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The Solid Waste Management Practices Gaps and the Roles of Stakeholders' Engagement in Successful Solid Waste Management in Juba City and Juba County of Central Equatoria State of South Sudan

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Abstract

Reliable and sustainable solid waste management is becoming a major issue for most developing countries due to increasing urbanization and population growth. A study was conducted in Juba City and Juba County of Central State, South Sudan. The objectives of study were to identify the sources, types, methods, and quantities of solid waste generated; to examine the prevalent diseases and disease vectors associated with solid waste; to assess the status of financial resources and willingness to pay for solid waste management; and to evaluate the roles of stakeholder engagement in effective waste management. The researchers collected data on solid waste generation, collection, disposal, and their impacts on the environment and human health in Juba City and Juba County. This study used a structured questionnaire administered of 600 randomly selected respondents (205 from Juba City, 375 from Juba County, and 20 key informant interviews), along with field observations. The data were analyzed using statistical methods, including descriptive statistics and softwares such as SPSS version 27, excel, and word. Researchers found that the study areas were heavily polluted because people dumped solid waste in open spaces and vacant plots. Households generated solid waste, included organic waste, plastic, and polythene bags. The Department of Environment and Sanitation, along with solid waste management companies, was responsible for overseeing waste management in the city, but the situation remains problematic. Poor waste management has decreased land value, created breeding grounds for disease-carrying vectors like rats, mosquitoes, and rodents, and facilitated the spread of serious diseases. Additionally, statistical analysis indicated that poor waste management practices were linked to health and environmental issues within the communities. To address these problems in Juba City and Juba County, there is a need to improve infrastructure, secure more funding, enhance governance, and increase public awareness and participation. To protect the environment and the health and well-being of residents, sustainable and long-term solutions are essential.

Keywords: solid waste, management practices, gaps, stakeholder engagement

Introduction

Solid waste management is an emerging issue that most global urban administrations are grappling with in discharging most solid wastes. According to (UN-HABITAT, 2010), about 1.7–1.9 billion metric tons of waste are generated in urban areas worldwide. A clear and comprehensive understanding of the solid waste management processes in the city is a prerequisite for the design of any effective remedial measures. Limited reliable data on solid waste has led to a lack of proper and effective operational plans, and conflicting institutional roles. Inadequate technical capacity and unsustainable financial support are some of the major reasons for failure in the management of solid waste in most cities in developing countries (UNEP, 2013). Solid waste management is a burning issue in a rapidly urbanizing world. With accelerated urbanization and industrialization, solid waste management practices are having a bearing on public health and the environment in urban areas of many developing countries (Kjeldsen et al., 2002; Laner et al., 2012; Mukherjee et al., 2015).

Waste collection in East African urban centers is not based on the total amount of waste generated but rather on the level of income of the service area (Kaseva & Mbuligwe, 2005; Okot-Okumu & Nyenje, 2011). In Kampala, Uganda, solid wastes are disposed of in open ground disposal and skips. The communities without access to transfer stations resort to open disposal methods, which include burning, burying, using wastes as animal feed, and indiscriminate disposal. Also, there is rampant littering caused by the indiscriminate disposal of waste in storm drainage channels, road verges, and open

lots, due to the carelessly disposed waste blocking storm water drains, causing floods, and also causing health hazards. Also in the same city, institutions like universities, schools, hospitals, and business complexes are served by private companies, while those not served with transport always take their waste individually to community collection points. The urban poor receive very low to no waste collection services due to inaccessible roads, unplanned facilities, and neglect by the urban councils.

In Kenya, the challenges of solid waste management are real. About 80% of collection transport is out of service (Gakungu & Gitau, 2012). In Nairobi, service providers ask citizens to pay for the solid waste management services without consultation and involvement (Tukahirwa, 2011/2012). It is due to this that a holistic and integrated effort to minimize the quality of solid waste generated requires cooperation and participation, particularly from the public (Samahet et al., 2012). Public concern and awareness have acted as solid waste management drivers in high-income countries (Marshall & Farahbakhsh, 2013). The public's willingness to cooperate and participate in waste management relies on their awareness and attitude as citizens. Extending service coverage to all citizens by eliminating uncontrolled dumping of waste remains a key priority in low- and lower-middle-income countries (Watson, 2013). It is important to note that Juba is one of the fastest-growing cities in South Sudan in terms of socio-economic activities and infrastructural development. It is also considered one of the fastest-growing cities globally (UNEP, 2013). There is no exact figure for the population of Juba city, but according to the Sudan population census conducted in 2008, it reported that the population of Juba city was 230,192 people (Population Census Report, 2008). The United Nations estimated the population of Juba city above one million as well (The Sudd Institute, 2012). Coupled with this socio-economic growth and industrial development, the city is experiencing rapid growth in its population due to the influx of returnees, internally displaced persons, and foreign technical experts seeking job opportunities in the industrial and business sectors. The population growth of Juba city was estimated to be 2.71% per year, and it is projected to reach 305,319 by 2015 (NBS, 2015).

According to the National Bureau of Statistics (2014), the average population density was 20.03 people per square kilometer. However, the increase in the population has subsequently increased the solid waste generated in areas with high population density. As such, the unprecedented increase in the volume and the variety of solid wastes generated is attributable to this increase in the population, the change in lifestyle and consumption patterns, and the unevenly distributed population density. The city's inadequate solid waste management systems are not coping with the growing population and the increase in the solid waste generated. Despite these socioeconomic and infrastructural improvements, Juba, like many developing cities worldwide, faces significant challenges in managing its solid waste. The management of solid waste is effective only if there is a proper institutional setup, strong legal and policy frameworks, sufficient technical competence, sustainable financial support, and adequate infrastructural facilities like roads and disposal sites (UNEP, 2013). Considerable efforts have been made by many NGOs and public institutions in the country to tackle the issue of solid waste management in Juba city and Juba County. Like many governments in developing countries, the Juba City Council is the only public institution mandated to manage the municipal waste, including solid waste, generated in the city and disposed off in Juba County. Integrated solid waste management is the best practice and approach that is used by institutions responsible for the management of urban solid waste and can be an ideal approach for Juba city and Juba County. This study seeks to fill the knowledge gap on solid waste management in Juba city and Juba County of Central Equatoria, South Sudan.

Literature Review

The Solid Waste Management Practices and Gaps in the Management of Solid Waste in Juba City and Juba County

Overview of Solid Waste Management

Municipal solid wastes are collected from households, non-hazardous waste from markets, commercial, institutional, industrial, and waste from street sweeping, and all of these encompass the function of collection, transfer, treatment, recycling, recovery, and disposal (Schübeler, 1996). Solid waste is something that has no further use and no value, which we wish to get rid off, and it comes from unusable residues in raw material, which are rejected by the community (Sankoh & Yan, 2014). With the progress of civilization and human development, the waste generated has become more complex since waste generation depends on population and urbanization, which largely contributes to the increase in solid waste (Sankoh & Yan, 2014). Approximately, the global municipal solid waste generation rate was 1.3 billion tons per day (Beede & Bloom, 1994). The need to manage this problem in a technologically, socially, and economically acceptable manner is mandatory for every nation of the world (Achankeng, 2004). The solid waste handling hierarchy is internationally accepted and recommended, and the following ascending order of preference is: open-burning, dump, incinerate, landfill, recycle, reuse, and prevent. Open burning and dumping are the least preferred and not recommended, even though many developing countries highly use them (Achankeng, 2004). The problem of municipal solid waste management varies in magnitude in different regions, nations, and cities worldwide. Currently, an estimated 54% of the world's population lives in urban areas, which is expected to increase to 66% by 2050.

According to the United Nations (UN), it was estimated that in 2025, the world population would be 8 billion inhabitants, and by 2050, the total population will be around 9.5 billion, 50% more than the current one. About 97% of this growth will be realized in Africa and Asia. The rising middle class in developing countries will shape both the economic and political landscape. The total amount of waste generated per annum worldwide (industrial, municipal, and hazardous) is more than 4 billion tons (Veolia, 2009). About 45% of it is considered municipal solid waste, while the rest is industrial and hazardous waste. Furthermore, it has been estimated by the United Nations that globally, urban household waste was going to increase by 44% from 2005 to 2025. As global impacts increase,

and if the present waste management trend is maintained, landfilled food waste is predicted to increase the landfill share of global anthropogenic emissions from 8% to 10% (Adhikari, 2006). Recycling is one of the most important sectors in terms of employment creation and employed 12 million people in just three countries—China, Brazil, and the United States. Generally, counting the casual sectors, the number of individuals working in reusing is assessed to be more than 20 million people (Medina, 2008). The waste management industry is one of the most dynamic ones on a global scale, with annual revenue above $430 billion and around 40 million workers. 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 the recycling business will be the foundation of it. Per capita waste generation increases with both the development level and the income level of the country (Wilson, 2012).

Management of solid waste has become a major challenge in most cities in developing countries (WaterAid, 2008). It is believed that if solid waste is properly managed, it can be a valuable resource, but if not effectively managed, it can become a source of environmental and human hazards. Non-governmental organizations believe that solid waste management is one of the most important components of urban sanitation. What, then, is solid waste management? The term solid waste management has been defined differently by different writers and authorities. For example, Sanitation Connection (2002) defines it as all activities that seek to minimize the health, environmental, and aesthetic impacts of solid wastes. A much more comprehensive definition has been provided by George Tchobanoglous et al. (1993), who state that solid waste management is the discipline associated with the control of generation, storage, collection, transfer and transport, processing and disposal of solid wastes in a manner that is in accord with the best principles of public health, engineering, economics, conservation, aesthetics, and other environmental considerations and that is also responsive to public attitudes. Inherent in this definition is the solid waste management process, which includes waste generation, storage, collection, transfer, processing, and disposal of the waste. Also included here is the way the wastes are handled until they are stored in storage containers.

Solid Waste Management Practices

In almost all countries, especially in third-world countries, solid waste management is one of the major challenges to municipal authorities (Xiang, 2019). The rapid and constant growth in urban population has led to a dramatic increase in solid waste generation with an important socio-economic and environmental impact (Sharholy et al., 2008). The notable effects are street littering, blocking drains and causing transmission diseases, flooding through breeding from burning of waste, harming animals that unknowingly consume waste, and hindering the tourism sector's contributions to the nation's socioeconomic development. Due to improper waste management system practices, the organic content of waste contaminates the soil, and human health, including animals' lives, are at risk. Municipal solid waste usually comprises household, packaging, and yard wastes, including institutional and commercial wastes, which are expected to double in the next decade (European Parliament & Council, 2008).

Waste management in developed and developing countries varies. In Asia, a developing continent, many countries face severe problems in managing urban solid waste. It is estimated that Asia produces 0.5 million tons of waste per day in towns and cities. Sri Lanka produces almost 3000 tons per day, with a yearly increment of 5%. Dumping of waste on authorized as well as unauthorized sites is a common practice, causing health problems to humans and imbalancing the ecosystems. Nevertheless, Europe, North America, and other developed regions have techniques for reducing the quantity of domestic waste and eventual disposal in landfills (AESSL, 2007). Municipal mayors and managers in developed countries are looking to the development of sanitary landfills around the outside of their cities as a quick fix. Landfills, however, require the acquisition of large areas as well as good day-to-day operation 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 transportation methods, scavenging, and a shortage of proper disposal sites complicate waste management services. The uncollected waste creates problems at the community level, blockage of drains, release of foul odors and toxic gases, and spreading diseases (Serageldin, 1994). There is a need for adequate resources to fund awareness campaigns to empower waste minimization at source, together with a minimal workforce that hinders municipalities' endeavors to attain their vision (Monyoncho, 2013). In Khulna, Bangladesh, the local government is responsible for the collection and disposal of the waste generated within its jurisdiction, as well as for the operation and maintenance of its equipment. At least, local government usually needs specialists and assets to supply a satisfactory and financially practical benefit. Effective solid waste management depends upon a fair distribution of responsibilities, authority, and revenue between the national government and all local governments (John, 2017).

Integrated Strategies for Solid Waste Management

Although solid waste is very challenging to manage and arrange, it is not completely futile. Imaginative ways of managing solid waste can be formulated to make solid waste valuable. The Centre for Ecological Technology (CET), which supports sustainable technologies in New England, undertook such an effort, turning waste composting into a way of doing business through collaboration with commercial transport, commercial waste generators, and farmers (Majercak, 2002). The project took off with the farmers being the composting agents who would then send the products to the market. Engaging in such a complex collaboration in itself presents an opportunity for constructing a collaboration that would beneficially take advantage of solid waste to make it productive. This would result in a double gain since composting can fit exceptionally well within commercial center elements because it allows benefits both financially (salary to agriculturists) and ecologically (diminishing greenhouse gases and lessening leachate generation) from

organic waste. Agriculturists, too, are enabled to manage their own waste by utilizing it as fertilizers, subsequently minimizing the use of synthetic or petroleum-based fertilizers (Majercak, 2002). Such an undertaking may not be too simple to begin and keep up, but it may turn out to be beneficial. In Africa, a very small volume of the generated solid waste is recycled or recovered, as there is little economic incentive and market for recycled materials (USEPA, 2002).

Bournay (2006) noted that wealthy nation-states continue to send waste to Asia and Africa, which turns out to extend the burden in those continents. This waste is in the shape of obsolete items that do not meet buyers' inclinations and standards within wealthy nations, and excessively produced goods for export. The defense of the rich countries is that the waste can be "recycled anyway" (Bournay, 2006). On the other hand, many European countries have reuse plans for glass and paper, but the effectiveness of such plans has been reduced by the increased generation of waste paper and glass, making solid waste issues still yet to be mitigated (USEPA, 2002). In addition, it sounds unreasonable to assume that there will be successful and productive reuse of waste in Africa when the most common strategy of waste administration and disposal is landfilling.

Landfilling has become the most immediate possible way of managing solid waste in most African countries because of the high prevalence of indiscriminate waste dumping. The authorities that primarily bear the responsibility to clean up cities, towns, and residential areas find it easier and time-saving to collect the waste and carry it to a landfill rather than sorting the waste for reuse, and even less for composting. Therefore, solid waste management challenges are worldwide, albeit at different levels in different parts of the world. The United States Environmental Protection Agency (USEPA, 1993) outlines and explains three main components in an integrated municipal waste management strategy: waste prevention, recycling (including composting), and combustion. A review of these components (USEPA, 2002) categorically introduces and defines five main activities in the hierarchy—waste prevention, recycling, composting, combustion, and landfilling—and the similarity is recognizable between the previous components and the subsequent activities classified.

Technologies for Municipal Solid Waste Management

Municipal solid waste (MSW) generation is rapidly increasing in South Sudan. These wastes need to be treated adequately to prevent environmental problems and enable the constant development of modern society. Landfilling and composting are the only technologies primarily used for waste management in most developing countries (Dlamini, Simatele, et al., 2019).

The Impacts of the Solid Waste on Human Health

Waterborne diseases: Municipal solid waste pollution is believed to be a major source of surface water pollution in Juba; thus, coupled with poor sanitation, it poses a direct effect on water quality. The poor water quality and sanitation can be directly reflected in the high rate of incidence of waterborne diseases, which is currently a serious health problem in Juba City. The incidence of these diseases is highly seasonal: the greatest problems usually occur at the start of the rainy season as rains and run-off wash the wastes and fecal matter accumulated during the dry season into streams and the Nile. Waterborne illnesses such as typhoid, diarrhea, hepatitis A, and dysentery, and several tropical diseases, including malaria, are a real threat to the public health of the city. According to the United Nations Environment Programme (2007), in 2005 and 2006, Southern Sudan experienced a major cholera outbreak in several towns, including Juba, Yei, Bor, and Malakal. The total number of victims recorded by the World Health Organization was over 16,000, with over 470 deaths. Cholera is a waterborne disease linked to fecal pollution of drinking water. The logical connection here is that municipal solid waste pollution provides favorable breeding sites for such disease vectors, especially during the rainy season. Pielou (1998) pointed out that human and animal fecal waste contains disease-carrying organisms such as the bacterium Escherichia coli (E. coli) and pathogens that cause cholera, typhoid, and cryptosporidiosis. According to Todar (2007), virulent strains of E. coli can cause gastroenteritis, urinary tract infections, and neonatal meningitis. In rare cases, virulent strains are also responsible for hemolytic uremic syndrome, peritonitis, mastitis, septicemia, and gram-negative pneumonia. Someone who has an E. coli infection may have these symptoms: bad stomach cramps and belly pain, vomiting, and diarrhea, which is sometimes bloody. All these are very common in Juba. There are potential risks to the environment and health from improper handling of solid waste. Direct health risks concern mainly workers in this field, who need to be protected as far as possible from contact with waste. There are specific risks in handling waste from hospitals and clinics. For the general public, the main health risks are indirect and arise from the breeding of diseases with municipal flies and rats.

Uncontrolled hazardous wastes from industries mixing with municipal wastes create potential risks to human health. Traffic accidents can result from toxic spills and wastes. There is the specific danger of concentration of heavy metals in the food chain, a problem that illustrates the relationship between municipal solid wastes and liquid industrial effluents containing heavy metals discharged to a drainage/sewerage system and/or open dumping sites of municipal solid wastes, and the wastes discharged thereby maintain a vicious cycle. Including these, some other types of problems are as follows:

Impacts of Solid Waste on the Environment

The decomposition of waste into constituent chemicals is a common source of local environmental pollution. This problem is especially acute in developing nations. Very few existing landfills in the world's poorest countries would meet environmental standards accepted in industrialized nations, and with limited budgets, there are likely to be few sites rigorously evaluated before use in the future. The problem is again compounded by issues associated with rapid urbanization. A major environmental concern is the gas release from 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 landfill gas composition at maximum anaero-

bic decomposition. Another problem with these gases is their contribution to the enhanced greenhouse gas effect and Climate change. Liquid leachate management varies throughout landfills in the developing world. Leachate poses a threat to local surface and groundwater systems. The use of dense clay deposits at the bottom of waste pits and plastic sheeting-type liners to prevent infiltration into surrounding soils is generally regarded as the optimum strategy to contain excess liquid. In this way, waste is encouraged to evaporate rather than infiltrate (Cointreau-Levine, 1997).

The Role of Stakeholders' Engagement in Successful Solid Waste Management in Juba City and Juba County

Stakeholders Responsible for Municipal Waste Management and Collection

Solid waste in Juba is managed by the Department of Environment and Sanitation of the Juba City Council. Solid waste quantities that are produced in Juba are large and expanding with developing prosperity and the progressing standard of living. The municipal waste generation normal rate is 0.5720 kg per person per day (Juba City Chamber, 2017). The population of Juba is 1,500,000, and this population produces roughly 950 tons of waste per day. The rainy season has a higher waste generation rate. Solid waste generation changes per day in addition to recurring seasonal variations. Collection frequency also influences waste generation; in general, more frequent collection produces more municipal solid waste. Expanding urbanization is one of the influences on the overall rate of solid waste production in South Sudan and many other nations. The quantity of generated waste could be a financial indicator and a function of the degree of a nation's development. The distinction in waste generation between cities in developed nations (1.5–2 kg per person per day) and those in developing nations (less than 1 kg per inhabitant per day) is significant. This distinction is due to consumption patterns, as industrialized nations consume more goods and use more packaging.

International or Regional Policies for Solid Management

Agenda 21 is a non-binding action plan of the United Nations with regard to sustainable development; it is a comprehensive blueprint for global actions for sustainable development into the 21st century. South Sudan, being a member of the United Nations, is a party and accountable to Agenda 21. It commits governments, United Nations organizations, development agencies, non-governmental organizations (NGOs), and independent sector groups to implement programs and actions that would halt and reverse the negative impact of human behaviors 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 framework 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 waste within their areas of jurisdiction. In South Sudan, there are no existing documented legal frameworks for solid waste management.

The Roles of National Government, State and Local Authorities in Involvement in Solid Waste Management

In urban areas, especially in rapidly urbanizing cities of the developing world, problems and issues of solid waste management in low-income settlements are of immediate importance (Schlüter, 2017). National governments and local authorities have to carry out their mandate to contribute to successful solid waste management. Traditionally, solid waste management encompasses the generation, collection, transportation, and disposal of urban waste. 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 that are not adequate to cope with the magnitude of the problem. The South Sudan national government is involved in solid waste management, but there is no specific law on solid waste management either in South Sudan or in Juba. As related laws, there is the National Environment Bill (2013), which was prepared by the Ministry of Environment and Forestry but has not yet been enforced, and the Local Government Act (2009). The bill has comprehensive content that includes waste management. Also, there is the South Sudan Environmental White Paper (2017), published in June 2018, which focuses attention on the need for proper disposal of waste as part of environmental policy. The Local Government Act has been formally implemented and describes general matters of public works by local governments. Under the Local Government Act, waste management is considered one of the public services to be provided by local governments, along with water supply, sanitation, electricity, transportation, and communication. The Juba City Council (JCC) has established its bylaws on waste management in Juba City, and revisions are ongoing to reflect new environmental standards and economic conditions.

The National Environment Policy (2015–2025) draft and the National Policy on Medical Waste Management (1st draft: November 2011) guide waste-related strategies. A waste management plan has been established based on a technical cooperation project with the Japan government. It aims to raise the collection ratio in the Juba City Council to 34% by 2023 and includes procurement of equipment and capacity building. However, due to the tight budget of Juba City and rapid population growth, the plan is not progressing as intended. The Juba City Sanitation Reform and Investment Plan states the need to invest in waste management to improve public health. The Ministry of Environment is responsible for developing environmental laws and policies, while the Department of Environment and Sanitation of the Juba City Council is responsible for waste collection, preparing collection plans, collecting fees, implementing collection and transportation, budget execution, and providing licenses to private companies. It is also responsible for procuring and maintaining collection vehicles, raising public awareness, and implementing environmental education together with block councils such as Kator, Juba, and Munuki. For waste disposal, Rejaf County is responsible for the opera-

tion and management of final disposal sites, preparing operational plans, implementing disposal works, executing budgets, collecting disposal fees, and procuring and maintaining dumping site equipment. The roles of stakeholder engagement in successful solid waste management in Juba City and Juba County, Central Equatoria, South Sudan, are critical, with the government's role being multifaceted and foundational.

Gaps in the Literature

The study assisted Juba City, Juba County, local government, and the national government in pinpointing institutional management deficiencies that intensify the solid waste management issue and necessitate pertinent departmental modifications to their administrative strategies to identify shortcomings within the solid waste management framework. There are many rules in this area, but only a few of them focus on strengthening institutions to better handle solid waste. The national government, non-governmental organizations (NGOs), United Nations agencies, researchers, and students can all be interested in this area and take action that will benefit not only Juba City and Juba County but also the entire country. The literature does not provide new insights into solid waste management, hence the existence of gaps. These gaps were addressed through field research.

Research Methodology

Research Design

The descriptive research design was used in the study. This design presents facts about the nature and status of the situation at one point in time of the study and describes present conditions based on respondents' reactions. The research was a socio-economic survey that examined the social and economic status of the respondents. In a nutshell, the research used both qualitative and quantitative types of data. The quantitative research method was prioritized since it is precise and is considered a vital attribute for decision-making when addressing a problem. Quantitative data were presented in numerical values from which statistical inferences were drawn. Qualitative data were used as non-numeric data, including focus group discussions, interviews, and observations in the sampled areas. The approaches used in this study included qualitative data in words obtained through key informant interviews and quantitative data in numerical form obtained through surveys, due to the need to clarify results and examine the consistency of findings obtained from both the survey and key informant interviews, as noted by Amin (2005) in addressing the research question of this thesis study.

Data Sources

The gathering of data plays an integral part in statistical examination. For a study to be carried out, researchers need to use different sources of data, and these sources can be categorized as secondary and primary (Douglas, 2015). As the term implies, primary data are gathered for the very first time, while secondary data refer to data that had already been gathered by other researchers or authors for other objectives but are related to the current study (Ajayi, 2017). According to Mason (2002), it is important to distinguish between data sources and approaches for producing data, and he observed that human beings can be seen as data suppliers because they can be stores of information, experiences, feelings, or other relevant aspects applicable to the research being carried out (Mason, 2002). Nevertheless, there is a wide spectrum of methods through which a researcher can produce data from individuals, such as observing people, talking to them, or collecting products that individuals have produced, for example, diaries. This study, therefore, employed both primary and secondary sources of data. As discussed earlier, primary data were gathered through focus group discussions, interviews, and observations. Secondary data were obtained by re-examining relevant literature, including published and unpublished resources and media reports. These secondary materials are important as they provide a wealth of information and documented experiences, such as drafts on solid waste management in Juba.

Data Collection Methods

The study used three methods of data collection (questionnaire, interview guide, and observation checklist) to obtain the required data concerning the research. Close- and open-ended questionnaires were used to collect data on the sources and types of solid waste, disposal methods, quantity of solid waste generated, common diseases and disease vectors associated with solid waste, financial status and willingness to pay for solid waste services, gaps in solid waste management, and the roles of stakeholder engagement in successful solid waste management.

The key informant interview guide was the second method used in the collection of qualitative data for this study. Key informants were selected because of their specialized knowledge and experience on the study topic. As argued by Dudley (2011), this approach should always be inclusive and diverse (Dudley, 2011). The researchers conducted semi-structured interviews in which they had a list of questions to be covered, often referred to as an interview guide, as described by Bryman (2001). Therefore, in this study, the researchers developed a key informant interview guide that began with an introductory message about the study and its rationale, followed by questions on the gender and position of the respondent, and open-ended questions aimed at collecting the key informants' views regarding the research topic. Interview guides were used across five sites, including the Juba City Council, Juba County, Ministry of Environment and Forestry, solid waste companies, the Ministry of Health, and the University of Juba (Directorate of Waste Management, Hygiene, and Water Supply). These were used to collect data on types of solid waste generated, knowledge levels, perceptions and practices of the community toward solid waste management, disposal methods, financial status, and existing policies on solid waste management to provide in-depth information on these aspects.

Data Analysis

Patten and Cochran (2002), Braun and Clarke (2006), and Vaismoradi, Jones, Turunen, and Snelgrove (2016) have examined conventional methodologies for descriptive qualitative research, highlighting traditional themes that arise during data collection. Thematic analysis is a method for identifying, analyzing, and articulating patterns or themes in collected data. A

theme is characterized as an attribute, descriptor, component, or concept that enables investigators or respondents to address the research questions. The data collected via the instruments were processed and synthesized in the following manner: quantitative data were processed and summarized into graphs, charts, and statistics with the help of SPSS version 27, Microsoft Excel, and word processing tools to convey meaning from the data obtained, examine relationships between independent and dependent variables, and meet the objectives of the study, as noted by Saunders, Lewis, and Thornhill (2009). Qualitative data were analyzed by summarizing responses to open-ended questions and collating all responses on a single page for collective examination. Similar responses were categorized, and the frequency of responses within each category was counted, allowing results to be reported quantitatively, as suggested by Dudley (2011). Dudley (2011) further pointed out that statistical tests were conducted to determine whether there was a relationship between the hypothesis and the performance of residents of Juba on solid waste management.

Results and Discussions

The Solid Waste Management Practices and Gaps in the Management of Solid Waste in Juba City and Juba County

The findings of the study revealed that managing solid waste is one of the biggest problems cities have, especially in areas that are growing quickly. For the health of the public, the environment, and the long-term growth of cities, good solid waste management is very important. To come up with good solutions for Juba City and Juba County, it is necessary to understand current practices and existing gaps in waste management. Juba usually uses both official and unofficial ways to deal with waste, some of which are more effective and environmentally friendly than others. Responsible waste management practices include collection, sorting, and safe disposal, such as recycling or sanitary landfills. Poor collection and transportation systems, open burning, and inadequate waste separation often indicate poor management. These challenges are typically caused by insufficient funding, weak governance, and limited public participation. As a result, open dumping and burning are common, posing risks to environmental and public health. These findings are consistent with (UNEP, 2013). Effective solutions require a clear understanding of how cities manage solid waste. In many developing cities, solid waste management is hindered by a lack of reliable data, inadequate operational planning, conflicting institutional roles, insufficient technical capacity, and lack of sustainable financial support.

The findings revealed that most respondents (40.3%) indicated that children were responsible for disposing of household waste, while 23% reported that private collectors managed their household waste, and 16.5% stated that domestic workers disposed of their household waste in landfills. About 11% of respondents handled household waste daily, while only 9.2% reported that the Juba City Council managed their waste disposal. According to Nanda and Berruti (2021) and Johannessen (1999), landfilling is one of the oldest and most common methods of solid waste disposal. Many landfills are open dumps with minimal control measures. Unlike engineered landfills, open dumps lack leachate management systems, landfill gas controls, and operational regulations such as user tracking or waste compaction. Johannessen (1999) observed that in many developing regions, especially in Africa, landfill systems are poorly engineered and rely heavily on open dumping methods.

The study found that most respondents (70%) indicated that there are no rules or laws governing solid waste management, while 30% reported that regulations have been proposed but are still awaiting approval. An officer from the Juba City Council noted during interviews that the state government introduced an internal order in 2015 banning plastic bags, with a fine of SSP 500 for violations. The Transitional Constitution of South Sudan (2011, Chapter II, Article 41) also includes provisions for environmental protection. The Environmental Protection and Management Bill (2015), drafted by the Ministry of Environment and Forestry, addresses waste management, climate change, and environmental protection but has not yet been enacted. The National Environment Policy (2015–2025) outlines strategies for environmental protection, including waste management. The Local Government Act (2009) assigns waste management responsibilities to local governments. The Juba City Council has also developed bylaws on waste management, though revisions are ongoing. Additionally, the Juba City Sanitation Reform and Investment Plan emphasizes improving public health through better waste management, while Rejaf Payam introduced its bylaw in 2017 (JICA Expert Team, 2020).

These findings differ from those of (UNEP, 1996), which proposed balanced, cost-effective, and sustainable waste management policies in Sudan. However, there are opportunities to improve these policies. In Kenya, the National Solid Waste Management Strategy developed by the National Environmental Management Authority (NEMA, 2014) aims to achieve sustainable waste management aligned with Vision 2030. Regarding the 3Rs (Reduce, Reuse, Recycle), 67% of respondents were unaware of the concept, while 33% were aware. Similarly, 78% lacked awareness of recycling practices, while only 22% were informed. These findings indicate low levels of awareness despite general knowledge of hygiene and sanitation. Rajput et al. (2000) suggested practical reuse strategies, such as reusing containers, avoiding unnecessary purchases, and using reusable bags. Abdel-Naser (2011) and Monyoncho (2012) also emphasized that waste recycling remains a major challenge due to limited awareness, funding constraints, and workforce shortages.

The findings further revealed that 77% of respondents were unaware of the possibility of reusing solid waste, while 23% acknowledged its benefits. Reusing materials such as paper, metal, glass, and plastic can support economic growth and reduce greenhouse gas emissions by minimizing landfill use. Proper recycling practices include separating biodegradable and non-biodegradable waste, composting organic waste, and using designated recycling bins. The study also found that 73% of respondents observed waste being dumped in streets, sewers, and drainage systems, while 27% did not.

The results indicated that awareness campaigns remain limited. Only 29% of respondents received training through cam-

paigns, 25% through door-to-door education, 15% via radio and television programs, 12% through seminars, and 9% through brochures. A smaller proportion (6%) received information from newspapers and magazines, while only 4% reported exposure to demonstration programs. These findings align with Abdel-Naser and Abdel (2011) and Monyoncho (2012), who noted that financial constraints and limited human resources hinder effective awareness campaigns.

The results further showed that 36% of respondents supported both municipal authorities and private waste collectors in managing solid waste, while 23% favored households, 18% supported both municipalities and households, 8% supported municipalities alone, and 6% preferred private collectors. Only 4% selected all stakeholders as responsible. These findings contrast with (UNEP, 1996), which emphasized integrated and balanced waste management approaches. Additionally, 59% of respondents expressed dissatisfaction with waste management in the city, while 28% were satisfied, 8.3% were very satisfied, and 4.7% fell into other categories. Overall, 73% of respondents reported significant issues with the waste disposal system in Juba City and Juba County.

The Meaning of 3rs in Solid Waste

The findings of the study show that the majority of respondents (67%) do not know the meaning of the 3Rs in solid waste management, while 33% of respondents know the full meaning. The 3Rs refer to Reduce, Reuse, and Recycle. Furthermore, the study reveals a lack of awareness regarding the recycling of solid waste. About 78% of respondents interviewed were not aware of waste recycling in the study area, while only 22% were aware. The findings indicate that most residents were not aware of recycling practices, although they had received awareness about general hygiene and sanitation.

In view of the key informant interviews regarding whether waste is recycled in Juba City and Juba County, the following responses were reported:

"I don't think solid waste is recycled, and illegal waste collectors and sorters work at the Juba-controlled dumping sites and the Mogoro illegal dumping sites in Juba City and Juba County. They work with recycling companies in Uganda that buy waste from these collectors in homes, businesses, and schools before sending it to Uganda. People in Juba City and Juba County usually deal with solid waste in very simple ways, and there are few, if any, large-scale recycling programs. The most common way to dispose of waste is open dumping, which frequently occurs in uncontrolled areas. This poses a serious threat to public health and the environment. There are some informal waste collection and scavenging practices, but these are not part of a structured recycling system. Instead, they are often driven by necessity rather than environmental awareness" (Respondent 13, personal interview, July 7, 2023).

Awareness about reused solid wastes and the types of materials reused in solid wastes

Table 1. Types of materials reused

Types of material reused	Frequency	Percentage
Used paper	24	4
Used glasses and glass materials	24	4
Used Metallic material	230	38.3
Used plastics and plastic materials	282	47
Wearied clothes	24	4
Others	16	2.7
Total	600	100

Source: Field Data, 2023

The study's results showed that 47% of respondents used plastics, 38.3% used metals, about 4% used paper, glass, and clothing materials, and only 2.7% chose other options. Most of the respondents, 77%, interviewed were not aware of reusing solid waste in their residences and institutions. About 23% were aware of reusing solid waste in their residences and institutions, and the reuse of materials contributes to economic development. Materials such as paper, metal, worn clothes, glass, and used plastic are potential waste that can be transformed into valuable resources. The advantage of reusing solid waste is that it decreases the generation of greenhouse gases since there is the redirection of the waste which is redirected from landfills. Additionally, recycling solid waste generated in households involves several steps: segregating garbage into degradable and non-degradable categories, using flattened boxes for recycling, creating compost at home from leftover food, fruit, and vegetable peels, and placing recyclables loosely in bins instead of using plastic bags.

Households' Waste Disposal in the Landfill

Table 2. Household waste disposal

House solid waste disposal	Frequency	Percentage
Private collector	138	23
My house workers	99	16.5
My Children	242	40.3

Daily worker	66	11
Juba City Councils	55	9.2
Total	600	100

Source: Field Data, 2023

The results showed that most of the respondents (40.3%) said that their children threw away household waste. 23% said that private collectors threw away their household waste, and 16.5% said that house workers threw away their household waste in landfills. About 11% of the respondents regularly dealt with household waste, but only 9.2% of the respondents said that the Juba City Council threw away household waste in the landfill.

Dumping of Solid Wastes on the Street

Most of the respondents (73%) have seen solid waste being thrown away or dumped on the streets, in sewerage, and in ditches in Juba County and City. However, 27% of the respondents who answered did not see solid waste being thrown away or dumped on a street, in sewerage, or in ditches during the data collection. The following details outline the respondents' dumping of solid waste on the streets of Juba City and Juba County: "Waste dumping on the streets in Juba City and Juba County is a big and complicated problem that has serious effects on public health, the environment, and the growth of cities. This problem isn't just in Juba; it's also common in developing countries where cities are growing quickly, and it's made worse by poor infrastructure, a lack of resources, and a growing population. To understand how complicated this problem is, we need to look at its root causes, the kinds of waste involved, the effects it has on the environment and health, and the social and economic factors that keep it going (Respondent 14 interview in Juba, 10th July 2023).

Awareness and Training on Solid Waste Management

The finding revealed that 75% of the respondents interviewed indicated a lack of awareness and training regarding solid waste management, while 25% of the respondents who were interviewed knew about and had training in solid waste management. In an interview with researchers, one of the key informants interview was conducted with the Juba City Council on the awareness and training of the staff on solid waste management in Juba City. One of the officials who was interviewed explained that: "Yes, yes, there were some of the awareness campaigns conducted by the Juba City Council (JCC) in collaboration with private solid waste companies in Juba City. For the training, some of the Directors, the CEO, and officers were sent to Japan and Bangladesh for the training on solid waste management, recycling, financial reports, and the operation and maintenance of the machines for the Juba City Council (Respondent 15 interviewed in Juba, 14th July 2023).

The Methods of Training and Awareness for Solid Waste Management

Table 3. The method of training and awareness on solid waste management

Favored method of awareness and training	Frequency	Percentage
Open seminars	72	12
Brochures were distributed to residents	54	9
Solid Waste Management Campaign	174	29
Door-to-door education	150	25
Education programs via newspapers & magazines	36	6
Education programs in radio and television	90	15
Exhibitions presenting good practices in solid waste management, sorting, and recycling	24	4
Total	600	100

Source: Field Data, 2023

The results indicated the preferred approach for training and awareness to enhance their comprehension. Less than half of the respondents (29%) said they learned about solid waste management through a campaign. 25% said they learned about it through door-to-door education, and 15% said they learned about it through radio and television talk shows. 12% said they learned about it through seminars, and 9% said they learned about it through brochures given to residents. Approximately 6% of the respondents supported educational initiatives through newspapers and magazines. Only 4% of the respondents were on display, showing successful ways to manage, sort, and recycle solid waste.

Those Who Play the Greatest Roles in Household Solid Waste Management

Table 4. Those who play the greatest roles in household solid waste management

Household solid waste management	Frequency	Percentage
The municipality	48	8
The Municipality and the private waste collectors	216	36
The private waste collectors	36	6
Municipality and household	108	18

The households	138	23
The household and the private waste collectors	30	5
All of the above bodies are responsible	24	4
Total	600	100

Source: Field data (2023)

The results showed that most of the respondents (36%) were for the municipality and the private waste collectors. 23% were for the households, 18% were for the municipality and the households, 8% were for the municipality, 6% were for the private waste collectors. Only 4% of the respondents chose all of the bodies responsible for solid waste management, while 5% supported the households and private waste collectors.

Rules and Regulations of Solid Waste Management

The study revealed that a majority of respondents (70%) indicated that solid waste management is devoid of rules and regulations, and there exists no distinct legal framework for waste management. 30% of the people who answered said that there are rules and regulations for solid waste management practice that have been sent to parliament, but are still waiting for approval. An officer from the Juba City Council told us during the interviews that the state government made an internal order in 2015 that plastic bags could not be used in Juba. The order also says that anyone who breaks it by using the banned plastic bags will have to pay a fine of SSP 500 at a court of law. Chapter II (Article 41) of the Transitional Constitution of the Republic of South Sudan 2011 as amended also lays out ways to protect and preserve the environment from pollution, abuse, and degradation caused by people. In 2010, the environmental protection law was introduced in parliament. It was meant to control how waste is handled in South Sudan.

The National Environmental Bill, also known as the "Environmental Protection and Management Bill, 2015" is the law in South Sudan that deals with solid waste management. It talks about climate change, natural resources, natural heritage and environmental protection. It also has a section on waste management that talks about building capacity, collecting fees, educating the public about the environment and raising awareness for effective waste management. The Ministry of Environment and Forestry wrote the bill, but it hasn't been passed yet. The National Environment Policy 2015–2025 is the main plan for protecting the environment. It includes solid waste management and talks about the problems and difficulties that come with managing solid waste. The Ministry of Environment and Forestry has come up with a policy that has been approved by parliament but is not yet law. The Local Government Act of 2009 lists the kinds of public works that local governments do. It shows that local governments are responsible for waste management, just like they are for water and sanitation, energy, transportation, and communication. The Juba City Council has also made its own rules for how waste should be handled in the city. It has been changed to fit the way things are now in Juba. The new bylaws aren't done yet, but the Juba City Sanitation Reform and Investment Plan was made to improve public health in the future, including how solid waste is handled. Rejaf bylaw already made its own bylaw in 2017 (JICA Expert Team Report, 2020).

These findings were also supported by the data obtained from one of the key informants, who explained the rules and regulations of solid waste management in Juba City and Juba County. One of the officials who was interviewed observed that: currently, there are no approved rules and regulations for solid waste management in Juba City and Juba County because the National Ministry of Environment and Forestry's proposed regulations, intended for use by the Juba City Council and Juba County, have not yet been approved by parliament. However, both the Juba City Council and Juba County have established their own rules and regulations, while Rejaf Payam created its own bylaw in 2017 (respondent 16 interviewed in Juba, 18th July 2023).

Evaluation of Rules and Regulations on Solid Waste Disposal Practices

The study's results showed that half (50%) of the respondents interviewed thought that the responsible bodies were not following the rules and regulations for solid waste disposal very well. Only 28% thought they were doing a good job, 13% thought they were doing a very good job, and about 9% of the people who were interviewed didn't know anything about the rules and regulations for solid waste disposal in an institution or residential area.

The existing policies on solid waste management in Juba City Council Officers showed that 75% of respondents were unaware of the solid waste disposal policies in their area, while 25% were aware of the policies and how they were applied. The state authority implemented an internal order in 2015 that outlawed the use of plastic bags in Juba. The order also provides that any person violating it shall be fined SSP 500 at a court of law for using banned plastic bags. In addition, the transitional constitution of the Republic of South Sudan 2011 as amended, Chapter II (Article 41), also provides measures needed to protect and preserve the environment from pollution, abuse, and degradation caused by human beings.

Those Who Set Policies for Solid Waste Management

Table 5. Those who set policies for solid waste management

Policies maker	Frequency	Percentage
State government	126	21
National government	180	30

Juba City Council	156	26
County Authority	138	23
Total	600	100

Source: Field Data, 2023

The majority (30%) of the respondents were for the national government, while 26% of the respondents were on the Juba City Council. About 23% respondents were from the county authority, and only 21% of the respondents were from the state government, which set policies in the area.

Punishment of Violators of Solid Waste Management Regulations

The study's results showed that half (50%) of the respondents interviewed argued that the responsible bodies were not following the rules and regulations for solid waste disposal very well. Only 28% responded they were doing a good job, 13% said they were doing a very good job, and about 9% of the people who were interviewed didn't know anything about the rules and regulations for solid waste disposal in an institution or residential area. In an interview conducted with one of the key informants, the following responses came up from the respondents on the punishment of violators of solid waste management regulations: "fines for brokers of the law of Juba City Councils, July 2022: failures to renew or working without out permit shall be fined with 50,000 – 150,000 SSP, Garbage trucks fined with 40,000 – 80,000 SSP, sewage tankers fined with 75,000 - 150,000 SSP, pollution of the environment, such as water pollution, fined with 30,000 - 60,000 SSP, burning of garbage's at premises with fined 30,000 - 60,000 SSP, littering or dumping of waste on the streets or open space, washing of car along the main road which polluted the environment with the fined of 5,000 – 10,000 SSP. No person is allowed to pour the construction materials in open space or outside the road with the fined of 100,000 – 200,000 SSP, fine for grass cutter machine working without operation permits with 5,000 -10,000 SSP, unclean environment fined with 50,000 -100,000 SSP, Environmental Impact Assessment (EIA) fined with 100,000 -100,000 SSP, and finally those who pour the waste well bore fined with 5,000 -10,000 SSP (Respondent 27 interviewed in Juba, July 2023).

The distance (in km) of the disposal site from the residential area

Table 6. Distance (in km) from the disposal site to the residential area

Disposal site	Frequency	Percentage
2 – 4KM	204	34
4 - 6 KM	126	21
6 - 8 KM	36	6
8 - 10 KM	60	10
10 - 12 KM	48	8
> 14 KM	126	21
Total	**600**	**100**

Source: Field Data, 2023

The study's results showed that most of the people who answered (34%) lived between 2 and 4 km away, 21% of the respondents lived 4–6 km or more than 14 km from the disposal site. 10% lived 8–10 km away, 8% lived 10–12 km away, and 6% lived 6–8 km away.

The Problem Experienced as a Result of the Waste Disposal System

The study's results showed that 73% of respondents reported problems with the waste disposal system in their residential areas, while 27% reported no problems experienced as a result of the waste disposal system. The results of the findings from one of the key informants held in Juba in one of the institutions of education explained that there are problems experienced in waste disposal systems. One of the officials interviewed observed that: I believe that Juba City and Juba County in South Sudan, like many other rapidly urbanizing cities in developing countries, are facing significant and multifaceted problems stemming from their waste disposal systems. These problems are closely linked to public health issues (which can lead to diseases and contaminate food and water), environmental concerns (like harmful liquids, medical waste, and electronic waste), and socio-economic effects (the high costs of managing waste), lack of public awareness and participation, and uncontrolled and unsanitary disposal practices, all caused by poor waste management (Respondent 17 interviewed in Juba, 30th July 2023).

Schedule for the Litter Bins to Be Emptied

Table 7. Schedule for the litter bin to be emptied

Demand for services	Frequency	Percentage
Daily	36	6
Twice a week	90	15

Once a week	64	10.7
Twice a Month	48	8
Once a month	56	9.3
No litter bins are scheduled in our area	306	51
Total	600	100

Source: Field Data, 2023

The study's results showed that most of the respondents (51%) said there were no litter bins planned for their areas, and 15% said there were two times a week. About 10.7% of the people who answered said they would empty the litter bins once a week, 9.3% said they would empty them once a month, and 8% said they would empty them twice a month. Only 6% of the people who answered said they would empty the litter bins every day.

The Role of Stakeholders' Engagement in Successful Solid Waste Management in Juba City and Juba County

The study's results show that solid waste management in Juba City and Juba County requires the involvement of multiple stakeholders, including the national government, state governments, non-governmental organizations (NGOs), United Nations agencies, community-based organizations (CBOs), local communities, and the informal waste sector. Due to rapid urban growth, inadequate infrastructure, and low public awareness, such collaboration is essential. The Japan International Cooperation Agency supports pilot projects in residential areas, while the Juba City Council is responsible for waste collection and operational costs. Capacity-building initiatives include training officials in Japan and Bangladesh, as well as infrastructure development such as constructing garages for waste collection vehicles and training staff in financial management. The study further found that the government, particularly the Department of Environment and Sanitation of the Juba City Council, plays a key role in policy formulation, enforcement, and infrastructure development. These findings are consistent with studies by Namilyango College (2011) and Lohse (2003), which identified key challenges such as inadequate dumpsites, low public awareness, insufficient funding, lack of legislation, weak political support, and a shortage of trained personnel.

The findings revealed that in Juba City and Juba County, about 69% of respondents indicated that solid waste management regulations apply to them. However, South Sudan lacks a comprehensive legal framework specifically dedicated to solid waste management. Existing provisions are found within the Environmental Protection and Management Bill (2015), which includes waste management components such as awareness creation, capacity building, fee collection, and environmental education. The bill also addresses climate change, natural resources, and environmental protection, but it has not yet been enacted by the Ministry of Environment and Forestry. The Local Government Act (2009), which has been implemented, assigns responsibility for waste management to local governments alongside other public services. These findings align with Ogawa (2002), who noted that many developing countries lack clear and coordinated solid waste management regulations, making institutional coordination difficult. Although multiple policies exist, such as environmental protection laws and local government acts, they are often poorly structured. Strengthening regulatory frameworks is essential to improve public health and environmental safety.

The research findings indicate that approximately 50.05% of respondents were aware of the roles and responsibilities of stakeholders in solid waste management, particularly within local administrative units such as Munuki, Kator, and Juba blocks. Local government was identified as the most effective level for addressing these challenges, followed by the county government (29%). The national government, including the Ministry of Environment and Forestry, Ministry of Finance, and Ministry of Health, as well as state-level institutions, supports NGOs such as JICA, UNMISS, and UNICEF. The Department of Environment and Sanitation of the Juba City Council oversees waste management in the city. With a population of approximately 1.5 million, Juba generates about 950 tons of waste daily, equivalent to 0.57 kg per person per day. Waste generation increases during the rainy season, and higher collection frequency also contributes to increased waste volumes. Urbanization is a key driver of waste generation in South Sudan and other developing countries. Waste generation is also an indicator of economic development, with developed countries producing 1.5–2 kg per person per day compared to less than 1 kg in developing countries. These findings are consistent with studies conducted in Ghana by Juba City Chamber (2017), Peter (2002), and Abrokwah (1998), which identified challenges across waste management stages, particularly in collection, transportation, and disposal. Major contributing factors include lack of awareness, weak enforcement of sanitation laws, and limited technological capacity.

The study identified several critical challenges in solid waste management in Juba, including inadequate funding, limited technical expertise, weak institutional frameworks, insufficient waste collection systems, poor resource management, and corruption. Interviews with key informants revealed low levels of public awareness regarding proper waste handling. Many residents lack knowledge of appropriate waste management practices, and financial constraints limit their ability to pay for regular waste collection services. Additionally, existing disposal facilities are insufficient to handle the volume of waste generated. Government environmental policies are not strong enough to address the growing waste management challenges. These findings are consistent with Onibokun (1999), who noted that many developing countries face shortages of qualified personnel in planning, operation, and management of waste systems.

The Company Operates Outside Juba

The study revealed that the majority of respondents (89.3%) in-

dicated that no companies operate outside of Juba City. It shows that only 10.7% of the people who answered said that there are companies that work with solid waste outside of Juba city. There are solid waste companies in the payams of Juba County. The results showed that interviews were held with officials from various institutions, including a key informant on responses to solid waste companies operating outside Juba City. One official who was interviewed noted that: “No, I didn’t hear of any solid waste companies operating outside Juba City. I am aware of solid waste private companies in Juba City and the surrounding pre-urban areas (Juba County), including City Linking, Tangies, and Al Mangalawi, which are contracted by the Juba City Council (Respondent 18 interviewed in Juba, 30th July 2023).

Adequate Stakeholder Engagement in Solid Waste Management
The study revealed that a majority of respondents (87%) indicated insufficient stakeholder engagement in Juba's solid waste management, as initiated by the local authority department. Approximately, 13% of the respondents affirmed that there is sufficient stakeholder engagement in solid waste management in Juba County, as initiated by the local authority department. During key informant interviews, respondents said that some international partners, such as JICA, UNEP, UNICEF, UNMISS, and UN-Habitat, are helping Juba with solid waste management. For example, UN-Habitat provided trucks for dumping waste. JICA gave trucks to pick up trash and take it to the dump. JICA built the Juba Controlled Dumping Site (JCDS), which is 500 by 500 hectares and will take 25 years to fill. The Japanese and South Sudanese governments have signed a Memorandum of Understanding (MOU) to support a pilot project in the residential areas. The project will train JCC staff, especially the directors, CEO, and officers, in Japanese and Bangladeshi. The results of the findings from one of the key informants held in Juba in one of the institutions of education explained that there is no adequate stakeholder engagement in solid waste management. One of the officials interviewed observed that: I think that there aren't enough people involved in solid waste management in Juba City and Juba County. If more people were involved in managing waste in both the city and the countryside, Juba City would have been able to better manage its waste. The Juba City Council tries to manage the city's waste, but the companies they hire fail due to a lack of funds. As you know, the money they receive from businesses, institutions, residential areas, and agricultural farms isn't enough to pay the companies and workers who collect waste in Juba City and Juba County of Central Equatoria State, South Sudan (Respondent 19, interviewed in Juba, 2nd August 2023).

The Rules and Regulations of Solid Waste Management Practices
The research indicated that a majority of participants (69%) asserted that South Sudan lacks regulations and a dedicated legal framework for solid waste management. 31% of the people who answered said that there are rules and regulations for how to handle solid waste. The law that applies in South Sudan is about how to handle solid waste. The National Environmental Bill, also known as the "Environmental Protection and Management Bill, 2015," talks about climate change, natural resources, natural heritage, and protecting the environment. It also has a section on waste management that talks about building capacity, collecting fees, educating the public about the environment, and raising awareness about how to properly manage waste. The Ministry of Environment and Forestry is working on the bill, but it hasn't been passed yet. The Local Government Act, 2009, has been made public. It talks about the public works that local governments do in general. It shows that waste management is one of the things that local governments do for the public, along with water and sanitation, energy, transportation, and communication. The National Environment Policy 2015–2025 talks about a complete way to protect the environment, which includes managing solid waste (SWM). The policy also talks about the problems and difficulties of managing solid waste (SWM) in South Sudan. The Ministry of Environment and Forestry has written a policy that has gone through parliament but is not yet law. The solid management master plan is now in place in Juba, South Sudan.

Penalty For Violators of the Rule and Regulations on Solid Wastes Disposed of Illegally
The study's results showed that most of the people who answered (65%) knew what would happen if they broke the rules about illegal solid waste disposal. For example, from 2014 to 2016, the Juba City Council (JCC) set fines of 100 SSP to 200 SSP for people who broke the rules. If someone refused to follow the rules, they could be arrested and brought to court, where they would have to pay a fine of 500 SSP if they were found guilty. About 35% of the people who answered don't know what the punishment is for breaking the rules and regulations when solid waste is thrown away illegally. In an interview conducted with one of the key informants, the following responses came up from the respondents on the penalty for the violators of rules and regulations on solid waste disposal. One of the officials who was interviewed observed that: “Fines for brokers of the law of Juba City Councils, July 2022: failures to renew or working without out permit shall be fined with 50,000 – 150,000 SSP, Garbage trucks fined with 40,000 – 80,000 SSP, Sewage tankers fined with 75,000 – 1,50,000 SSP, pollution of the environment, such as water pollution, fined with 30,000 -60,000 SSP, burning of garbage’s at premises with fined 30,000 -60,000 SSP, littering or dumping of waste on the streets or open space, washing of car along the main road which polluted the environment with the fined of 5,000 – 10,000 SSP, No person is allowed to pour the construction materials in open space or outside the road with the fined of 100,000 – 200,000 SSP, fine for grass cutter machine working without operation permits with 5,000 -10,000 SSP, unclean environment fined with 50,000 -100,000 SSP, Environmental Impact Assessment (EIA) fined with 100,000 -100,000 SSP, and finally those who pour the waste wellbore fined with 5,000 -10,000 SSP (Respondent 27 interviewed in Juba, July 2023).

Adequate Policy from the Government for Solid Waste Management
The study's results showed that most of the people who answered (54%) said that the National Government or State Government has not set up a specific adequate policy for waste management to support successful solid waste management. However, 46% of the people who answered said that there are adequate policies

set up by the national government or state government to support successful solid waste management, but have not yet been put into place. For example, the Environmental Protection and Management Bill of 2015 addresses climate change, natural resources, natural heritage, and environmental conservation, and includes a section on waste management that covers capacity development, fee collection, environmental education, and public awareness for appropriate waste management. The Ministry of Environment and Forestry is working on the bill, but it hasn't been passed yet. The National Environment Policy 2015–2025 is a plan for protecting the environment that includes solid waste management (SWM). The policy also talks about the problems and difficulties of managing solid waste (SWM) in South Sudan. The Ministry of Environment and Forestry wrote the policy draft, and it has been approved by parliament, but it is not yet an official law. A good management plan for Juba, South Sudan. Juba City Council (JCC) has made rules for how waste should be handled in the whole city. It has been changed to fit the current state of affairs in Juba. The new bylaws aren't done yet, but the Juba City Sanitation Reform and Investment Plan was made to improve public health in the future, including how solid waste is handled. Rejaf Payam already made its own bylaw in 2017.

The Government has a High Priority for Solid Waste Management in an Institution

The study's results showed that most of the people who answered (67%) thought the government didn't put a lot of importance on solid waste management. Only 33% thought the government did. This is why they made the Juba City Council (JCC), blocks, quarter councils, and the Juba Rejaf Solid Waste Management Group (JRSWMG), which are all working. The results from one of the key informants revealed that in Juba city and Juba County, majority of the people responded that the government doesn't give high priority to solid waste management in institutions. One respondent narrated that: "many people in Juba City and Juba County, South Sudan, don't think solid waste management is very important, especially our National, state, and County governments. The rapid growth of the Juba population due to urbanization and the movement of people from their states to Juba City and Juba County has put a lot of stress on its new infrastructure and public services, including solid waste management. The lack of comprehensive urban planning and limited financial and human resources often leads to inadequate waste collection, transportation, and disposal systems. Open burning, uncontrolled dumping, and informal waste pickers are common signs of a solid waste management system that is struggling. In addition, the institutional framework for solid waste management in Juba County would include parts of the national, state, and local governments. It is hard to tell how big the waste problems really are and how well any solutions work because these institutions often don't work well because of a coincidental mandate, poor coordination, a lack of a clear legal and regulatory framework, and no systems for collecting and monitoring data (Respondent 20, interviewed in Juba, 10th August 2023).

Involvement of Community Participation in Solid Waste Management in an Institution

The study's results showed that 61% of respondents said yes to the idea of community involvement in solid waste management. Only 39% said no to the idea of community involvement in solid waste management in their institution. One of the key informants in Juba explained the results of the findings regarding community participation in solid waste management at the institution. One of the officials interviewed observed that: "Juba County and Juba City are both urban and pre-urban areas that produce a lot of different kinds of solid waste, like organic waste, paper waste, plastic waste, and hazardous materials. Institutions encompass educational entities (universities and schools), healthcare facilities (clinics and hospitals), government offices, as well as commercial and religious organizations. The size and type of waste produced will be very different depending on the size and purpose of the institution. A lot of people in our community know about and are involved in solid waste management, but right now, we aren't doing anything because the Juba City Council and the county government aren't working together. I don't even know how far they've come with waste management in the city and the county (Respondent 20, Juba, August 15, 2023).

The Type of Equipment for Solid Waste Management Operations

Table 8. The type of equipment for solid waste operations in Juba

Vehicle	JCC				TOTAL
	DES	Juba Block	Kator Block	Munuki Block	
JICA Dump Truck (12m3)	0	1	1	1	3
GA Dump Truck (10m3, 3.5 ton)	1	1	1	1	4
Compactor 12 m3 (Main Road)	1	4	3	4	12
Compactor 12 m3 (Residential)	0	2	2	4	8
Container Carrier 8 m3 (Lift type)	1	2	4	3	10
Containers 8m3	3	6	11	9	29
Bulldozer					1
Backhoe loader					1
Total number	**6**	**16**	**22**	**22**	**68**

Source: Field Data, 2023

The study found that Juba's solid waste management operations use JICA and dump trucks that can hold 12 m^3 and 3.5 tons. There are seven of these trucks in Juba, spread out over four locations: The Department of Environment and Sanitation (DES) has 1 dump truck. The Juba block has 2 trucks, the Kator block has 2, and the Munuki block has 2. There are also 20 compactors (12 m^3) for the main roads and neighborhoods. They are spread out like this: There are 6 in the Kator block, 6 in the Munuki block, and 1 on the main road. The Department of Environment and Sanitation (DES) is responsible for these. There are also 108 m^3 container carriers that can lift containers. They are spread out like this: The Department of Environment and Sanitation (DES) has 1 container carrier. Juba block has 2, Kator block has 4, and Munuki block has 3. There are 29 garbage containers (8m^3) in total, and they are spread out like this: The Department of Environment and Sanitation (DES) has 3 containers, the Juba block has 6 containers, the Kator block has 11 containers, and the Munuki block has 9 containers in Juba City Council. 1 bulldozer and 1 backhoe loader are meant for Juba County, but they haven't arrived yet.

The service provider collects the community's trash every day, and on average, it weighs 48 tonnes. If the service provider doesn't pick up the daily waste, it will pile up for two or three days. If we don't implement better waste management plans, the sanitation situation will spiral out of control. The service provider picks up the trash that the community makes and takes it to the disposal site, where it is disposed of. The most common way to get rid of these wastes is to leave them in the open at the disposal site, since there is no landfill in the municipality. The responding officer discussed the environmental impact of the community's open trash dumping site. Crude dumping is not advisable due to the environmental problems it causes, such as attracting flies, mosquitoes, and rodents; polluting water; emitting unpleasant odors and smoke into the air; and damaging land. People in the community want to burn things instead of throwing them away because they think all land disposal is hazardous and too expensive. Many dumps are poorly managed because they lack sufficient equipment. Because of this, the waste is burned during the dry seasons. Even so, the private service provider has problems with its contract to provide sanitation services for the community. For example, it doesn't pick up trash on time, skips trucks, other equipment breaks down often, logistics wear out, and it takes a long time to pay the various workers who are part of the public-private partnerships.

Challenges Facing Solid Waste Management

Juba faces many challenges regarding the provision of various public services and the development of social infrastructure due to the impacts of the conflict; regarding solid waste management (SWM). There are multiple problems such as lack of funds, low ability of administrative staff, lack of legal framework to support organizations, shortage of resources and deterioration of the sanitary environment. No enough trucks for solid waste management, lack of skills, lack of awareness, misused of solid waste management, workers do not have protective equipment, Lack of trucks for transporting solid waste management, lack of environmental bill for solid waste management and lack of capacity building. Solid waste management systems in underdeveloped nations demonstrate an array of challenges, amongst them financial constraints, inadequate technical personnel, and a lack of legislation and strict enforcement, which have been outlined below:

Financial and economic constraint: In a broader perspective, solid waste management is given extremely little priority in developing nations. Consequently, very meager resources are committed to the solid waste management sector by the governments, and the levels of services necessary for the safety of public well-being and the environment are not realized. Lohse (2003) has also portrayed that the challenges militating against monetary resources and metropolitan expenses is due to the lack of financial capital. According to him, this financial gap is expanding as municipal urbanization increases, giving rise to the requirements of infrastructure and other facilities, including appropriate landfills for waste disposal.

Inadequate technical personnel: In the majority of underdeveloped nations, there is generally a lack of human resources at both national and local levels with the technological know-how needed for solid waste management planning and implementation. Several officers responsible for solid waste management, particularly at the local level, lack technical backgrounds or training in engineering or management. Without adequately trained personnel, government-initiated projects cannot be effectively managed. Consequently, the development of human resources in beneficiary nations receiving external support is crucial for the sustainability of such projects. An additional limitation in developing nations is the absence of comprehensive strategies for solid waste management at both local and national levels. Onibokun (1999) observed that many public officials are unable to attract suitably qualified personnel for various aspects of waste management, including planning, operations, and supervision.

Lack of legislation and enforcement: In most developing countries, the absence of effective legislation for solid waste management contributes to unclear institutional roles and poor coordination among responsible agencies. In these contexts, legislation related to solid waste management is often fragmented, with multiple laws such as environmental protection acts and local government acts containing overlapping provisions. These regulations, enforced by different agencies, are frequently duplicated, leading to gaps in regulatory frameworks necessary for effective solid waste management systems. According to Ogawa (2002), legislation related to solid waste management in developing countries is often inconsistent, and there is a need to integrate public health and environmental protection laws to address these challenges comprehensively. In Ghana, major constraints in solid waste management include lack of knowledge, disregard for regulations, absence of enforcement mechanisms to penalize sanitation offenders, and limited availability of technological expertise (Abrokwah, 1998).

The Current Activities Regarding Solid Waste Management

Solid waste management in Juba City and Juba County is currently characterized by a developing master plan, limited public collection services and problems with getting rid of waste and

recycling. A master plan was recently put into place to help with long-term efforts but problems with resources and infrastructure are making it hard to carryout. Some private companies and NGOs are involved but most of the trash ends up in open dumps, which is bad for people's health and the environment. The following respondents elucidated the informants' interview in Juba City concerning the present operations of solid waste management. One of the officials who was interviewed observed that: "The City Council is currently responsible for managing solid waste. They do this by running projects in residential areas, collecting waste and operational costs, and training Juba City Council staff in Japan and Bangladesh, especially the Directors, Chief Executive Officer (CEO), and Officers. They also train the accountants of the Department of Environmental and Sanitation and the Juba City Councils, and are building a large garage to store 30 compactors (Respondent 15 interviewed in Juba, 30th July 2023).

The solid waste management master plan for Juba City and Juba County is as follows: the Juba City Council (JCC) launched a "solid waste management master plan for Juba City 2021-2030. The plan aims to strengthen governance, foster community ownership, and implement sustainable waste management practices, the plan was developed with support from the Japan International Cooperation Agency (JICA), the plan includes goals like increasing waste collection rates and improving landfill management. Waste collection and disposal: public waste collection is limited, primarily serving markets and large-scale waste generators, household waste, which constitutes a significant portion of the total waste, is largely excluded from formal collection services, insufficient resources, like waste trucks and appropriate disposal sites, hinder effective collection, poor road conditions and heavy rains exacerbate collection challenges, particularly in residential areas, open dumping and illegal dumping sites are common, with limited or no measures for pollution control, a major dumpsite, Juba City Dump Site (JCDS), is located approximately 20km from Juba town and is not properly managed, There are concerns about health risks associated with the dumpsite, including the presence of mosquitoes, flies, and scavengers. Recycling and Waste Reduction: Community awareness about waste management and recycling is low. There are initiatives to improve waste pickers' health and safety and to promote recycling. Some informal recycling activities exist, such as the collection and melting of scrap metal.

Conclusions

Solid waste management (SWM) in most developing countries is often characterized by inadequate service coverage, operational inefficiencies of services, limited utilization of recycling activities, inadequate management of non-industrial hazardous waste, and inadequate landfill disposal (Zurbrugg and Schertenleib, 1998). Although distinct differences exist between waste management in developed and developing countries, as developing countries achieve economic growth coupled with population growth, the environmental and economic burden of solid waste management will increase. The significant strides made in achieving the current level of success in the developed countries' waste management systems are broadly due to their belief that a sustainable waste management system is based on sound guiding principles, strong service delivery values, with as many locally based solutions as possible, and moving at a fiscally responsive pace. This mindset is needed to move waste management in cities and largely in developing countries towards achieving higher levels of sustainability, and any substantial change in the Solid Waste management will require close cooperation between the government, private sector, and citizens. However, analysis of the several studies' result indicated that solid wastes management by a public to private partnership was more favorable for dealing with urban solid waste than management by other practices since it provided a strong selective collection programs, reduce the amount of solid waste sent to sanitary embankments, led to the recovery an area of land previously degraded by the incorrect disposal of urban solid waste and stimulated the installation of an energy recovery unit.

Based on the findings of the study, the following conclusions were made: Major sources, types, methods and quantity of solid wastes that were generated and disposed in Juba city and Juba county include residential wastes such as streets sweeping, follow by Agriculture such as food waste, Commercial waste which was the markets, hospital medical wastes, hotels and restaurant, Institutional wastes such as universities, colleges, schools and government ministries and construction wastes including demolition waste, and others wastes in Juba include: worn wastes, metallic wastes, hazardous wastes, plastic wastes, container wastes a significant portion of population does not have access to waste collection services and only a fraction of the generated wastes are collected by door to door collection system introduced by Juba City Councils (JCC), Japanese International Cooperation Agent (JICA) Non-governmental Organization (NGOs) and private companies. The majority of the respondents knew solid waste disposal methods as represented by those digging a hole around the house and disposing, dumping, or burning. Some throw it in open space or on street of Juba for the collection, disposed on the backyards of the house, bury their wastes, throw it wastes in to the nearby the rivers/streams and throw in to the nearby ditches, most of the residents had little knowledge on solid wastes disposal, types of diseases and diseases vectors associated to solid wastes which is caused by poor waste disposal while small portion of the respondents had moderate advanced knowledge on solid waste disposal, types of diseases and diseases vectors caused by poor wastes disposal in Juba Controlled Dumping Site (JCDS) and Mogoro Illegal Dumping site.

Open dumping was the popular method of waste disposal. Others are digging a hole around the house and disposing of, burning, throwing it on the streets, composting, and reusing. The majority of the respondents were not aware of the segregation of solid waste. Long distance to the JCDs dumping site, lack of environmental policies, lack of equipment, lack of vehicles, lack of skill, lack of environmental bills, lack of collection points, lack of awareness, lack of protective equipment for workers, misused of funds collected for solid wastes management and lack of understanding with National and State Ministries of Environment and forestry were the major challenges

faced on solid waste management efforts by residents.

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