into irresponsible management of waste. Young and middle aged persons are not only receptive to adoption of new technology but due to their level of knowledge are likely to have a more positive attitude towards modern waste management practices (Smith, 2014). More educated persons are likely to make better decisions towards the various types and sources of solid waste produced due to their high knowledge and their attitudes toward solid wastes as compared to their less educated counterparts (Clein, 1999).

Ndum (2013) noted that in most municipalities in Western African Countries, 65% had no information on solid waste disposal. The relevant Councils took very little effort to provide households information concerning waste management. The environmental pollution that is associated with indiscriminate waste disposal has serious negative impacts on public health and safety (Mamady and Mafoul, 2014; Mamady and Hu, 2011). Mamady (2016) noted that most residents in Guinea are not aware that improper waste disposal leads to diseases such as cholera, typhoid, diarrhoea and respiratory infections. Abdel-Naser and Abdel (2011) observed that solid waste recycling is a problem of major relevance for all societies; however, finding strategies to cope with problem is becoming a hard work, owing to the increasing awareness of environmental problems by population and authorities.

2.5 Practices on solid waste management in the World

Waste management in the developing and developed countries varies. For example, in Asia, a developing continent, most countries face severe problems in managing urban solid wastes. It is estimated that Asia generates 0.5 million tonnes of wastes per day and cities and towns in Sri-Lanka generate almost 3000 tons/day, with an annual increase of 5%. Dumping of wastes on authorized as well as unauthorized sites is the common practice causing health problems to humans and misbalancing the ecosystems. European countries, North America and other developed countries have techniques for reducing the quantities of domestic waste and eventual disposal in landfills (AESSL, 2001).

Municipal managers [in the developed countries] are looking to the development of sanitary landfills around the periphery of their cities as a first solution. Landfills however, require the acquisition of large areas as well as good day-to-day operation in order to minimize potential negative environmental impacts. The other option is mass burn incineration similar to systems found in OECD countries (Rand, et al, 2000). In the developing world poor management, outdated collection and transport methods, scavenging and a shortage of proper disposal sites, complicates waste management services. The uncollected waste then creates problems at the community level- clogging drains, releasing foul odours and toxic gases, and spreading diseases (Sersgeldin, et al, 1994).

A study conducted in Ghana shows high rate of urbanization in African countries indicates a rapid accumulation of solid waste. Social and economic development that most African countries have witnessed since the 1960s have also contributed to an increase in the waste generated per capita (Owusu et al; 2012; Ahmed and Ali, 2011). Yamba (2004) observed that in Zambia, there was no separation of the various types of solid waste, the waste components are just mixed and dumped in areas that are not designated for waste disposal. Monyoncho (2012) argues that the best way of managing solid wastes is the internalization of costs (by levying charges for the use of the services). This is especially beneficial when a command and control policy is not effective. Government intervention is necessary for this. The major problem for solid waste management is the internalization of costs of waste disposal.

According to Lusaka City Council (2004) solid waste management is the responsibility of Lusaka City Council (LCC) waste management unit. The waste management unit (WMU) has partnered with Community Based Enterprises (CBES) and were responsible for the day to day management of the waste system in peri-urban areas. Monyoncho (2012) noted that lack of sufficient funds to finance awareness campaigns to encourage waste

minimization at source along with minimal workforce impede municipalities' efforts to achieve their vision. Moreover, the study done In Khulna, Bangladesh by Norley (2009) that local governments are responsible for the collection and disposal of the wastes generated within their jurisdiction, as well as for the operation and maintenance of their equipment. However, local governments usually lack the authority and resources to provide a satisfactory and economically viable service. Effective and efficient solid waste management depends upon an equitable distribution of responsibilities, authority, and revenue between the national government and all the local governments.

2.6 Factors influencing solid waste management in developing countries

There are many factors that influence solid waste management and that must be considered in the design of a solid waste management system (Zurbrugg, 2000). These include waste quantity and composition, access to waste for collection, awareness and attitudes, institution and legislation:

2.6.1 Waste quantity and composition

Domestic waste from industrialized countries has a high content of packaging made of paper, plastic, glass and metal, and so the waste has a low density. In many developing countries wastes contain large amounts of inert such as sand, ash, dust, and stones and high moisture levels because of high usage of fresh fruit and vegetables. These factors make the waste very dense (high weight per unit volume). The consequences of this high density are that vehicles and systems that operate well with low-density wastes in industrialized countries are not suitable or reliable when the wastes are heavy. The combination of extra weight, the abrasiveness of the sand and the corrosiveness caused by the water content, can use very rapid deterioration of equipment (Zhu, *et al*, 2007). If the waste contains a high proportion of moisture, or is mostly inert material, it is not suitable for incineration, and so the treatment upon is ruled out. Recycling or salvaging operations often reduce the proportion of combustible paper and plastic in waste before it reaches the treatment stage.

2.6.2 Access to waste for collection

Many sources of waste might only be reached by roads or alleys, which might be inaccessible to certain methods of transport because of their width, slope, congestion or surface. This is especially critical in unplanned settlements such as slums or low-income areas and thus largely affects the selection equipment (Benneh, *et al*, 1993).

2.6.3 Awareness and attitudes

Public awareness and attitudes to waste can affect the whole solid waste management system. All steps in solid waste management services, the opposition to the sitting of waste

treatment and disposal facilities, all depends on public awareness and participation. Thus this is also a crucial issue, which determines the success or failure of a solid waste management system, (Nabegu, 2009).

2.6.4 Institution and legislation

Institution issues include the current and intended legislation and the extent to which it is enforced. Standards and restrictions may limit the technology options that can be considered. The policy of governments regarding the role of the private sector (formal and informal) should also be taken into account. The strength and concerns of trade unions can also have an important influence on what can be done.

2.7 Challenges of solid waste management in developing countries

Problem areas of Municipal Solid waste management (MSWM) in developing countries can be described as inadequate service coverage, operational inefficiencies of services, inadequate management of hazardous and health waste and environmental issues. The quantity of waste arising – solid, liquid and gaseous are generally considered to be growing across the globe as a result of increase in the world's population, increasing industrialization, increasing urbanization and rising standards of living (UNEP, 1994).

Moreover, major advances in the development of new materials and chemicals have increased the diversity and complexity of the waste streams. Consequently, wastes are taking on a new economic importance, not only in terms of revenues generated by the waste treatment and disposal industry, but also because wastes may have a residual value as a secondary raw material which can be recovered or reused. However, The study carried out in Kampala, Uganda by the Namilyango College (2001) identified several challenges related solid waste management which included lack of dumpsite, ignorance of the community about the need for proper waste disposal, lack of legislation, Lack of finance, lack of awareness among the public, lack of political support and lack of trained personnel for waste management.

Moreover, the study done in Ghana by Peter (2002) which states that problems are encountered at all levels of waste management, particularly, collection, transportation and disposal. Generally, existing public facilities, including sanitary facilities, are inadequate to serve the user population, and the sheer volume of municipal solid waste generated in the country's urban centres is overwhelming. While existing waste disposal facilities are inadequate to deal with the quality and quantity of waste generated, more sophisticated systems are expensive and their maintenance requirements are high. So the factors affecting solid waste management in developing countries are briefly explained below.

2.7.1 Inadequate service coverage

Solid waste collection schemes of cities in the developing countries generally serve only a limited part of the urban population. The majority of the people, especially in slum areas remain without waste collection services. These are usually the low-income earners living in poor conditions in semi-urban areas. One of the main causes of inadequate collection services is the lack of financial resources to cope with the increasing amount of generated waste produced (Zurbrugg, 2000).

2.7.2 Operational inefficiencies of services

Operational inefficiencies are due to inefficient institutional structures, inefficient organizational procedures, or deficient management capacity of the institutions involved as well as the use of inappropriate technologies (Nze, 1978). With regard to the technical system, often the “conventional” collection approach, as developed and used in the industrialized countries, is applied in developing countries. The used vehicles are sophisticated, expensive and difficult to operate and maintain, thereby often inadequate for the conditions in developing countries. After a short time of operation usually only a small part of the vehicle fleet remains in operation. Transport also relies on operational vehicles, and frequent breakdowns coupled with parts shortages can immobilize collection vehicles for extended periods of time. For example, UNEP (1996) estimated that in cities in West Africa, up to 70% of collection/transfer vehicles may be out of action at any one time.

2.7.3. Inadequate management of hazardous wastes

Healthcare wastes are generated as a result of activities related to the practice of medicine and sales of pharmaceuticals (Zurbrugg, 2003). Some of the health-care wastes coming from any particular hospital or institution are similar in nature to domestic solid wastes, and may be called “general health-care wastes”. The remaining wastes pose serious health hazards because of their physical, chemical or biological nature, and so are known as “hazardous healthcare wastes”.

In many cases the most dangerous items in health care wastes are needles from syringes and drips, because the needles shield the virus from chemical disinfectants and a harsh external environment, and the sharp point allows easy access for the viruses into the blood stream of anyone who is pricked by the needle (WHO, 2004). The key to improving health care waste management is to provide better methods of storage and to train the staff to adopt safer working practices and segregate as hazardous healthcare wastes from the general health care wastes. Some waste materials need special treatment because their properties make them more hazardous chemicals not only a matter of technology and legislation, but

also of enforcement, funding and financial instruments (WHO, 2004). Changing processes to use less hazardous substitutes and minimizing hazardous waste quantities that are discarded can be seen as preferred options in dealing with any difficult waste.

2.7.4. Inadequate management of human health risks issues

There are some human health risks associated with solid waste handling and disposal in all countries to some degree, but certain problems are more acute and widespread in underdeveloped nations. Cointreau (1982) has classified these into four main categories: presence of human fecal matter, presence of potentially hazardous industrial waste, the decomposition of solids into constituent chemicals which contaminate air and water systems, and the air pollution caused by consistently burning dumps and methane release. Human fecal matter is present in every solid waste system, in developing nations the problem varies with the prevalence of adequate sanitary disposal systems such as municipal sewerage or on-site septic systems, and outhouses. In areas where such facilities are lacking (especially shantytowns and over-crowded municipal towns), the amount of human fecal matter present in the solid waste stream is likely to be higher.

This presents a potential health problem not only to waste workers, but also to scavengers, other users of the same municipal drop-off point, and even small children who like to play in or around waste containers. Waste pickers are highly susceptible to disease, and it has been proposed to provide low-cost or free protective gear, such as gloves, boots, and clothing, to prevent contact injuries and reduce pathogens. Experience in Calcutta, India however has shown that most gear is simply sold by the workers for cash, and they continued to work as before (UNEP 1996). Provision of basic health care, especially immunizations, seems to be a more promising.

2.7.5 Environmental and health issues in developing countries

The decomposition of waste into constituent chemicals is a common source of local environmental pollution. This problem is especially acute in developing nations where existing landfills don't meet acceptable environmental standards, due to limited budgets, (UNEP, 1994). The problem is again compounded by the issues associated with rapid urbanization. As land becomes scarce, human settlements encroach upon landfill space, and local governments in some cases encourage new development directly on top of operating or recently closed landfills. A major environmental concern is gas released by decomposing garbage. Methane is a by-product of the anaerobic respiration of bacteria, and these bacteria thrive in landfills with high amounts of moisture. Methane concentrations can reach up to

50% of the composition of landfill gas at maximum anaerobic decomposition (Cointreau and Levine, 1996).

The increasing consumption of resources results in huge amounts of solid wastes from industrial and domestic activities, which pose significant threats to human health Frosch (1996). However, the ills of inappropriately disposed municipal solid wastes are quite numerous to be mentioned. Health deterioration, accidents, flood occurrences, and environmental pressures are some of the negative effects of ineffective solid waste management. For example, a devastating landslide swept through the Koshe Garbage Landfill located on the outskirts of the capital city Addis Ababa, burying a number of makeshift homes under tons of refuse, claiming scores of lives and leaving many others injured. It was reported by emergency workers at landfill that the death toll had reached 113 and was expected to climb. As many as 150 people are believed to have been at the site at the time of the landslide (Haywood, 2017).

2.8 Strategies and options for sound waste management

Given the large number of individual issues and specific problems in various municipal solid waste management systems, it would seem tempting to address individual issues as they arise and apply local fixes, so as to keep collection and disposal services operating continuously as efficiently as possible. Indeed, in the short term, this is likely to be a good approach. In considering the long term, however, it is apparent from the scope of the problems and the external factors brought to bear upon municipalities that a broader, more integrated set of solutions will be necessary in order to adequately address MSW systems in the future. UNEP, (1996) calls these sound practices. With that in mind, sound practice is a technology or policy that embodies a reasonable balance of feasible, cost-effective, sustainable, environmentally beneficial, and socially sensitive solutions to SWM problems.

In other words, sound practices function together to achieve defined solid waste policy goals, while appropriately responding to the entire set of conditions that constrain the choices available in specific MSWM decisions (UNEP, 1996). This means, that a sound practice not only achieves specific goal in MSWM, but, to the extent possible, it takes into account the demands of the specific situation where a proposed solution is to be implemented. In the end, determining what constitutes sound practice is context-specific. The varieties of factors that help determine what sound in a situation is sufficiently large that any recommendation must be tested against the reality of a particular circumstance. Therefore, rather than striving for avoidance of pollution or risk to human beings, policy makers should direct resources where they would yield the greatest return to society. For example, while

MSWM decision makers may strive to capture the recyclable components in the waste stream and to minimize the environmental damage done by the handling and final disposition of waste, sound practice will require that resources be allocated in a way that seeks the balanced achievement of all of society's goals.

2.8.1 Solid Waste Reduction

It would seem that the easiest and most effective way to manage solid waste is to reduce the amount of waste to be disposed. This is a strategy that seems simple in concept but has shown promise. However the amount of waste produced, even in developed countries, is often a function of culture and affluence. For example the developed countries have developed, a “throw away culture”, since consumer goods are cheap has resulted in an increase in packaging (more items are individually packaged), resulting in significant increases in MSW as production becomes cheaper. An emphasis on mass production and the development of cheap consumer goods has caused quality and longevity of goods to be sacrificed in the name of lowest market price, causing people to be more likely to simply throw away and replace items instead of repairing or maintaining them (Zerbock,2003).

2.8.2 Integrated approach to waste management

An integrated approach to waste management will have to take into account community-and regional-specific issues and needs and formulate an integrated and appropriate set of solutions unique to each context (Schübeler 1996, UNEP 1996, de Klundert et al 2001, Senkoro 2003). As with any issue in developing nations, solutions which work for some countries or areas will be inappropriate for others. Specific environmental conditions will dictate the appropriateness of various technologies, and the level of industrialization and technical knowledge present in various countries and cities will constrain solutions. Studies on MSW issues however repeatedly discuss certain approaches as being at least adaptable to many developing nation scenarios.

United States Environmental Protection Agency (EPA, 2002), notes that sound environmental management is achieved when the 3Rs approaches are implemented according to the order, first source reduction, second recycling and third reusing the wastes. These approaches emphasize waste reduction (creation of less waste and increased material recovery) and appropriate disposal options as part of an integrated evaluation of needs and conditions. UNEP (1996) laid out a series of questions to be asked when evaluating technologies and policies in the context of an integrated MSW system.

2.8.3 Recycling of solid waste

As noted, one of the approaches to waste management is by separating or sorting waste generated and eventually using it for other form of production. Separating waste materials at the household level occurs to some extent almost universally, and prevents the most valuable and reusable materials from being discarded. Following in-home retention of valuable material, waste-pickers currently remove most valuable materials either before garbage enters the waste stream or en route, especially in the lower and middle-income areas of many municipalities. In these instances, there is little need for additional encouragement of recycling. Even in the more affluent areas of developing cities, often there are found itinerant “buyers” of waste materials such as cardboard and glass.

These buyers could help to divert many materials out of the waste stream. Since recycling materials is a financially viable undertaking, small enterprises have and will continue to spring up whenever there is an opportunity. In fact the theft of source-separated recyclable materials has been documented in many pilot schemes in both developed and developing nations (UNEP, 1996). Municipalities should not only recognize the trade in recyclables, they should embrace it. By allowing small enterprise to address the problem, valuable funds are saved jobs are created, and landfill space is saved. Perhaps through micro-loans or some small-scale assistance, local governments could support and legitimize these entrepreneurs. Recycling inorganic materials from municipal solid waste is often well developed by the activities of the informal sector although such activities are seldom recognized, supported, or promoted by the municipal authorities. Some key factors that affect the potential for resource recovery are the cost of the separated material, its purity, its quantity and its location.

The costs of storage and transport are major factors that decide the economic potential for resource recovery. In many low-income countries, the fraction of material that is won for resource recovery is very high, because this work is done in a very labor-intensive way, and for very low incomes. Recycling has the advantage of: reducing costs of the disposal facilities, prolonging the site span, and also reducing the environmental impact of disposal sites as the organics are largely to blame for the polluting leaches and methane problems (UNEP, 1996).

2.8.4 Dumping of Solid Waste

The dumping of solid waste in landfill is the probably the oldest and definitely the most prevalent form of ultimate solid waste disposal. Many “landfills” are nothing more than open, sometimes controlled, dumps. The difference between landfills and dumps is the level

of engineering, planning, and administration involved (Johannessen, 1999). Open dumps are characterized by the lack of engineering measures, no leachate management, no consideration of landfill gas management, and few, if any, operational measures such as registration of users, control of the number of “tipping fronts” or compaction of waste. In an examination of landfills throughout the developing world in 1997-1998, Johannessen (1999) found varying amounts of planning and engineering in MSW dumping; among the various regions visited, African nations (with the exception of South Africa) had the fewest engineered landfills, with most nations practicing open dumping for waste disposal.

2.8.5 Incineration of Solid Waste

Another option for waste management is incineration. Incineration should not be considered a disposal option, since following incineration there is still some quantity of ash to be disposed of (probably in a landfill), as well as the dispersal of some ash and constituent chemicals into the atmosphere. It should instead be considered more in terms of its waste-reduction potential, which can be 80-95% in terms of waste volume (Rand, *et al*, 2000). This appears to be an extremely attractive option, however, with occasional exceptions; incineration is an inappropriate technology for most low-income countries like South Sudan. Above all, the high financial start-up and operational capital required to implement incineration facilities is a major barrier to successful adoption in developing countries (Rand, *et al*, 2000; UNEP, 1996).

Reduction by incineration, along with sanitary disposal of the residue, would therefore be a useful alternative to traditional disposal methods, and have proven useful in Island nations such as Bermuda and the British Virgin Islands (Lettsome, 1998). Negative environmental consequences of incineration mostly revolve around airborne emissions. Certainly, incinerators should not be located where prevailing wind patterns would carry emissions over densely settled areas. The use of emissions reduction technology, although expensive, should be mandatory in any new construction. Incineration volatilizes many compounds potentially harmful to human health: metals (especially lead and mercury), organics (dioxins), acid gases (sulfur dioxide and hydrogen chloride), nitrogen oxides, as well as carbon monoxide and dust (UNEP, 1996).

2.9 International/Regional policies for solid waste management

Agenda 21 is a comprehensive blue print for global actions for sustainable development into the 21st century. South Sudan being a member of the United Nations is party and accountable to Agenda 21. It commits governments, United Nations organizations, development agencies, nongovernmental organizations and independent sector groups to

implement programs and actions which would halt and reverse the negative impact of human behaviour on the physical environment and promote environmentally sustainable economic development in all countries. In the context of waste management, Agenda 21 presents Section 21 on environmentally sound management of solid waste, particularly highlighting program areas and associated strategies to be implemented by all countries to ensure proper waste management (Agenda 21, 1994). How this frame work has been implemented is a question of debate.

In Kenya, the Environmental Management and Coordination Act (EMCA, 1999) as well as National Environmental Management Authority (NEMA) regulations on waste management mandate the respective local authorities to ensure a clean and healthy environment by properly managing wastes within their areas of jurisdiction. In South Sudan, there are no existing documented legal frameworks on solid waste management.

2.10 Conceptual Framework

The conceptual framework illustrates the relationship between the dependent variables like waste handling practices (open dumping, reuse or recycle and composting) and the independent variables like knowledge, attitudes, policies, types and sources of solid wastes and socio economic status (education and income level) of solid waste handling practices.

From the illustration in Figure 1, it can be observed that the independent variable like high level of knowledge will contribute to proper solid waste management practices. The higher the level of knowledge on solid waste management the greater the population or individual tends towards sustainable waste management. Conversely, lack of knowledge brings about poor solid waste management practices. Policies and positive attitudes of the community towards solid waste management are likely to reduce the health hazards of the solid wastes. The socio economic status (income and education level) of the respondents influence solid waste management as high-income individuals may easily meet the cost for proper waste management. On the contrary, low-income individuals may not be able to meet the cost for proper waste management.

Furthermore, the intervening variables like lack of proper budgetary allocation by the government may lead to improper disposal of solid waste as the government may not be ensuring the proper hygiene of the public. Long distances from the collection centres may interfere with the proper solid waste handling practices in the state as the households may not afford to take their solid waste to the designated disposal resulting to random disposing of solid waste around the households. However, it is presumed that strengthening the legal and

institutional Frameworks, capacity building and proper solid waste management strategies will yield several outputs like proper solid waste disposal, improved health standards and save the environment from pollutions.

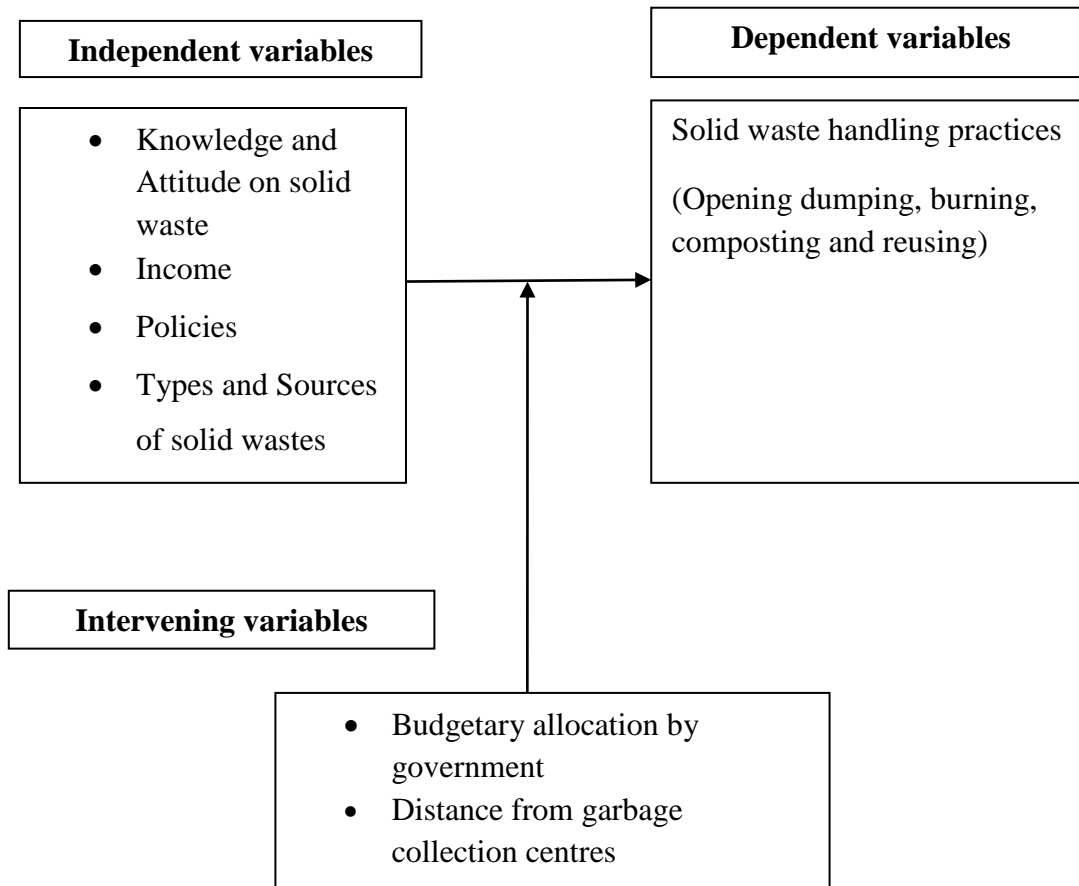


Figure 1. Conceptual framework

CHAPTER THREE METHODOLOGY

3.1 The study area

3.1.1 Physical location

The study was carried out in Bor, the capital of Jonglei State, which is in the central South Sudan, approximately 190 km north of Juba (capital of South Sudan) by road and the largest city in the country. It borders Eastern Equatoria State to the South- East, Central Equatoria to the South, Lake State to the West, Upper Nile state to the North and Pibor County to the East. Bor town lies between latitude N 6°33' and longitude E 31°33' respectively. It covers an area of 25sq km and has eight (8) Bomas (locations), namely, Akoybany, Panapet, Pakwaw, Leekyak, Nigel, Leudier, Malou and Langbar Boma. The town is located along the east bank of White Nile (figure 2).

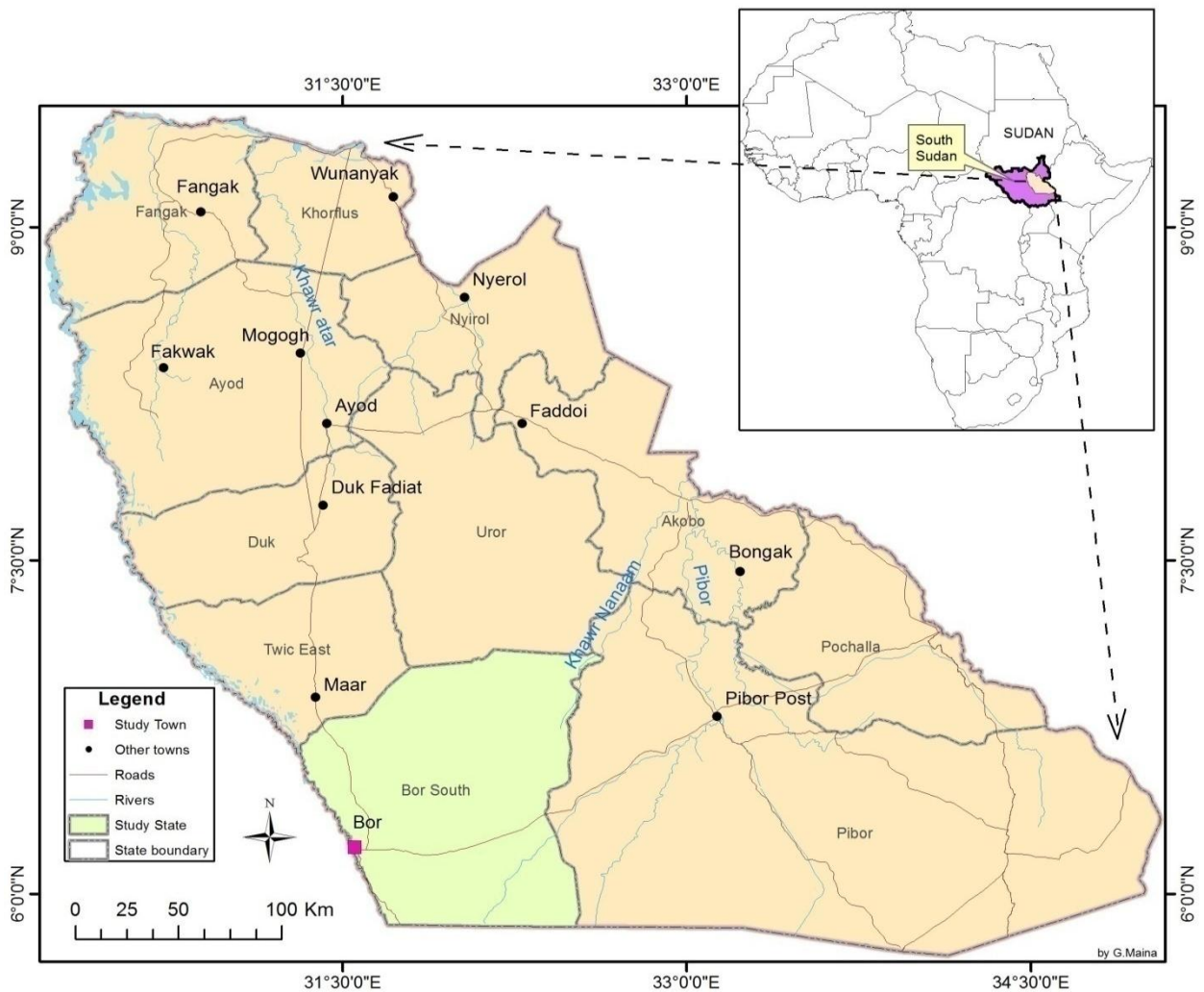


Figure 2. Map of the study area

Source: Maina (2015)

3.1.2 Climate

Bor town has two seasons. These are dry and wet seasons, dry season starts from November to April and wet season starts from May to October.

3.1.3 Population and economic activities

According to the Central Bureau of Statistics in Sudan (2008), the total population of Sudan was 39,154,490 with Southern Sudan population estimated at 8,260,490 of the total population (CBS, 2008). The population of Jonglei State was 1,358,602 of the total population of Southern Sudan with Bor population estimated at 221,106 (CBS, 2008).

Bor town is inhabited by six Nilotic Ethnic groups, namely, Nuer, Dinka, Murle, Anyuak, Kachipo and Jieh. According to United Nations Mission in Sudan (2010), Bor town has an estimated population of 221,000 people (UNMIS, 2010). The socio-economic activities of people of Bor are mainly agro-pastoralists and fishing activities along the River Nile. The main livelihood activities in the town include farming, cattle keeping, fishing, hunting and trading.

3.2 Research design

The descriptive research design was used in the study. A descriptive research presents facts about the nature and the status of the situation at one point in time of the study and describes the present conditions based on reactions of the respondents of the research. The research was socio-economic survey which embarked on social and economic status of the respondents. The research used both qualitative and quantitative types of data. Qualitative data was that data that use non-numerical data such as interviews and observations in the sampled areas while quantitative data was that data that was presented in numerical values and from which statistical inferences were made.

3.3 Sample size and sampling procedure

3.3.1 Sample size

The sample unit that the study used were households. Household respondents formed the target population and a total of 384 respondents were administered questionnaires that was obtained using Anderson *et al*, (2007) theorem at 95% confidence level; hence the sample size was determined as follows:

$$n = Z^2pq/e^2$$

Where,

n = required sample size

Z = the standard normal deviate at the required confidence level. In this research Z = 1.96 at 95% confidence level

P = Population proportion estimated with the desired characteristic being measured. In this research $p = 0.5$

$q = 1 - p$

e = Acceptable error precision, $e = 0.05$

Therefore, Sample size $(n) = 1.96^2 \times 0.5 \times 0.5 / 0.05^2 = 384$.

3.3.2 Sampling procedure

The study was conducted in Bor town. Total of three hundred and eighty four (384) households were selected at random to participate in questionnaire survey in the study area. A sample was proportionately chosen base on the population of each sub-location, one hundred and fifty households were randomly selected from Bor Municipal Council to participate in administration of the questionnaire survey, one hundred and thirty four households from Akoybany boma and one hundred households from Malou Boma respectively. The study used purposive sampling to select key informants from Bor Municipal Council (5), Department of Environmental Science at Dr. John Garang Memorial University of Science and Technology (10) and Ministry of Health (5).

3.4 Data collection

The study used three methods of data collection (Questionnaires, Interview guide and Observation checklist) in order to obtain required data concerning the research. Close and open- ended questionnaires (Appendix I) were used to collect data on the socio-economic characteristic of the respondents, types and sources of solid wastes generated, perception and practices of the community toward solid waste management, solid waste disposal methods, factors and challenges related to solid waste management and existing policies on solid waste management to household heads.

Interview guides (Appendix II) were used in three sites (Bor Municipal Council, Department of Environmental Science at Dr. John Garang University and Ministry of Health) to collect data on the types solid wastes generated, knowledge levels, perception and practices of the community toward solid waste management, disposal methods, factors and challenges and existing policies on solid waste management in order to give an in-depth information on those areas of solid waste management.

Observations (Appendix III) were also made on the types of solid waste generated and solid waste management practices observed along the streets and homesteads.

3.5 Validity and Reliability

3.5.1 Validity

Validity of the questionnaire was done to test for clarity, relevance of the questions to the study area and whether the questions stood for the purpose intended. In this case, all research objectives were covered by cross-checking the corresponding items. Validity was established by expert judgment (Gay, 1987); where the instruments were reviewed by the study supervisors in the Department of Environmental Science within the Faculty of Environment and Natural Resource Development of Egerton University. Validation of instruments was carried out to improve their effectiveness for collecting relevant data.

3.5.2 Reliability

A pilot study was conducted in Juba town in Central Equatoria, which was not part of the study area; although it had similar characteristics as the study area. The residents of Juba town were faced with similar situation on waste management as those in Bor town. The researcher then analyzed the items and responses that were given and accordingly improved the scope and comprehensiveness of the instruments.

The pilot study was carried out on 20 households with similar attributes as those of the one already studied. The completed questionnaires were collected, then data coded and analyzed. This helped to identify problems that subjects encountered when responding to question items, and to identify items that had ambiguities. The objective behind this pilot study was to assess the clarity of the instruments' items so that those items found to be inadequate for measuring the variables were either discarded or modified. Piloting of instruments was also done to gain familiarity with the coding and statistical methods to be used in analyzing data.

Reliability of the instruments was determined by computation of Cronbach's Coefficient Alpha. Cronbach's Coefficient Alpha was used to examine such a relationship and an index of at least 0.70 was taken to mean instruments were reliable (Frankel and Wallen, 2003). The Cronbach's alpha formula was suitable because it assesses reliability for both multiple choice and essay questions (Gall *et al*; 1996). The questionnaires were found to have 0.96 reliability index and thus considered appropriate for data collection. This indicates that they were clearly understood. Scales in the instruments in which Cronbach's Coefficient Alpha were less than 0.70 in the pilot study had some of their items either modified or discarded to increase the reliability of the scale. Having revised the instruments basing on the

comments from the educational experts and the reliability results, the question items were appropriately administered to the selected sample.

4.6 Data Analysis

Data was collected, edited, coded, cleaned, organized and analyzed using Statistical Package for Social Sciences (SPSS). The analysis of the data employed descriptive statistics (means, percentages, measures of central tendency and frequencies) and Pearson correlation to achieve the required results.

Table 1: Summary of Data Analysis

Research Questions	Variables	Analysis Methods
1. What are the types and sources of solid waste produced?	Types of solid wastes (plastic, paper, food waste, metal), sources of solid wastes	Descriptive statistics (means, percentages, frequency distribution)
2. What are the knowledge levels and attitudes of the community toward solid waste?	Knowledge Attitude	Descriptive statistics (percentages, frequency distribution)
3. How is solid waste handled?	Dustbin, open dumping, rubbish pit, reuse or recycle	Descriptive statistics (means, percentages, frequency distribution)
4. What are the solid waste disposal practices?	Open dumping, burning, incineration, landfills	Descriptive statistics
5. What are the factors and challenges related to solid waste management?	Income, education level, age, awareness, sex, long distance, funds	Descriptive statistics Correlations
6. What are the existing policy frameworks for solid waste management?	Policies on SWM	Descriptive statistic

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents the results, interpretation and discussion of the findings of the study. The results are presented qualitatively and quantitatively. Questionnaires of three hundred and eighty four (384) were administered to household heads but only three hundred and eighty (380) were analysed, so four (4) questionnaires were spoiled during the survey. The responses from the respondents were analyzed using descriptive statistic and Pearson correlation.

4.2 Socio-economic characteristics of the respondents

The subjects for the study comprised of household heads in the study area. The study gathered information on the respondents' personal attributes. These attributes encompassed the age, sex and level of education, household size, household income and how respondents manage their wastes.

4.2.1 Sex of the respondent

On the issue of gender, the results of the study showed that majority of the respondents were female. About 75.8% of the respondents were female while 24.2% were male.

4.2.2 Respondents' age

Majority (24.0%) of the respondents were aged 34 - 41 years. This was closely followed by respondents in the age bracket of 26-33 years and 42-49 years who comprised a proportion of 22.1%, each. About 11.8% and 11.6% of the total respondents were aged 58 - 65 and 50-57 years, respectively. There were very few respondents aged between 18-25 years as represented by 8.4% of the total respondents as in Table 2 below.

Table 2: Respondents' age brackets

Age brackets	Frequency	Percent
18-25 years	32	8.4
26-33 years	84	22.1
34-41 years	91	24.0
42-49 years	84	22.1
50-57 years	44	11.6
58-65 years	45	11.8
Total	380	100.0

Note. Mean Age = 40.85, Std. Deviation = 14.97.

Source: Field Data (2016)

The mean age of the respondents was 40.85 with a standard deviation of 14.97 years. All the respondents (100.0%) in this study were aged not more than 65 years. This implies that all the respondents were either in their youthful or middle age. Age has an influence on the respondents level of knowledge, attitudes and practices (KAP) toward solid waste management. Young and middle aged persons are not only receptive to adoption of new technology but due to their level of knowledge are likely to have a more positive attitude towards modern waste management practices (Smith, 2014).

4.2.3 Level of education of the respondents

Most of the respondents had no formal education as shown in Figure 3.

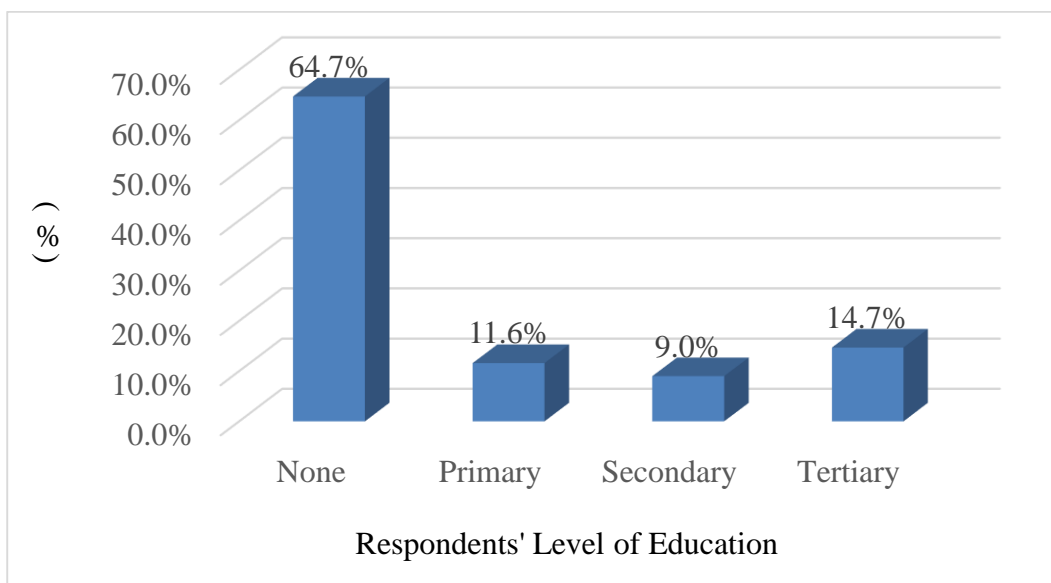


Figure 3. Respondents' Level of Education

Source: Field Data (2016)

Majority (64.7%) of the respondents had not gone to school and thus lacked formal education. About 14.7% of the respondents had tertiary level of education while 11.6% and 9.0% had primary and secondary level of education, respectively. These results imply that majority of the respondents lack adequate formal education which is a prerequisite to better embrace solid waste handling practices. In addition to this, the level of education of the household heads can influence the kind of decision that may be made on behalf of the entire household with regard to handling of solid wastes. More educated persons are likely to make better decisions on handling of various types and sources of solid waste produced due to them being knowledgeable on appropriate solid waste management when compared to less educated population (Clein, 1999).

4.2.4 Household Size

The average number of household members is shown in Table 3.

Table 3: Number of household members

Number of household members	Frequency	Percent
1 – 2 members	33	8.7
3-4 members	105	27.7
5-6 members	136	35.7
7-8 members	99	26.1
More than 8 members	7	1.8
Total	380	100

Minimum = 1, Maximum = 9, Mean = 5.14, Standard Deviation = 1.85

Source: Field data (2016)

Majority of the households in the study area had 5 - 6 family size as represented by 35.7% of the respondents. About 27.7% of the households had 3 – 4 members while 26.1% had 7 – 8 members. About 8.7% of the households had 1-2 members. It was just 1.8% of the households who had more than 8 members. The mean household size in the study area was 5.14 with a standard deviation of 2.0.

4.2.5 Monthly income in South Sudanese Pounds (SSP)

The study area had households whose income per month varied as shown in Table 4.

Table 4: Household Income

Household Income	Frequency	Percent
Less than 1,000.00	234	61.6
1,000.00 – 4,999.00	127	33.4
5,000.00 – 9,999.00	11	2.9
10,000.00 – 14,999.00	6	1.6
15,000.00 – 19,999.00	1	.3
20,000.00 and above	1	.3
Total	380	100.0

Minimum = 200.00, Maximum = 27,000.00, Mean = 1561.10, Standard Deviation = 2295.71
1\$= 6 SSP, Per Capita Income = SSP260.18 or \$43.36

Source: Field data (2016)

It can be observed that majority of the respondents had monthly income Less than 1,000 as represented by 61.6% of the total respondents. About 33.4% of the respondents had monthly income ranging between 1,000.00 and 4,999.00. It was only 2.9%, 1.6% and 0.3% of the households that had monthly income of between 5,000.00 – 9,999.00, 10,000.00 – 14,999.00 and 15,000.00 – 19,999.00, respectively. Very few households were in the category of high incomes as represented by just 0.3% of the households who had monthly incomes of 20,000.00 and above. The per capita income stands at SSP 260.18 or \$43.36. This indicates that low per capita incomes in Bor town will results in low volume generation of solid waste which can poses a lesser threat to environmental quality and human health. These results are Consistent with World Bank (2012) that the per capita income is below the global \$ 57.00 per month (\$1.90 per day) as well as the mean per capita income in Sub-Saharan Africa which stands at \$1.70 per day or \$51.00 per month.

4.2 Major types of solid wastes produced

Table 5: Characterization of solid waste from three dumpsites

Solid waste	Residents' dumpsite	Makuach road dumpsite	Anyindi road dumpsite
Plastic	✓	✓	✓
Paper	✓	✓	✓
Organic	✓	✓	
Glass		✓	✓
Metal		✓	
E-waste		✓	
Pharmaceutical waste			✓
Wooden	✓		

Source: Field data (2016)

From the observation in table 5 above showed that the most common types of solid wastes tick from the observation checklist from the three dumpsites were plastic and paper. The other types of solid wastes include organic, glass, metal, e-waste, pharmaceutical waste and wooden waste. The long term exposure of pharmaceutical wastes on human health may results in acute and chronic damages in human' tissues, reproductive systems and inhibition of cell formations. The human health risks that may result from e-wastes include breath difficulties, coughing, respiratory infections, convulsions and death. E-waste workers are exposed to other hazards leading to physical injuries and chronic ailments such as asthma, skin diseases, eye irritations and stomach disease (Raghupathy *et al*; 2010).

Table 6: Types of solid wastes

	Frequency	Percent
Plastic	156	41
Organic	110	29
Paper	57	15
Wooden	24	6.3
Metallic	2	0.5
Others	31	8.2
Total	380	100

Source: Field Data (2016)

The findings of the study from households' respondents showed that the common type of solid waste generated in Bor town was the plastics (41%). This was closely followed by organic wastes, papers, wooden and metallic as represented by 29%, 15%, 6.3%, and 0.5% of the total respondents respectively. Other types of solid wastes accounted about 8.2% of the total wastes generated as shown in Plate 1 below.



Plate1: Types of solid wastes at Anyidi road dumpsite in Bor town on 15/02/2016

Findings from the interviews with the key informants showed that the commonest type of solid waste generated in Bor town was plastic. The other types of solid wastes include organic waste, metallic, wooden, pharmaceutical waste, glass and papers.

These results agrees with Phuc (2010) whom in a study that sought to characterize the amount and composition of solid waste in Vietnam observed that total wastes, food wastes and plastic wastes were the major types of wastes generated. The results also agrees with Nagabooshnam (2011) whom in a study on Solid Waste Generation and Composition in Gaborone, Botswana, noted that close to 50,000 tonnes of the annual amount of solid waste to landfill was paper, garden and wood waste, textile, food, metals, glass, electronic waste, plastics and fines. These waste categories were then classified into four types, i.e. housing, commercial, industrial and others. More than half of the received waste at the landfill originates from households. Waste from the commercial sector accounts for approximately 30% of the generated waste while the remains are mainly a waste of others (e.g. defence waste, Institutional waste). Industrial waste constitutes a minor part of the waste generated in Gaborone.

4.3 Major sources of solid wastes

The findings of the study showed that the major sources of solid waste generated in Bor town are summarized in Table 7.

Table 7: Sources of solid waste generated

Sources	Frequency	Percent
Residential	345	90.8
Commercial	17	4.5
Institutional	6	1.6
Agricultural	8	2.1
Construction	4	1.1
Total	380	100.0

Source: Field Data (2016)

The results indicate that places of residence were the major sources of solid wastes in the study area as illustrated by 90.8% of the respondents. About 4.5% of the respondents indicated commercial places as a major source of solid wastes in the town. Agricultural fields, institutions and construction sites as major sources of solid wastes in the town were represented by 2.1%, 1.6% and 1.1% of the respondents, respectively. The findings of the

study from observations showed that the major types of solid wastes generated from UN Agencies and NGOs include E- wastes, metallic, plastic, papers and wooden wastes.

These results are consistent with Badran and Hagggar (2006) who identified various sources of solid wastes as commercial, industrial, agricultural and residential. Nabegu (2010), Nagabooshnam (2011) and Okot-Okumu (2012) noted that household wastes are often generated from several sources where variable human activities are encountered. They argued that most solid waste from developing countries are generated from households (55–80%), followed by commercial or market areas (10–30%) with varying quantities from streets, industries, institutions among others. Waste from these sources are highly heterogeneous in nature (Valkenburg *et al.*, 2008) and have variable physical characteristics depending on their sources; notably in their composition are food waste, yard waste, wood, plastics, papers, metals, leather, rubbers, inert materials, batteries, paint containers, textiles, construction and demolishing materials.

4.4 Knowledge levels of the community toward solid waste disposal

4.4.1 Knowledge on solid waste disposal, effects and diseases

This study sought to determine the respondents’ knowledge levels towards solid waste disposal methods, effects of poor waste disposal methods and diseases caused by poor waste disposal methods. The results are shown in Table 8 below.

Table 8: Likert scale on solid waste disposal, effects and diseases of poor waste disposal

	Knowledge levels					Total
	No	Very low	Low	Moderate	Advanced	
Methods of solid waste disposal	8.4%	26.1%	48.7%	9.2%	7.6%	100
Effects of poor methods of waste disposal	11.6%	39.7%	29.7%	15%	4%	100
Diseases caused by poor waste disposal	28.4%	20.4%	33.9%	9.7%	7.6%	100

Source: Field data (2016)

The respondents' knowledge levels on solid waste disposal methods were varied. The results in Table 8 shown that majority of the respondents had no knowledge to low knowledge on solid waste disposal methods as represented by 83.2% of the respondents while only 16.8% of the respondents had moderate to advanced knowledge on solid waste disposal methods. This indicates that majority of people in Bor town lack adequate knowledge on solid waste disposal which might lead to poor waste management in the area. This is consistent with Jurczark (1997) study who observed that generally, generation of total municipal solid waste had significantly increased in Poland due to poor management of waste which in turn was attributed to lack of knowledge. These results also agree with Ndum (2013) who noted that in most municipalities in Western African Countries, 65% had no information on solid waste disposal. The relevant Councils took very little effort to provide households information concerning waste management.

Majority of the respondents had no knowledge to low knowledge on effects of poor waste disposal as represented by 81% of the respondents while only 19% of the respondents had moderate to advanced knowledge effects of poor waste disposal. This agrees with the study done in Guinea that the environmental pollution that is associated with indiscriminate waste disposal has serious negative impacts on public health and safety (Mamady and Mafoul, 2014, Mamady and Hu, 2011).

As far as respondents knowledge on diseases caused by poor waste disposal was concerned, this study noted that majority of the respondents had no knowledge to low knowledge as represented by 82.7% of the respondents while only 17.3% had moderate to advanced knowledge on diseases caused by poor solid waste disposal. These are consistent to the study done by Mamady (2016) who noted that most residents in Guinea are not aware that improper waste disposal leads to diseases such as cholera, typhoid, diarrhoea and respiratory infections.

4.4.2A awareness of recycling on solid wastes

The findings of the study showed that majority of the respondents (97.9%) indicated not to be aware of recycling services on solid wastes in the study area. It was just 2.1% of the respondents who were aware of the recycling of wastes in Bor town. Since there was no recycling of solid waste in Bor town so awareness creation to the residents was no sufficient.

The findings of the study from the interviews showed that residents did not receive information on recycling of solid wastes and number of key issues about poor solid waste management but they only received awareness on the general hygiene and sanitation.

According to Abdel-Naser and Abdel (2011) solid waste recycling is a problem of major relevance for all societies. However, finding strategies to cope with problem is becoming a hard work, owing to the increasing awareness of environmental problems by population. Monyoncho (2012) noted that lack of sufficient funds to finance awareness campaigns to encourage waste minimization at source along with minimal workforce impede municipalities' efforts to achieve their vision.

4.5 Practices of the community towards solid waste management practices

4.5.1 Solid waste disposal methods

The findings of the study showed the methods of solid waste disposal used in the study area. The results in Figure 4 below shown that open dumping was the most popular method as presented by 62.4% of the respondents.

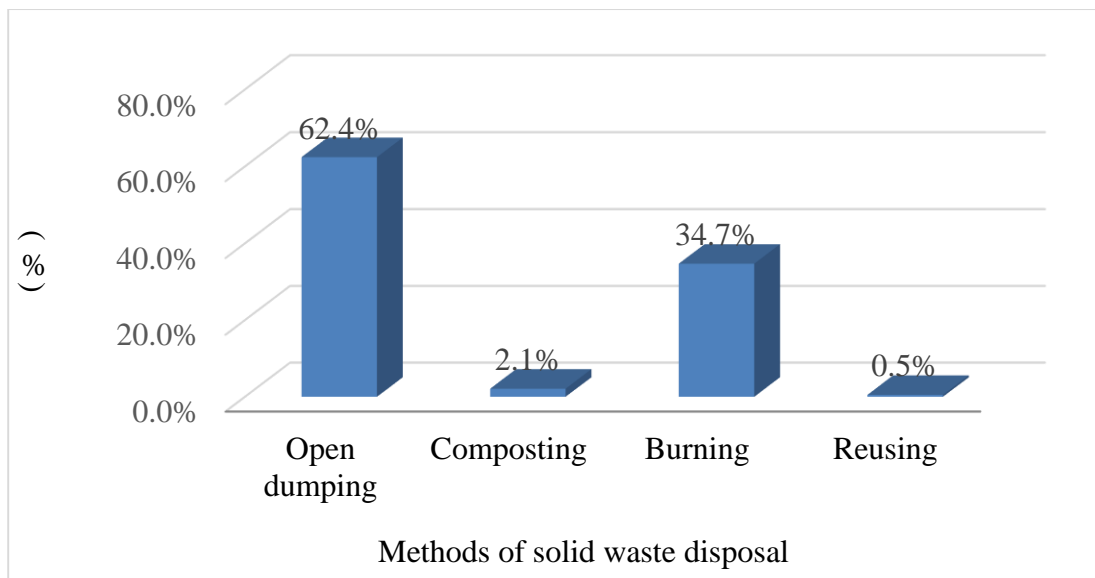


Figure 4. Solid waste disposal methods

Source: Field data (2016)

About 34.7% of the respondents were using burning method for their solid wastes disposal. It was only 2.1% and 0.5% of the respondents who were using composting and reusing methods for solid waste disposal.

From the observation in Bor town, there are two types of open dumpsites which have not been fenced and the people around have open access to those dumpsites. This open access of the community to the dumpsites have impacts on the people, which might results to injury of the people, inhale toxic gases, provide opportunity for waste recyclers and idle youth, and finally, the people around might also contract diseases like typhoid, malaria, diarrhoea, upper

and lower respiratory infections due to poor hygienic maintenance of the dumpsite. Moreover, open burning is also practiced by the people around the dumpsites and so all the solid wastes collected from different sources in the town are openly burned at the dumpsite without proper measures to control the smoke releases into the air which might affect the people indirectly or directly through the release of dioxins and other toxic gases as shown in Plate 2 below.



Plate 2: Burning of waste at the Anyidi road dumpsite in Bor town on 03/01/2016

According to Tay (2007) the environmental conditions of uncontrolled dumpsite is extremely dangerous, with severe environmental pollutions such as foul odours, air pollution, rodents spreading pathogens in the surrounding areas and the employees are highly exposed to diseases and hazardous wastes. These results are also consistent with Medina (2002) and Zerboc (2003) who found that composting is one of the most significant aspects of sustainable solid waste management practiced by most rural households.

4.5.2 Storage of solid waste

The findings of the study showed that majority of the households (54.2%) disposed of their solid wastes in open dumps. About 30% of the respondents dumped their solid wastes in rubbish pits. It was only 15.3% and 0.6% of the respondents that stored their wastes in dustbins and polythene papers, respectively.

Gurtong (2015) conducted an assessment in Bor County and noted that the disposal of solid waste may create problems to the growth of population and development of Bor. The

disposal of waste in open pits was found to have become a routine in places of Makuach Payam in Bor County. Hazardous semi-solid or solid matters, created by human or animal activities were not well disposed. Most of the solid wastes, like paper, plastic containers, bottles, cans, and even used iron sheet and electronic goods are non-biodegradable, which means they do not get broken down through inorganic or organic processes. Decaying wastes attract household pests and result in urban areas becoming unhealthy, dirty, and unsightly places to reside in as shown in Plate 3 below.



Plate 3: Open dumpsite in Bor town on 16/02/2016

4.5.3 Segregation of solid wastes

The findings of the study showed that majority of the respondents (76.8%) were not aware of segregation of solid wastes in the study area. It was just 23.2% of the respondents who were aware of segregation of solid wastes in the study area. This implies that segregation of solid wastes may not be very popular in the study area since most households are not aware of the practice and this may lead to mixed up of solid wastes at the disposal site causing bad odor and diseases to human beings.

Segregation and sorting usually occurs under very unsafe and hazardous conditions and the effectiveness of segregation is relatively low as unorganized sector segregates only important discarded materials from waste stream which can guarantee them comparatively higher economic return in the recycling market (Kaushal *et al*; 2012). Lack of segregation deprive proper scientific disposal of waste (Singhal and Pandey, 2000).

4.5.4 Sources of information on solid waste segregation

Table 9: Information on solid waste segregation

	Frequency	Percent
None	284	74.8
Radio	53	13.9
Friends	29	7.6
Relatives	12	3.2
School	2	0.5
Total	380	100.0

Source: Field Data (2016)

The findings of the study in Table 9 above showed that majority of the respondents (74.8%) did not get information on solid waste segregation, 13.9% got information from radios. About 7.6% of the respondents cited friends as a major source of information on solid waste segregation while 3.2% and 0.5% of the respondents indicated relatives and school as a source of information. This implies that the use of radio may be the best way of accessing information on solid waste management and disposal. These results agree with Gabriel (2015) who concluded that in South Sudan, just like most parts of the world, radio is deemed as the fastest, affordable and the best means of disseminating information to the dispersed heterogeneous population because it is flexible and it can cover a wide range of area.

4.5.5 Reasons for not separating solid wastes at the household

The findings of the study showed that most of respondents were not separating solid wastes in their households and stated some of the reasons for not doing so and their responses were summarized in Table 10.

Table 10: Reasons for not separating solid waste at the households

Reasons	Frequency	Percent
Lack of space	251	66.1%
Can't see importance of separating	56	14.7%
Can't afford	52	13.7%
Time consuming	12	3.2%
No ready market for recyclables	9	2.3%
Total	380	100.0%

Source: Field data (2016)

Majority of the respondents stated that lack of space was their major hindrance against separation of solid wastes in their households. This was represented by 66.1% of the total respondents. About 14.7% of the respondents argued that they could not see the importance of separating their solid wastes while 13.7% of the respondents argued that it was too expensive and thus they could not afford to implement solid waste separation. A few respondents argued that it was time consuming (3.2%) and that there was no ready market for recyclables (2.3%). Most urban dwellers are faced with shortage of space where they can practice their major household chores including waste management practices such as solid wastes segregation.

Yamba (2004) observed that in Zambia, there was no separation of the various types of solid waste, the waste components are just mixed and dumped in areas that are not designated for waste disposal.

4.5.6 Retention and frequency of solid waste collection

The findings of the study showed that majority of the respondents (55.3%) stated that they took more than one day before they disposed of their solid wastes. About 35.8% of the respondents indicated that they retained their solid wastes for one (1) day before finally disposing them. It was only 8.5% of the respondents who were found to be disposing their solid wastes every 12 hours in this study. This implies that most households could be generating low quantities of wastes that were not economical to dispose daily.

As per frequency of solid waste collection, majority of the respondents stated that solid wastes are collected twice in a month as represented by 59.3% of the total respondents. About 13.9% of the respondents indicated that wastes were collected twice a week while 6.8% of the respondents indicated that waste was collected once a week. The low frequency of solid waste collection may be caused by the large number of households being served by few service providers in the study area.

From the interviews with key informants showed that Municipal council collect the residents' solid wastes at a frequency of twice a week. Once the waste is collected at site, then it is taken by municipal vehicles to the dumpsite.

4.5.7 Charges levied and payment per month for the services

The findings of the study showed that majority of the respondents (67.1%) indicated that they were charged for the service while 32.9% stated that they were not charged for the services. Furthermore, majority of the respondents (95.2%) mentioned that they incurred SSP 200.00 for the service while 2.4% incurred 250.00 with another similar proportion (2.4%) incurring an amount of SSP 300.00 per month. All the respondents who were charged for the solid waste collection and disposal services rated the charges as low.

The findings of the study from the interviews with key informants showed that Municipal council charge a fee of 200 SSP for solid wastes services. Monyoncho (2012) argues that the best way of managing solid wastes is the internalization of costs (by levying charges for the use of the services). This is especially beneficial when a command and control policy is not effective and Government intervention is necessary for this.

4.6 Attitudes and perceptions of community toward solid waste management

4.6.1 Perception towards solid waste separation and responsibility

The findings of the study showed that majority of the households' respondents (50%) were of the perception that separation of solid waste was not good idea. About 45% of the respondents were of the perception that the practice was good idea while 3.9% and 1.1% of the respondents thought it was a time wasting and dirty job.

Majority of the respondents stated that it was the responsibility of the individuals to collect solid wastes in their households. About 97.9% of the respondents argued that it was the responsibility of individuals to collect solid wastes. A few respondents (1.1%) stated that it was Bor Municipal council that was supposed to collect waste while 1% felt that Bor

Municipal Council and individuals (together) were the ones responsible for solid waste disposal.

Moreover, majority of the respondents (85.3%) indicated that it was the responsibility of the mothers to dispose the solid wastes generated in their households. About 7.6% and 7.1% of the respondents argued that it was the responsibility of fathers and house girls, respectively, to dispose solid wastes in their households. However, most respondents (59.5%) indicated that majority of the people did not ensure that waste is taken to the designated site. It was just 40.5% of the respondents that indicated that solid waste should be taken to the designated disposal site. In Bor town, solid waste management is the responsibility of Bor Municipal Council.

These are consistent with the study done In Khulna, Bangladesh by Norley (2009) that local governments are responsible for the collection and disposal of the wastes generated within their jurisdiction, as well as for the operation and maintenance of their equipment. However, local governments usually lack the authority and resources to provide a satisfactory and economically viable service. Effective and efficient solid waste management depends upon an equitable distribution of responsibilities, authority, and revenue between the national government and all the local governments. In addition, According to Lusaka City Council (2004) solid waste management is the responsibility of Lusaka City Council (LCC) waste management unit. The waste management unit (WMU) has partnered with Community Based Enterprises (CBES) and were responsible for the day to day management of the waste system in peri-urban areas.

4.6.2 Ways of improving Solid Waste Management

The findings of the study showed respondents' perceptions on how solid waste management can be improved in their households. The responses on this question are summarized in Table 11.

Table 11: Ways of improving Solid Waste Management

Responses	Frequency	Percent
Environmental policies	40	10.5
Designated disposal site	228	60.0
Awareness	34	9.0
Ignorance	78	20.5
Total	380	100.0

Source: Field data (2016)

Majority of the respondents (60.0%) mentioned that establishment of designated disposal sites can improve solid waste management in the households located in the study area. Other respondents indicated that establishment of good environmental policies (10.5%) and creation of awareness (8.9%) can significantly improve solid waste management within the households. About 20.5% of the respondents did not provide any suggestion how solid waste management may be improved in their households. These results imply that designating major disposal sites, good environmental policies as well as vigorous awareness creation are some of the ways that may be used to reduce the problem of solid waste management in the study area. The city authorities can tap on the perceptions of the residents in order to come up with a participatory and more acceptable method of dealing with solid waste.

4.6.3 Waste collection and transport services to households

The findings of the study showed the authorities that provide solid waste collection and transport services to household members in the study area and the results were summarized in Figure 5.

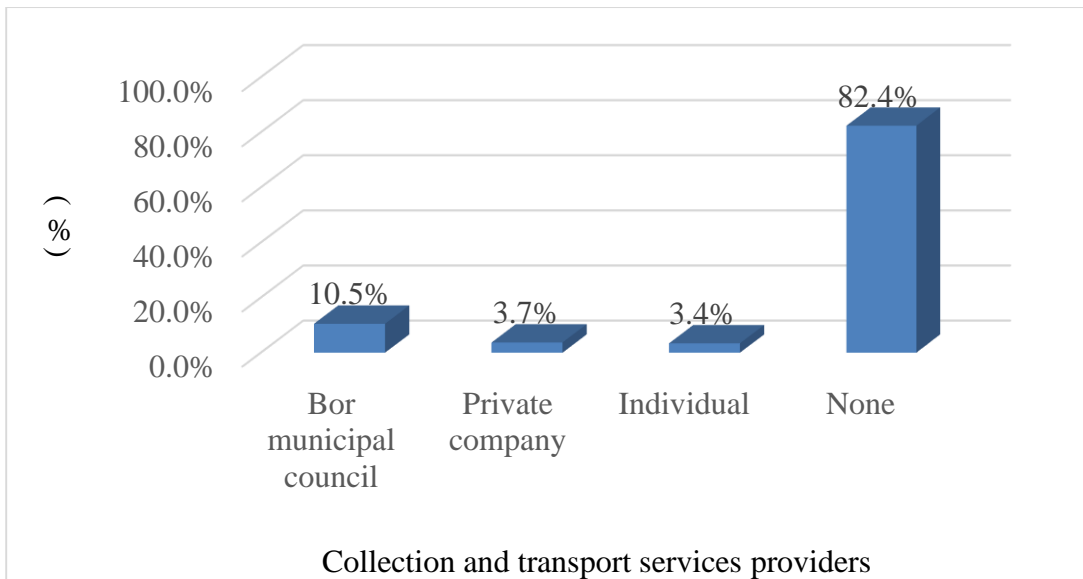


Figure 5: Collection and transport services providers to households

Source: Field data (2016)

Majority of the respondents (82.4%) stated that there was no authority that provide collection and transport services to household members in Bor town. About 10.5% of the respondents indicated that Bor town council collected and transported solid wastes in the study area. A few respondents, 3.7% and 3.4%, cited private companies and individuals, respectively, as the major solid waste collection and transport providers. The services rendered by authorities that collect domestic solid waste were perceived by majority of the respondents (55.7%) as very poor while 44.3% stated that the services were good.

These are consistent with the study conducted in Ghana that high rate of urbanization in African countries contributes to a rapid accumulation of solid waste. Moreover, social and economic development that most African countries have witnessed since the 1960s have also contributed to an increase in the waste generated per capita (Owusu *et al*; 2012; Ahmed and Ali, 2011). These results are consistent to Gabriel (2015) who noted that most households in major towns of South Sudan are not served by any waste collection and disposal service provider and therefore are forced to initiate their own way of managing their solid wastes as in the Plate 4 below.



Plate 4: Truck offloading solid wastes at Anyidi road dumpsite on 09/01/2016

4.7 Challenges and factors related solid waste management

4.7.1 Challenges related solid waste management

The major challenges faced by residents in waste management are summarized in Figure 6.

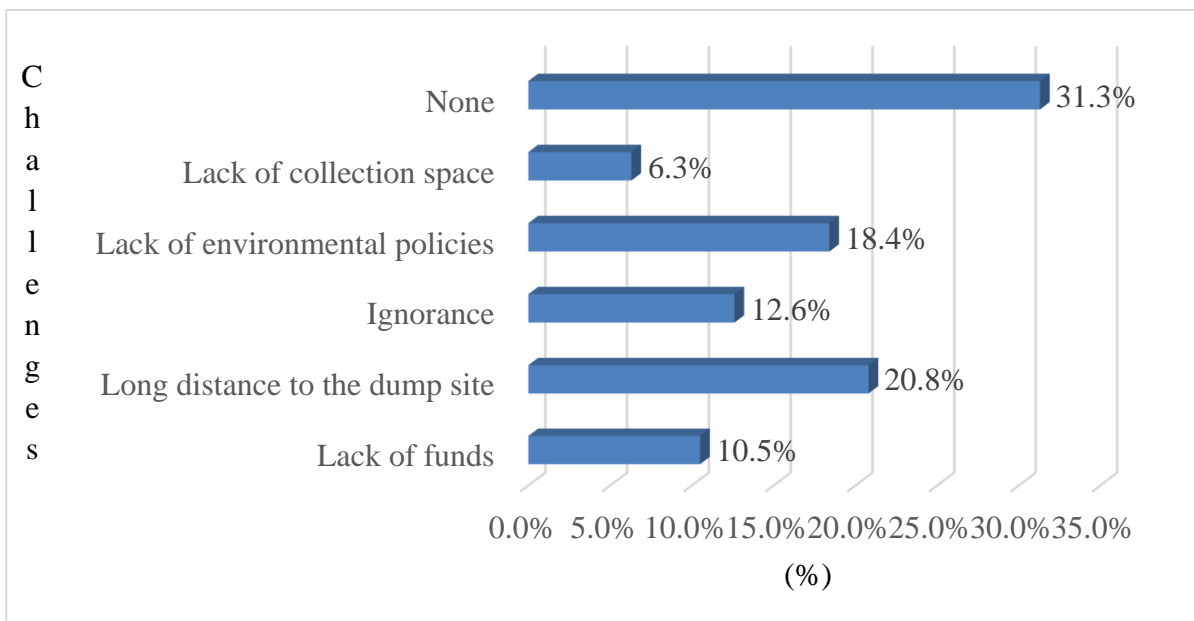


Figure 6: challenges related to solid waste management *Source: Field data (2016)*

The findings of the study showed that majority of the respondents (31.3%) did not find any major challenges related to solid waste management. This was closely followed by long distance to the dump site as represented by 20.8% of the respondents. About 18.3%, 12.6% and 10.6% of the respondents argued that lack of environmental policies, ignorance and lack of funds, respectively, were also major challenges towards solid waste management.

The findings of the study from the interviews with key informants showed that many challenges contributed to poor solid waste management in the study area. First of all, most residents lack proper information on solid waste management and also knowhow on the best practices applicable in waste management in urban setup such as Bor town. There is also lack of funds on the part of residents to be able to finance waste management practices in a consistent manner. Lastly, there is hardly any environmental policy put in place by the government to combat poor solid waste disposal in the study area.

These findings are in consistent with the study carried out in Kampala, Uganda by the Namilyango College (2001) that identified several challenges related solid waste management which included lack of dumpsite, ignorance of the community about the need for proper waste disposal, lack legislation, Lack of finance, lack of awareness among the public, lack of political support and lack of trained personnel for waste management.

4.7.2 Challenges of collection, storage and disposal of solid wastes

Some of the challenges encountered during storage, collection and disposal of solid wastes are summarized in Table 12.

Table 12: Challenges during collection, storage and disposal of solid waste

Problems	Collection		Storage		Disposal	
	Freq.	Percent	Freq.	Percent	Freq.	Percent
No bags	250	65.8%	285	75.0%	3	0.8%
No roads	2	0.5%	2	0.5%	35	9.2%
No collection sites	100	26.3%	4	1.1%	123	32.4%
No vehicles	18	4.7%;	1	0.3%	127	33.4%
No skills	3	0.9%;	1	0.3%	1	0.3%
Others	0	0.0%	1	0.3%	2	0.5%
None	7	1.8%;	86	22.6%	89	23.4%
	380	100	380	100	380	100

Source: Field data (2016)

The findings of the study showed that majority of the respondents (65.8%) argued that lack of bags was the major problem during collection of solid wastes. Other problems encountered during collection include lack of collection sites (26.3%), lack of vehicles (4.7%), lack of skills (0.9%) and lack of roads (0.5%).

As far as challenges encountered during storage of solid waste was concerned, this study noted that majority of the respondents (75.0%) stated that lack of bags was the major problem during storage, followed by other problems like lack of roads, lack of collection sites, lack of vehicles and lack of skills. About 22.6% of the respondents argued that they did not encounter any challenge on storage of solid wastes.

As far as solid waste disposal was concerned, respondents indicated to be faced with a number of challenges. The most stated challenge with regard to solid waste disposal was lack of vehicles and lack of collection sites (inaccessible) as mentioned by 33.4% and 32.4% of the respondents, respectively. About 9.2% of the respondents indicated lack of roads as a major challenge in solid waste disposal. The challenges of lack of bags, lack of skills among other challenges were represented by less than 5.0% of the respondents.

These are consistent with study done in Ghana by Peter (2002) which states that problems are encountered at all levels of waste management, particularly, collection, transportation and disposal. Generally, existing public facilities, including sanitary facilities, are inadequate to serve the user population, and the sheer volume of municipal solid waste generated in the country's urban centres is overwhelming. While existing waste disposal facilities are inadequate to deal with the quality and quantity of waste generated, more sophisticated systems are expensive and their maintenance requirements are high.

4.7.3 Correlations between socio-economic factors and solid waste disposal methods

Table 13: Correlation of socio-economic factors and waste disposal methods

Variables	Pearson Correlation	Sig. (2-tailed)
Age	0.006	0.914
Education level	0.012	0.823
Income (SSP)	0.029	0.566
Awareness	0.016	0.845
Sex	0.031	0.552

N= 380

Source: Field data (2016)

The analysis in Table 13 above showed that at 95% confidence level, there was no relationship between age of the respondents and solid waste disposal methods. This indicates that age of a household head does not increase or reduce the levels of solid waste disposal methods. The analysis in Table 13 also showed that at 95% confidence level, there was no significant difference between education levels of the respondents and solid waste disposal methods. This implies that the level of education does not increase or reduce the levels of waste disposal methods. The analysis in Table 13 further showed that at 95% confidence level, there was no significance difference between monthly income (SSP) of the respondents and solid waste disposal methods. This indicates that income has no influence on solid waste disposal in Bor town and this can spread across households with both low and high incomes. The analysis in table 13 showed that at 95% confidence level, there was no significance

difference between awareness level of recycling of solid waste and solid waste disposal methods. This indicates that since there is no recycling of solid waste in Bor so awareness of the residents is not sufficient on solid waste disposal methods. The analysis in Table 13 finally showed that at 95% confidence level, there was no relationship between sex of the respondents and solid waste disposal methods. Although there was no relationship between the socio- economic factors and solid waste disposal methods, the residents are still facing some challenges like lack of environmental policies, long distance to dumpsite, lack of fund, ignorance and lack of infrastructure in managing solid waste in Bor town. These are inconsistent with the study done in Ghana that revealed that sex, age and education level negatively correlated with solid waste disposal methods (Aaniamenga *et al*; 2014).

4.8 Existing Policies on Solid Waste Management

The findings of the study from the interviews of the officers from Bor Municipal Council showed that there was an internal order that was made by the state authority in 2015 that banned the use of plastic bags in Bor town. The order also provides that any person violating the order shall be fined with SSP 500 at the court of law for using the banned plastic bags. In addition, the Transitional Constitution of the Republic of South Sudan 2011 Chapter II (Article 41) also provides measures needed to protect and preserve the environment from pollution, abuse and degradation caused by human beings. The environmental protection law that was to regulate waste management in South Sudan was presented in parliament in 2010 but right now is still pending for approval in the parliament.

These results are inconsistent with UNEP (1996) that found existence of policy that embodies a reasonable balance of feasible, cost-effective, sustainable, environmentally beneficial, and socially sensitive solutions to SWM problems in Sudan. However, there existed a big room for improvement and streamlining of such policies.

In Kenya, National Solid Waste Management Strategy has been formulated with an aim of gearing the Country towards achieving sustainable solid waste management with Zero Waste as a guiding principle. The Strategy has been developed by NEMA to enable the Country meet the Kenya Vision 2030 targets (NEMA, 2014).

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

This section presents summary of key study findings as well as conclusions and recommendations which are logically arranged in line with the objectives of the study. Some areas of further research have also been suggested.

5.1 Conclusions

Based on the findings of the study, the following conclusions were made:

Major types of solid wastes that were generated in Bor town include Plastic, organic waste and papers which were obtained from places of residence, commercial places, agricultural fields, institutions and construction sites.

Most residents had no knowledge to low knowledge on solid waste disposal, effects and diseases caused by poor waste disposal while only small portion of the respondents had moderate to advanced knowledge on solid waste disposal, effects and diseases caused by poor waste disposal. Majority of the respondents have negative attitudes toward solid waste separation while only few respondents have positive attitudes toward solid waste separation in their households. In addition, majority of the respondents have negative attitudes toward those authorities' responsible for solid waste collection while only small percentage of the respondents have positive attitudes toward those responsible for waste collection in Bor town.

Open dumping was the most popular method of waste disposal. Other methods included burning, composting and reusing. Majority of the respondents were not aware of segregation of solid wastes.

Long distance to the dump site and lack of environmental policies were the major challenges faced by residents on solid waste management. Other challenges included ignorance and lack of funds and lack of collection space. Lack of bags, lack of collection sites, lack of vehicles, lack of skills and lack of roads also constrain solid waste management efforts by residents.

The findings from the officers of Bor Municipal Council showed that there was an internal order that was made by the state authority in 2015 that banned the use of plastic bags in Bor town.

5.2 Recommendations

In view of the findings and the conclusion drawn above, this study makes the following recommendations:

Since the bulk of the solid waste generated can be recycled (metals, glass, plastic), efforts should be made to link up with agencies dealing with waste recycling. Moreover, since waste can be a resource, the recyclable waste can form a source of livelihood for idle and unemployed youth who can collect it from premises where it is generated.

The government/municipal council should vigorously launch a widespread awareness campaign to deal with the negative perceptions and low knowledge of the community toward solid waste disposal methods.

Government efforts to build more waste disposal sites in the study area should be supported and necessary budget allocated.

There should also be efforts to improve road infrastructure in the area to support easier waste disposal. Since there are no waste collection bins, these should be strategically placed in identified central sites so as to reduce indiscriminate dumping and ease waste collection by municipal vehicles.

Since there are no relationship between socio-economic factors and solid waste disposal methods, then there is need by the State government to educate the residents on the challenges facing them.

Government efforts to formulate policies on other types of solid wastes and incorporate with the existing order that banned used of the plastic bags in Bor town.

5.3 Recommendations for Further Research

The findings of this study would act as a base for more research on solid waste handling practices in the study area. This study was not exhaustive and recommends further research on:

- i) Willingness to pay for waste collection services
- ii) Effective models for involving the community in integrated waste management and converting waste to a resource

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APPENDICES

APPENDIX I: HOUSEHOLD QUESTIONNAIRE

Hello, my name is Garang Manyok John; I am a student from Egerton University. I am conducting this study as a partial fulfilment for the Award of a Master Degree of Science in Environmental Science. This questionnaire was drafted in assessing solid waste handling practices in Bortown, South Sudan. Please answer all the questions with honesty. The information you will give is purely academic and it will be treated with a lot of confidentiality. I am requesting you to kindly participate in this study by responding to the following questions.

PART I: BACKGROUND INFORMATION

Q1. Household characteristics

Household Member	Age	Sex	Education level	Main Occupation	Monthly Income
1					
2					
3					
4					
5					
6					
7					

Q2. Specify the main household income generating activities you are involved in:

	Income Generating Activity	Household numbers	Location of activity	Monthly Income
1				
2				
3				
4				

PART II: TYPES AND SOURCES OF WASTES GENERATED

Q3. What are the types of wastes generated in your household?

	House waste	Tick appropriately
1	Paper wastes	
2	Plastic bags	
3	Containers	
4	Food wastes	
5	Vegetable wastes	
6	Cloth wastes	
7	Wooden wastes	
8	Metallic wastes	
9	Glass	
10	Others:	

Q4. What are the sources of solid wastes generated in your household? Tick against some of the sources given below.

- 1) Residential
- 2) Commercial
- 3) Institutional
- 4) Agriculture
- 5) construction
- 6) others-----

PART III: SOLID WASTE MANAGEMENT AT THE HOUSEHOLD LEVEL (PRACTICES, DISPOSING, ATTITUDES AND KNOWLEDGE)

Q5. How do you store the wastes generated in your household

- 1) Dustbins
- 2) Rubbish – pits
- 3) Open dumping
- 4) Polythene papers
- 5) Others:

Q6. Have you heard of the segregation of solid waste?

- 1) Yes
- 2) No

Q7. Whom did you get information on waste segregation?

- 1) Friends
- 2) relatives
- 3) newspapers
- 4) school
- 5) radio

Q8. What do you think about solid waste segregation/ separation in your home?

- 1) Good idea
- 2) Time wasting
- 3) Dirty job

Q9. What are the reasons for not separating solid wastes at the house hold?

- 1) Lack of space
- 2) Can't see importance of separating
- 3) Cannot afford separate bins
- 4) Separation is time consuming
- 5) No ready market for recyclables
- 6) Pay for solid waste (expensive)

Q10. How long do you retain the waste in your residence before disposal?

- 1) 12hours
- 2) 1 day
- 3) More than one day

Q11. Have you heard of recycling? 1) Yes 2) No

Q12. Are there any waste collection and transport services offered in the area?

- 1) Yes
- 2) No

Q13. If yes to Q12; who provides the collection and transport services? Tick against any of these that could be providing waste collection services in the area at any given time.

- 1) Bor Municipal Council
- 2) Private Company
- 3) Individual Arrangement
- 4) None

Q14. How often do the collectors mentioned above in Q13 collect the wastes?

		Number of times waste is collected					
		Once a week	Twice a week	Once per month	Twice a month	Irregular	Never collected
	Waste collectors						
1	BMC						
2	Private company						
3	Individual arrangement						
4	Others:						

Q15. Are there any charges levied for the services mentioned in Q14 above?

- 1) Yes
- 2) no

Q16. If yes to Q15; how much do you pay per month for the services mentioned in Q15?

	Waste collector	Charges levied in South Sudanese Pounds (SSPS) per month
1	Bor Municipal Council	
2	Private Company	
3	Individual Arrangement	
4	Others	

Q17. In your own view how do you rate the charges?

- 1) High 2) Average 3) Low

Q18. How often would you want the waste to be collected in a month?

- 1) Once a week
 2) Twice a week
 3) Once in two weeks
 4) Twice a month
 5) Once in a month

Q19. If there are waste collectors that collect domestic solid waste; how do you rank the services offered?

- 1) Very good 2) Good 3) Poor 4) Very poor

Q20. In case there are no waste collectors, indicate in the following table the waste disposal system (s) you use for disposing each waste.

Waste disposal system							
		Open dumping	Composting	Recycling	Burning	Reusing	Other methods
	Household waste						
1	Paper wastes						
2	Plastic bags						
3	Containers						
4	Food wastes						
5	Vegetable						

	wastes						
6	Cloth wastes						
7	Wooden wastes						
8	Metallic wastes						
9	Glass						
10	Others:						

Q21. Whose responsibility is it to clean the surroundings?

- 1) The individuals
- 2) The Bor Municipal Authority
- 3) Both

Q22. Do you think it is appropriate for individuals to clean their own surroundings?

- 1) Yes
- 2) No

Q23. Explain your answer.....

Q24. Where do you get most of your information on solid waste management issues?

- 1) Environmental groups
- 2) Newspapers
- 3) Radio
- 4) TV
- 5) Other.....

PART IV: FACTORS AND CHALLENGES RELATED TO SOLID WASTE MANAGEMENT.

Q25. In your opinion, how serious is the problem of waste management

- 1) Very serious
- 2) Somewhat serious
- 3) Not serious
- 4) Don't know

Q26. How far (in metres) is the disposal site from your place of residence?

.....

Q27. Who normally takes the waste to the disposal site? (Tick against the person/people responsible)

- 1) Father
- 2) Mother
- 3) Children
- 4) House girl

Q28. Are there any problems that you have been experiencing as a result of the waste disposal system(s) in your area?

- 1) Yes
- 2) No

Q29. If yes to Q 28; specify the problems.

.....

Q30. Indicate the problems you encounter while handling domestic solid wastes throughout these processes.

	Waste management process	Problems encountered
1	Storage of domestic solid wastes	
2	Collection and transportation of domestic solid wastes	
3	Disposing domestic solid wastes	

Q31. In your own opinion what can be done to improve domestic solid waste management in your area or household

.....

Q32. State the factors affecting solid waste disposal in your households

.....

PART V: EXISTING POLICY FRAMEWORKS FOR SOLID WASTE HANDLING PRACTICES

Q33. Do you have any existing policies for solid waste management in your locality?

- 1) Yes
- 2) no

Q35. If yes to Q33, then state them

.....
.....

Appendix II: Interview guide for key informants on solid waste handling practices in Bor town

1. What types of solid waste do you have in your community?
2. What are the sources of solid wastes generated in your community?
3. What methods do your residents use to dispose solid waste?
4. How do the residents store their waste prior to collection?
5. How often does the municipal council or private company collect the waste in your community?
6. How much does the municipal council/ private company charge for the collection of waste?
7. What are the factors contributing to poor solid waste management in your community?
8. What problems do you have in your community concerning solid waste management?

Appendix III: Observation checklist on solid waste management

	Activities	Observation Areas		
	Types of solid wastes	Bor Municipal Council (tick appropriately)	Akoybany Boma (tick appropriately)	Malou Boma (tick appropriately)
1.	Plastic bags/bottles			
2.	Glass			
3.	Papers			
4.	Food wastes			
5.	Vegetable wastes			
6.	Animal wastes			
7.	Cloth wastes			
8.	Containers			
9.	Metallic wastes			
10.	Wooden wastes			
	Solid waste management practices			
11.	Open dumping			
12.	Composting			
13.	Burning			
14.	Landfill			
15.	Incineration			
16.	Presence of dustbins			

Appendix IV: Likert scale showing knowledge levels on solid waste disposal, effects and diseases caused by poor waste disposal

State five (5) methods of solid waste disposal

The marks obtained by the household' respondents were ranked (no knowledge = 1, very low = 2, low = 3, moderate = 4 and advanced = 5) base corrected answers scored by the respondents.

State five (5) effects of poor solid waste disposal

The marks obtained by the household' respondents were ranked (no knowledge = 1, very low = 2, low = 3, moderate = 4 and advanced = 5) base corrected answers scored by the respondents.

State five (5) diseases caused by poor solid waste disposal

The marks obtained by the household' respondents were ranked (no knowledge = 1, very low = 2, low = 3, moderate = 4 and advanced = 5) base corrected answers scored by the respondents.