

Municipal Solid Waste Management in Juba City: A Case Study of Juba city, South Sudan

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Abstract: There are excellent opportunities for Juba city (South Sudan) to provide a wide range of urban services including waste management in the informal settlement, which have a direct positive impact on resident's health, creation of employment, and poverty reduction. This study shows how government involves the community in the solid waste management in order to solve the problem of uncollected waste after the failure of the municipal council to do so. The study examines the performance of the existing solid waste collection and disposal practices, resident's willingness to participate, and identifies problems relating to the solid waste management system of Juba. Methods used in the study are, questionnaires, interviews and observations. It has been found that there is illegal dumping of waste and over 90% of the people participates the questionnaire refuse paying collection fees. The success of people-based solid waste management depends on the participation of the residents and has a great relation with its local economy. The findings from this study could be used in preparing an improved solid waste collection process.

Key words: Government, Municipal solid waste management; Public participation, Questionnaire, Urban service

1. Introduction

Solid wastes are non-liquid wastes that arise from human and animal activities and are discarded as useless or unwanted. These include both organic and inorganic fractions such as kitchen refuse, product packaging, grass clippings, cloth, bottles, paper, paint cans, batteries, etc. Solid waste generated in the municipality, encompasses heterogeneous and homogeneous wastes from urban, peri-urban regions. Municipal solid waste management (MSWM) is associated with the control of waste generation, its storage, collection, transfer and transport, processing and disposal in a manner that is in accordance with the best principles of public health, economics, engineering, conservation, aesthetics, public attitude and other environmental considerations.

There has lots been said and demonstrated about the inadequacies in solid waste management and its associated problems. A research conducted by (Gebriil and al 2010) concluded that population growth, rapid urbanization, and industrialization resulted in

increasing problems of solid wastes in Benghazi City. (Jin, al et al. 2013) reported that the disposal and handling of waste lead to environmental degradation, damage of the ecosystem and pose great risks to public health in Pabna City. The study shows that there is a significant link between the improper management of urban solid wastes and the environmental pollution. In this research, it pointed out that Pabna was facing serious environmental degradation such as land, water, and air pollution and public health risk such as skin disease, asthma, diarrhea, and even skin diseases, etc., due to uncollected disposal of wastes on streets and other public areas, drainage congestion by haphazardly dumped wastes, and contamination of water resources near uncontrolled dumping site. A study by Abel (2007) provided an information base to plan for the equipment required for the collection and transport of waste in a City of Ogbomoso, Nigeria. The study was aimed at making decisions on possibilities for waste reduction through sorting and recycling, and disposal methods. It highlighted a very high proportion, more than three quarters, of organic waste in total waste flows of the city. Saha (2013) reported that the disposal and handling of

waste lead to environmental degradation, damage of the ecosystem and pose great risks to public health in Pabna City. The study shows that there is a significant link between the improper management of urban solid wastes and the environmental pollution.

(Goel 2008) had critically reviewed MSW practices in India and found that the major problem was underestimation of generation rates and, therefore, underestimation of resource requirement, lack of technical and managerial inputs, lack of reliable and updated information, and for this approach to waste management resulting in inefficient utilization of resources. (Chandra and Devi 2009) studied problems and prospects of municipal solid waste in Mysore City. Their findings showed the current system of municipal solid waste management in Mysore City was not adequate as per municipal solid waste (management and handling) rules. (Tadesse and al 2008) analyzed the factors that influence household waste disposal decision making. Results showed that the supply of waste facilities significantly affect waste disposal choice. Inadequate supply of waste containers and longer distance to these containers increases the probability of waste dumping in open areas and roadsides relative to the use of communal containers. In their study, (Bekin and al 2007) noted that in the absence of appropriate institutional structures, it becomes difficult to ensure solid waste reduction at an individual level. They continue to emphasize that waste reduction may only be viable in a community with some control over production and consumption of some items (Bekin and al 2007). This kind of arrangement is bound to give power to the existing structure to operate in a manner within their own choice of means. In Bangladesh, (Hai and Ali 2005) studied the solid waste management system of Dhaka City Corporation (DCC) and found that DCC was not able to offer the desired level of services with the existing capacity and trend of waste management. (Zubrugg and Ahmed 1999) stated that problem areas in developing countries include: (i) inadequate service coverage and operational inefficiencies of services, (ii) limited utilization of recycling activities, and (ii) inadequate landfill disposal. (Vidanaarachchi and al 2006) conducted a study in Sri Lanka on the problems, issues, and challenges of solid waste faced in the country's Southern Province, and they found that only 24% of the households had regular access to waste collection and that in rural areas it was less than 2%. They also found that a substantial number of households in areas without waste

collection expected local authorities to collect their wastes. (Sharholy and al 2008) presented a comprehensive review of the characteristics, generation, collection and transportation, disposal and treatment technologies of municipal solid waste practiced in India. The study is concluded with a few suggestions for the efficient management of such waste such as involvement of public and private sectors through NGOs, increasing the public awareness, proper timing and scheduling for collection of waste from house to house, proper design and placing of collection bins, proper maintenance of transport vehicles for such wastes.

There are also some researchers who had documented how an adequate legal framework contributes positively to the development of the integrated waste management system (Abdelnaser and al 2007), (Asase and al 2009) while the absence of satisfactory policies (Mrayyan and Hamdi 2006) and weak regulations (Seng and al 2010) are detrimental to it. With regard to the pricing for disposal, (scheinberg 2011) noted that there are indications that high rates of recovery are associated with tipping fees at the disposal site. High disposal pricing has the effect of more recovery of waste generated that goes to the value chains or beneficial reuse of waste. Also, (Pokhrel and viraraghavan 2005) mentioned that insufficient financial resources limiting the safe disposal of waste in well-equipped and engineered landfills and absence of legislation are also factors contributed to the pricing for disposal. In addition, (chung and poon 2001) agreed that having a clear structure of charges for waste collection and disposal in place may even work as an incentive for waste reduction.

They believe that there is need to change the approach for waste reduction from the “command-and-control” to the use of economic incentives and “polluter-pays” (chung and poon 2001). This can be a step in involving the public in solid waste management and also forms an impetus for innovative thinking to devise cheaper and more convenient ways of managing solid waste. Another supportive study by (Parrot 2009) discussed the statutory, financial, and physical aspects of MSW management in the City of Yaounde’, the capital of Cameroon. They identified transportation distances, infrastructure quality, and accessibility as decisive factors on waste collection considerations in this city. In relation to recycling, (Omran 2009) investigated attitudes of households toward recycling solid waste in the state of Kedah in Northern Malaysia. They conclude that simple improvements at bring sites could significantly increase recycling rates. If dwellers and shopkeepers are given waste storage containers of a standard size and collection is done regularly, then people are less likely to throw waste onto roadsides (Omran and al 2009). In Thailand, (Suttibak and Nitivittananon 2008) investigated the factors that In the developed countries, solid waste management (SWM) belongs to prominent thrust areas for pursuing research (Shehdar 2009). High population growth rates, rapidly varying waste characterization and generation patterns, growing urbanization and industrialization in developing countries (Troschintz and Mihelcic 2009) are the important reasons for paying attention towards MSWM as more area is required to accommodate waste (Idris, Inane et al. 2004). Several studies suggest that reutilizing of solid waste is not only a viable option to MSWM (Kasseva, Mbuligwe et al. 2000) but also desirable—socially, economically, and environmentally One of the significant problems in urban India is almost no segregation of MSW and disposal of construction and demolition debris (C&D), plastic wastes, commercial and industrial refuses, and e-waste

(Buenrostro, Bocco et al. 2003). Annually, about 12 million tons of inert waste are generated in India from street sweeping and C&D waste and, in the landfill, sites, it occupies about one-third of total MSW. In India, MSWM is governed by Municipal Solid Waste (Management and Handling) Rules, 2000 (MSWR) and implementation of MSWR is a major concern of urban local bodies (ULBs) across the country. Minghua et al. (2009) stated that in order to increase recycling rates, the government should encourage markets for recycled materials and increasing professionalism in recycling companies. Factors like poor and inefficient coverage and operation of services, inadequate or missing recycling strategies and activities, limited or unproductive management of wastes were mentioned by some scholars as factors contributing to poor solid waste systems in any country (Henry et al. 2006; Vidanaarachchi et al. 2006; Omran and Gavrilesco 2008; Longo and Wagner 2011). Other factors mentioned by other researchers are financial support for recycling projects and infrastructures (Nissim et al. 2005; Moghadam et al.2009), recycling companies in the country

The Republic of South Sudan became a new nation and Africa's 54th country on July 9th, 2011, after a peaceful secession from the Sudan through a referendum in 9, January 2011. As a new nation, South Sudan has the dual challenge of dealing with the legacy of more than 50 years of conflict and continued instability, along with huge development needs. Formal institutions are being built from a very low base and the capacity of government to formulate policy and implement programs is limited but growing. The main objectives of this paper are to identify types and quantity of solid waste accumulation in the studying area; and evaluate the role of the government and community in solid waste management processes at household levels.

2. Materials and Methods

The primary data were collected through interviews with the government officials, questionnaires with the citizens and observations based on the field visit. The secondary data were collected through literature reviews such as research studies and reports in books, journal articles, internet sources, and government reports. Questionnaires, interviews and observations have been used in this study to obtain important information about solid waste collection. Each item in the questionnaire was developed to address specific objective of the study including examining the performance of the existing solid waste collection. Structured or closed ended and unstructured open-ended questionnaires were formulated for the purpose of this study. Self-administered questionnaires were distributed to the heads of households. This was done so to make sure there is proper understanding of the questions and return of all questionnaires. Structured and unstructured interviews were another source of primary data collected. Interviews were conducted with local government leaders including solid waste management inspectors of Juba city council Munuki Block. Observation was done by several visits' residential areas, business places, markets, restaurants, streets, dumping site. Another method used to collect secondary data used was literature review. Review of different materials including books, articles, policies, internet, previous research studies. Once the questionnaire has been administered, the masses of raw data collected were systematically organized in a manner that facilitated analysis. Both descriptive and statistical analysis was anticipated; therefore, the responses in the questionnaire were assigned numerical values and analyzed.

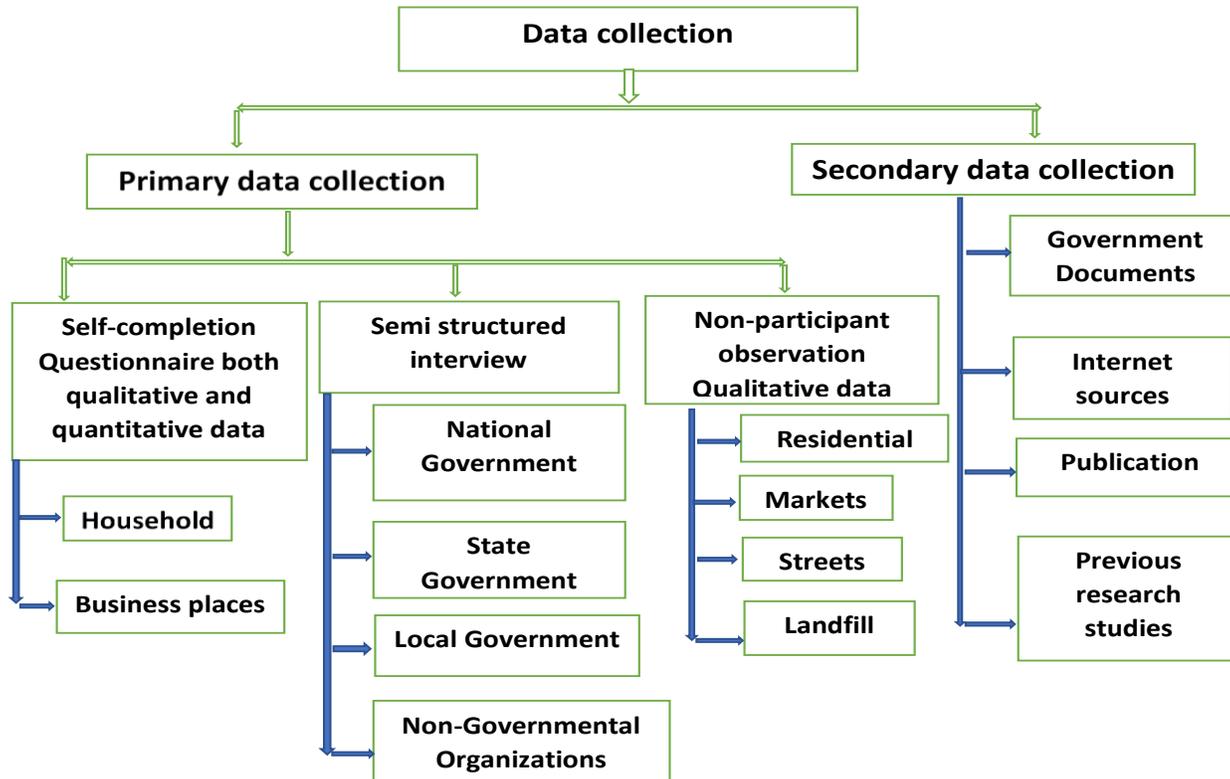


Figure 1: Schematics of the data collection methods.

3. Municipal Solid Waste Management Currently Practices in Juba City

3.1. Solid Waste Generation

Solid waste in Juba city is managed by the department of Environment and sanitation of Juba city council, solid waste quantities which are produced in the City of Juba are large and increasing with the growing affluence and improved standard of living. Municipal waste generation average rate reaching 0.5720kg/per person/day (source Juba city council 2017), the population of Juba city is 1.500.000 such population generate approximately 942 tons of waste per day. Rain season is a higher waste generation rate. Solid waste generation changes per day in addition to the recurring seasonal variations. Collection frequency also affects waste generation; in general, a more frequent collection produces more MSW. Increasing the urbanization is one of the affects in the overall rate of solid waste generation in many countries (Pokhrel, Viraraghavan et al. 2005). The quantity of generated waste is a socioeconomic indicator and a function of the degree of a nation’s development. The difference in waste production between cities in developed countries (1.5–2 kg/person/day) and those in developing countries (generally less than 1 kg/inhabitant/day) is noteworthy (Guermoud and al 2009). This significant difference is due to consumption modes, as industrialized countries consume more products and use more packaging.

Table 1. The amount of waste generated from households in three Blocks (Districts) Juba city (estimated in tons/day) (source: Juba city council record 2017).

Juba city council	population	Unit (kg/per person/day)	Waste amount (ton/per)
Munuki block	675,000	0.572 (kg)	386 (ton)
Juba block	450,000	0.571 (kg)	257 (ton)
Kator block	375,000	0.798 (kg)	299 (ton)
Total	1.500.000	0.654 (kg)	942 (ton)

3.2. Solid Waste Sources and Compositions

This section provides composition data for MSW produced in three (3) Block or (Districts) of Juba City Council Municipal Solid Waste core components are food waste, plastics (bag and bottle), metals, paper, aluminum, textiles, garden waste. It contains mixed composition of waste including both degradable and non-degradable materials, and the wastes are usually collected without sorting. Compositing is one of the ways of recycling biodegradable wastes. Most of the non-degradable wastes are potentially recyclable materials, whereas the degradable materials can be composted. Plastics mainly come from water and fruit juice bags and containers (source Juba city council).

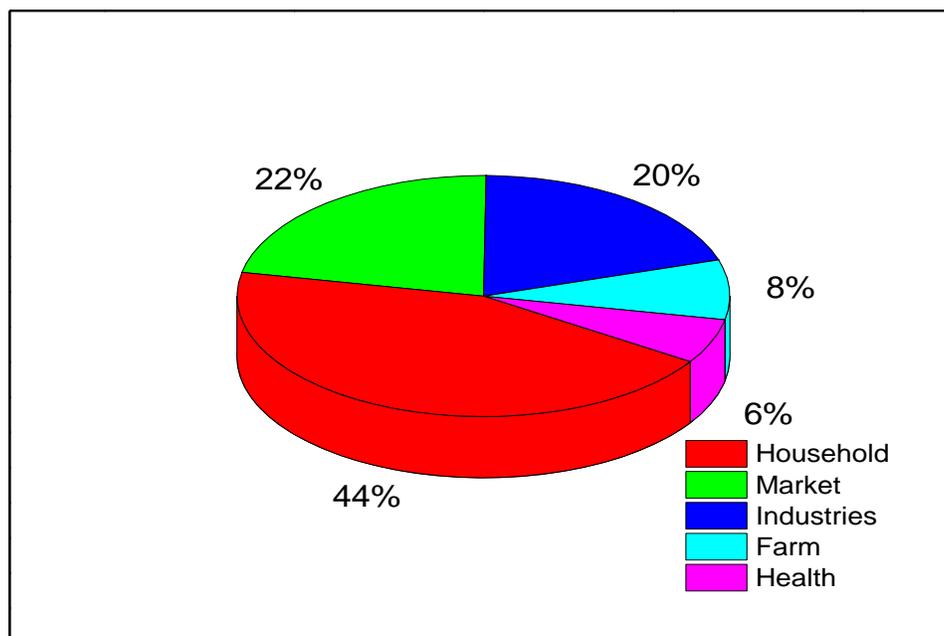


Figure 2. sources of municipal solid waste in Juba city (source: field survey).

At first, it is critical to identify the sources of the municipal solid wastes. Based on the data we collected, most of the waste comes from household and considerable amount of daily waste needs to be treated and follow by the market and industries. Farm and health facilities discarded little amount of waste.

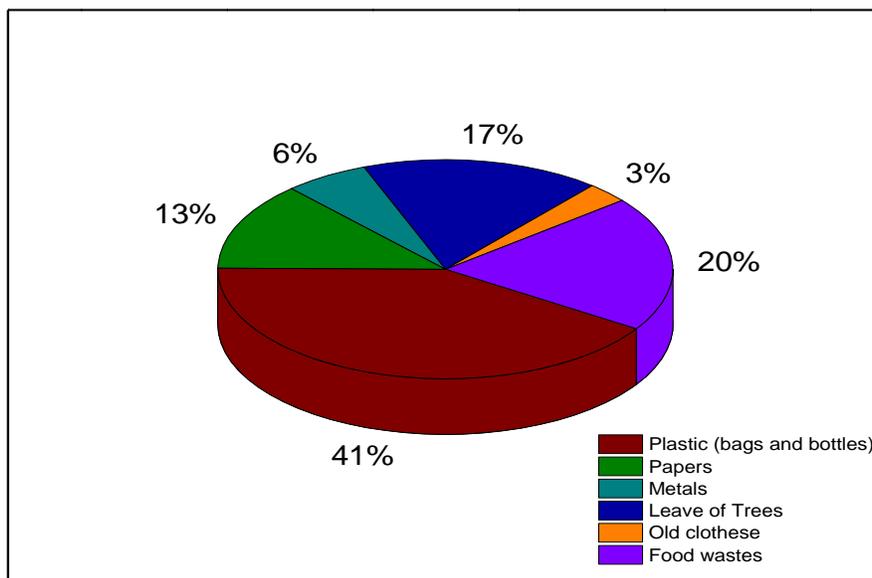


Figure 3: solid waste compositions in Juba city (source: field survey).

There are different types of waste depending on the number of the family and standard of living. Components of Municipal Solid Waste during the field survey it was generally observed that plastic (Bags and Bottles) are the common wastes which comes from the city as shown on (Figure3) 41% according to respondents, this poses high risk to the environment. In the absence of appropriate waste management most of these wastes are burned and possibly produce a considerable amount of VOC (Volatile Organic Compounds) in addition to this when it is buried it may stay non- degradable in the soil for along years about (30 years). Food waste (organic wastes) is the second large waste produce after plastics (bags and Bottles) if its 20% as shown on the (Figure 3), follow by Garden wastes 17%, and papers 13%, metals 6%, Textile (Clothes) 3% very little waste discarded according to (Figure 3) in the study area.



Figure 4: Picture components of solid waste at uncontrol landfill (source: field survey).

3.3 Solid Waste Collection, Transportation, Disposal and Recycling

Juba city council, department of Environment and sanitation is a body in charge of management all waste types within three Blocks (Districts) of Juba city but only the garbage collection just limited to the markets and business places, restaurants and road, main streets and in some areas like first- and second-class residential areas the collection is just covering small area and the rest of residential areas without collection services due to lack of fund, facilities e.g.; tipper/compactor trucks to collect the garbage's, lack of private companies to take over residential areas in garbage collection. Juba city council department of Environment and sanitation has five zones all lies within the area map of Juba city administration managed by a zonal coordinator together with environmental officers and public health officers, rate collectors, supervisors. Operates on a centralized system where all the garbage trucks are sent from head office to the zones no containers provide by the city council.

Collection and transport are of significant importance in reducing waste accumulation, Solid waste collection and transport are often conducted in the morning's hours. Lack of funding and inadequate maintenance causes a shortage of vehicles for waste collection, Juba city council ability to maintain waste collection is low and the 10 vehicles owns by Juba city council are broken out of three compactors provided by UNICEF in September 2016, one has already broken and not operational. Efficient solid waste collection depends on the proper selection of vehicles, which should be enforced with a consideration of road conditions, and availability of spare parts, servicing requirements, and haulage distances.

A cause for serious concern is that most localities dispose of, and sometimes burn, their waste in random open dumps that do not adherence to health and safety requirements. Local authorities use the burning method for volume reduction or for financial

reasons. The budget for disposal is very small and does not cover further treatment. Thus, localities perform waste disposal services according to the available resources from the collection fees. In turn, collection services deteriorate because the localities have highly limited financial resources.

The gathered information indicates that Juba does not employ and sorting or recycling processes for waste. Sorted recyclable wastes from households are also uncollected. In addition, specific containers for waste segregation are unavailable. People throw away materials as waste regardless of their possible benefits. These types of waste mainly include iron, aluminum, pipes, plastic bags, plastics, magazines, and newspapers.

3.4. Challenges Facing Solid Waste Management in Juba city

Lack of fund from government for garbage collection, Lack compactor Trucks to collect the garbage, higher rate of renting trucks for garbage disposal. Garbage collection is limited to the business places and in first and second-class residential areas leaving out quarter councils. Lack of private companies to take over residential area in garbage collection. Most of the staffs are not trained in the field of waste management another thing is Impassable roads in some residential areas. Unwillingness of some business owners in paying garbage collection fees, Low salaries for the cleaners. Deteriorating economy has made things difficult in the markets, etc.

3.5. Economy and Regulations for Waste Management

The perennial economic crisis that characterizes the waste sector in the City of Juba needs to be addressed to improve waste management in the city. In this regard, the central government can significantly improve its fund allocation to municipal governments in a softer way and fixed schedule in order to avoid delay payments for waste who require funds to meet the operational costs of solid waste collection. At the same time, the municipal governments can be supported to improve revenue mobilization from local sources. Such support can be achieved by attracting qualified finance and accounting staff professionals who can identify additional sources of funds, such as taxes on properties and business. Employing such qualified persons can also improve the financial management practices of the assemblies by plugging leakages and preventing corruption. Additional revenue can also be raised from clients of waste disposal services.

It is clearly known that finance is an important resource for sustainable solid waste management. However, in case of Juba city it can be stated that most of the municipal corporations do not have many resources due to various constraints and priorities. One of these constraints are due to the absence of transparency in financial regulations by incorporating the double-entry system such as existing fiscal incentive to public private partnership projects that provide a capital incentive for solid waste management alternatives or encouraging the private-sector participation, grants of soft loans, subsidies, and exemption from taxes.

Laws, policies, and regulations are important tools for managing solid wastes in any country. However, the lack of proper legislation on the solid waste management has been one of the major issues for illegal dumping. The shortage of sufficient legislation makes it difficult to allocate clear authorization to urban sector institutions associated with solid waste management. There is a

shortage of public compliance with waste disposal and dumping laws. This lack of implementing the laws regarding the waste disposal produces a public lack of respecting the laws as well as encouraging ineffectual waste handling practices such as wasting and dumping of waste in drains and at roadsides.

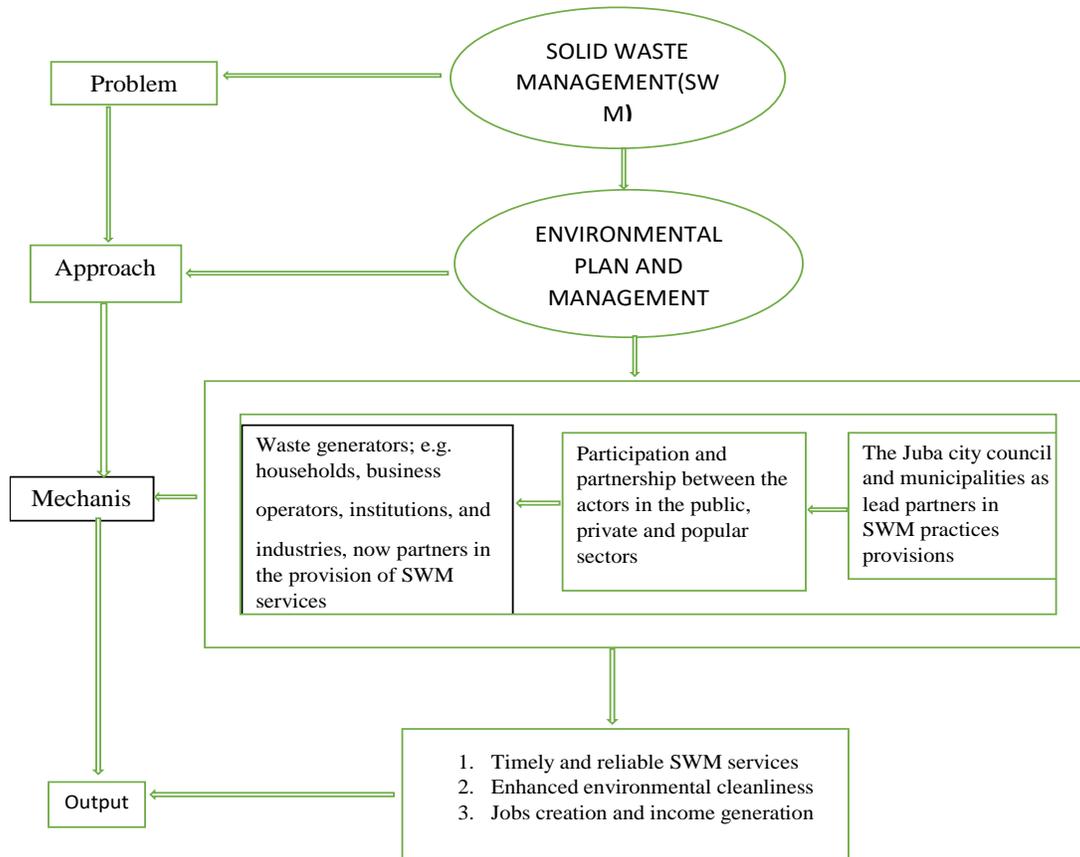


Figure 5. Proposed practices for solid waste management improvements

4. Discussions

Juba City suffers from the aggravating problem of solid waste at the density populated, based on the data collection and analysis, it was revealed that the authority of solid waste in the city of Juba City lacks experience and effective practice in the collection, transportation and disposal of waste, that it is still uses traditional methods of collection and transport of conventional waste disposal randomly in old dumps where health standards are not available, and it operates its work without prior study to the city’s population increase and urbanization in the outskirts of the city, and its lack of control over waste collection process in all three blocks (districts) regularly. neighborhoods and the marginal areas of the city where we find piles of garbage on the roads, water canals and space on the outskirts of neighborhoods as is the case of the neighborhoods of Kator and the old market (Konyokonyo Market) and the main streams that this phenomenon has become a concern of the city’s population, but still a limited service was provided by the administration of Juba city council to some parts of the city, especially in the main streets, the city’s residents, in some neighborhoods.

The main aim of the study was attempted to examine the current situation and practice of municipal solid waste management in the City of Juba. However, Laws and regulations to preserve the environment are not applied due to the lack of a suitable mechanism by the administration of solid wastes in Juba without exception, while we found that some developing countries applied regulations and texts that support and keep the environment clean. This study has proved that the traditional practice for solid waste collection and disposal is useless, for example, that the citizen burnt the waste nearby houses and some citizen carries their wastes to the main streams (Khor) and when it is raining the rain water wash all the garbage to the Nile. Lack of awareness of the health risks of solid waste among families, in general, and decision makers in particular were one of the major obstacles. The illiteracy of some families and workers of solid waste administration or around of the seriousness of such wastes in terms of the types of pests, diseases, and germs may transmit to the healthy and the resulting loss of lives, financial losses, and time which we desperately need. Improving solid waste collecting and disposal requires the ability and the proper approach, and it is linked to improving and maintaining the local infrastructure and as soon as possible due to the urgent need to upgrade local roads in some neighborhoods of the city so that the vehicles' have the ability to gather during the raining season and in all conditions. The study revealed a lack of awareness of citizens of how to get rid of household's waste routes properly, that respondents believe that the solid wastes are thrown in open places in the city, rubbish and wastes end to burn a suitable way for getting rid of them. It is essential to educate the citizens particularly future generations of the importance of benefiting from the disposed garbage. Generating solid waste in Juba City rises up to about 942 tons/day during 2017, and collecting such waste in the city faces the problem that the compressing trucks not have the ability to engage in some city neighborhoods not because they do not have good roads, some roads are also narrow, so vehicles cannot have easy access to these areas. Additionally, municipal of solid wastes should be separated and be stored in separated containers.

The more applicable and used ones are categorized into three different color of containers known as (green, blue, and brown colors), and they should be provided with a lid. For instance, the first container should be used for storing paper and cardboard, the second should be used for other recyclable materials, and the third one should be used for organic materials. It is preferred that the containers that will be used in institutions such as offices, shopping centers, and schools should be designed according to the quality and quantity of waste generated by the institutions. Another important strategy for improving municipal solid waste management in the city is that the roadside waste collection. It is a method where residents sort recyclable items into the specific collection containers offered by the local authorities. Although many residents collect the relatively high valuable things from the domestic wastes before they place them into the collection sites, most reusable and recyclable items are used to be sent to dump site and burn them there without recycling. Solid waste collection is considered one of the most important processes in the management of solid waste the one who the directors monitor and evaluate the performance daily or weekly collection process, the timetable should be design and given to drivers put programs specific time of collection.

According to the results from the data analysis, the following recommendations are presented and proposed to improve the MSWM in Juba city. (1) Municipal solid waste Management problem in South Sudan especially in Juba town required collective responsibility and authority. This responsibility should be shouldered by local authorities at the state and national level including: the private sector, government and non-governmental organizations. (2) The government should provide the best service to the society, the different unit operations involved in collection, storage, transport, recovery and disposal. (3) Reduce the use of drinks poly bottles for storing water; (4) Ban the use of plastic (bags and water bottles). (5) Encouraging use of (bag and water bottles) that environmentally friendly. (6) Managing excreta of pet dogs and cats. (7) Recycling of solid waste should be considered as one of the alternatives to waste disposal. (8) The Public health authority should provide standard waste containers or garbage bags to each household and must be collected after three days. (9) The government should create the program of public health and environmental awareness on local radios and televisions.

5. Conclusions

This pioneering study on solid waste disposal in Juba Town is intended to be a pointer to the problems of solid waste management and their implication to environmental health rather than offering scientific solution to them. The result of this study reflects in poor solid waste management as most of the disposed waste are done locally and, in most cases, burned regularly emitting high smoke in the air nearest to resident. The best way of solving the problem is provision of facilities and sanitary disposal of solid waste must be far from away from the residential area.

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