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Prospects of the Involvement of Stakeholders in Solid Waste Processing in Developing Nations

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Abstract

This paper has covered relevant grounds in the literature for understanding the phenomenon of solid waste, its generation, challenges, processing approaches and strategies, the underlying philosophies in the approaches and strategies, as well as case studies of the efforts made in different parts of the world, with interest in driving factors for stakeholder involvement in solid waste processing. In particular, the review found that information on the failure of existing SWM systems in underdeveloping nations of Africa, Asia, and Latin America are widely reported, but the explanation on the capacity and networking/collaborations for the involvement of stakeholders is found to be limited in scope and utility. This review has highlighted information that equips the researcher to investigate the scope of involvement of the stakeholders in solid waste processing, with particular attention to their resource capacity and networking/collaboration efforts to contribute towards bridging the knowledge gap in this respect.

Keywords: Solid waste, Stakeholders, Waste processing, Management, Sustainable

1 Introduction

Solid waste management (SWM) has been recognized as a critical infrastructure globally, that is as essential as freshwater, power, and telecommunication that should be provided in all urban centers [1]. When a public health crisis, like the Covid-19 epidemic, exacerbates the solid waste management problem, its importance as a vital function manifests clearly [2]. While SWM is amongst the singnificant hygenic barriers for preventing diseases transmission [3], the mounting of uncollected rubbish in cities is a major cause of shame for authorities and resentment to the residents which can lead to a hostile political response in some circumstances [4]. Stakeholders are increasingly held accountable for the failure of the management systems due to inadequate, ineffective, and unsustainable practices [1].

Growing rates of Covid-19 pandemic, population, urbanization, industrialization, and rising standards of living have led to the rapid increase in the types and quantity of solid wastes. This is because human activities inevitably generate solid wastes every day due to process applications and consumption. As documented by WHO cited in [5], Between 1990 and 1992, urban growth rates in Africa and Asia were 4.9 percent and 4.2 percent, respectively, whereas urban growth rates in Europe and North America were 0.7 percent and 0.1 percent, respectively. During the 1950s, African cities had urban populations ranging from 1 percent to 3 percent of the entire population, but these statistics have now risen to almost 60 percent of the total population [6]. Unfortunately, over 60 percent of solid trash created in underdeveloped nations is not collected. [7], while sixty-five percent (65) of the population are living in urban areas where solid waste management services are lacking [8]. The situation today is more acute due to increasing urban populations without commensurate growth in policy and the capacity of stakeholders to adequately and effectively process solid wastes generated in their areas to recover, reuse and recycle materials for a sustainable management system. The increasing quantities of waste generated in the urban centers remain a challenge for stakeholders to adequately and effectively manage. In African municipalities, for example, generation may increase up to five-fold by the year 2025, with over 70 % made up of organic waste [9]. Most cities contend with problems associated with waste, especially environmental pollution in its various forms (air, water, land, and soil). Although it is well understood that stakeholders involvement in solid waste processing (SWP) is essential for a sustainable waste management system because it encompasses the full waste management chain from generation, collection and to final disposal, the scope of their involvement is not clear. But the expectation is that each stakeholder should possess a specific function targeted at improving the adequacy and effectiveness of solid waste processing through active participation and continuous interaction. The current global attention in waste management is shifting towards integrated solid waste management (ISWM) a sustainable system that emphasizes volume of waste reduction, resource-recovery, reuse, and recycling. This concern forms the basis of this paper.

2 Solid Waste Processing

Solid waste processing is a novel approach to waste management. Instead of seeing it as unwanted thing to be discarded, trash is viewed as a resource that has value. Solid waste processing focuses on the recovery and salvation of reusable and recyclable materials from waste, and reduction strategies since total prevention are rather impossible in real life. The process starts at the source of generation and involves

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materials sorting and separation, reducing biodegradable wastes sent to landfill [10], salvaging resources from the waste streams [11], reducing the hazard of waste, recovering materials that can be recycled, deriving energy from waste (EFW) and as extracting refuse-derived fuel (RDF) [12]. It also includes the reduction of mass and volume of the wastes. The volume of waste can be reduced by up to 90 % and the weight of the waste by up to 60 % [13]. Waste processing techniques for solid organic and inorganic materials are gaining popularity across the world [14]. In the context of this study, Solid Waste Processing is defined as waste reduction, reuse, recycling, and material Recovery.

Waste generators have a major responsibility to reduce, segregate, and properly discard the waste in line with the guiding regulations. Furthermore, with rapid changes in quantity and composition of solid waste, regulatory bodies must have constant conversation with the stakeholders to introduce appropriate regulations to enhance solid waste processing. The involvement of stakeholders in solid waste processing activities, should consider the existing rates and volume of solid waste generation, the solid waste stream, existing solid waste management systems, methods and practices, and existing challenges. The techniques for solid waste processing include anaerobic digestion, biodegradation, composting, fly-tipping or illegal dumping, incineration, landfill, mechanical biological treatment, mechanical recovery facility, open dump, recycling, resource recovery, waste collection, waste picking, waste sorting, waste treatment, and waste-to-energy [15]. The most preferred steps in sustainable waste processing include prevention of waste generation, which is the top priority if possible. The way to achieve this is through waste processing; waste reduction, reuse, recycling, and material recovery.

2.1 Sustainable Solid Waste Processing (SSWP)

Various ideas about the ways and means to go in respect of solid waste processing have been developed to guide policy makers, waste managers and other stakeholders in solid waste processing to achieve effective and sustainable management systems. The major techniques are as follows:

2.2 Waste processing hierarchy

This involves options or stages for solid waste processing: waste reduction (lowering the amount produced), reuse (using materials repeatedly), recycling (using materials to make new products), recovery (salvaging materials and recovering energy from waste), and landfill (safe disposal of waste to landfill) in this order of priority options.

2.3 Reduction

Waste reduction involves waste handling at the source and separation and processing of solid wastes. In recent years, there are agitations for Waste Prevention and Zero Waste. Waste handling, technically defined as waste storage, encompasses actions linked with managing waste till the waste is stored in a storage container for collection. Handling entails conveying the full garbage containers to the collection areas. Sorting of waste into separate parts is vital in the treatment/handling and storage of solid waste at the source. Sorting and processing of solid wastes entails materials recovery of trash that has been sorted at the source via curbside pick up, disposed of and trade in centers [6]. The seggragation and sorting of waste sorted at the source plus the sorting of mingled wastes generally take place at a material recoveries facility, transfer stations, combustion facilities, and disposal sites. Waste reduction also includes waste prevention. Technically waste prevention denotes source reduction. It is the practice of designing, manufacturing, purchasing, or using materials from the waste, in such a way that the amount or toxicity of trash created is minimise [16].

2.4 Zero waste

According to Zero Waste International Alliance, zero waste is an ethical, efficient, economical, and visionary goal guiding lifestyle changes and practices emulating sustainable natural cycles, where all discarded materials are designed to become resources for others to use. Zero waste maximizes recycling, minimizes waste, lessens consumption and guarantee that items are designed to be remade, mended or recycled directly into the environment or the marketplace [17]. As such, companies design items to minimise material usage and allow reuse, recycling, and recovery as a result of this fundamental shift in responsibility and financing.

2.5 Reuse

Waste re-use is a technique involving the re-utilization of items in their end of life stage without the need for further value addition or reprocessing [18]. It involves, composting of urban organic wastes and the feeding of kitchen and food wastes to domestic animals and livestock. Reused items can be dashed to the poor or sold to people, thus, reducing the volume of the waste [13].

2.6 Recycling

Recycling is an effort that involves cooperation on both the domestic and industrial levels. It involves processing waste through conversion of parts or all of the waste into other useful material or to recover the original raw matter [19], noted that recycling municipal solid waste is of great importance because wastes like plastic, glasses, rubbers, iron, copper, newspapers, snacks, water sachet, etc. are all recyclable and will become sources of wealth. Currently, new ways of recycling municipal waste are now being adopted in several regions across the world. It includes pyrolysis, in this procedure, organic matter is thermally decomposed in a vacuum. Pyrolysis is a method that employs heat to chemically degrade organic molecules without the usage of oxygen. The process of severe pyrolysis leaves just carbon as a residue, which is referred to as carbonization. The pyrolysis technique may also be used to convert polymers into biomass liquid fuel [14]. Gasification is another ecologically acceptable waste disposal process. Recycling is a resource recovery technique that entails collecting and reusing waste items such as empty beverage cans. The resources used to make the goods can be recycled into new ones. The item for recycling can be sourced separately from ordinary waste using specialized bins and collection trucks. This is known as kerb-side recycling, and it requires the waste owner to segregate it into individual containers (usually wheelie bins) before collection. Aluminum beverage cans, copper wire, steel food and aerosol cans, old furniture or equipment, polyethylene and PET bottles, glass bottles and jars, paperboard cartons, newspapers, magazines, and light paper, and corrugated fireboard boxes are among the most commonly recycled consumer items etc [19]. Because these objects are generally made of a single type of material, recycling them into new products is extremely simple. Complex items (such as computers and electronic equipment) are more difficult to recycle since they require more disassemble and separation. The types of recyclable materials vary by town, city and nation. Different recycling programs exist in each city and nation. These approaches have been widely applied with varying degrees of success. The experience in the application of these approaches has mainly been the failure of the approaches to

create an effective and sustainable solid waste management system in line with sustainable development goals. Recycling processes provide a prospect to gain monetary value from waste [20]. Municipal waste recycling helps the environment by eliminating any greenhouse gases from the landfills, there is no problem with landfill space not being available, even in highly populated areas where landfills are already full, and recycling municipal waste using pyrolysis and gasification results in products that can be sold for a profit [21]. While overall recycling has increased, recycling of particular items has developed considerably: 42 percent of paper, 40 percent of plastic soft drink bottles, 55 percent of aluminum beer and soft drink cans, 57 percent of steel packaging, and 52 percent of appliances are presently recycled. In Sri Lanka, 60 – 80 percent of paper waste is due to product packaging. We need to look for more and better ways of waste disposal that do not affect the greenhouse gas levels any more than necessary. This means searching out the most non-polluting methods available today and there are currently two or three ways in which we can achieve this. True recycling does not start at the bin. It starts with the buying of products. Many countries have made efforts to adopt and use ideas on source reduction. Since 2000, Sri Lanka has made significant strides in adopting modern techniques of waste processing. Rayong for example has successfully implemented city-wide composting programs, opened new recycling exchange centers, produces fertilizer from organic waste and boosted power/energy via a recently constructed biogas plant.

2.7 Recovery

Waste recovery is about using waste to replace other non-waste materials to achieve a beneficial outcome in an environmentally sound manner. The step towards resource recovery from solid waste disposal comes from the fact that resources are slowly getting depleted from the earth's surface. [22]. Resource recovery can take place by following the three principles – reduce, reuse, and recycle. Municipal solid waste is a sustainable and renewable source of energy. Materials are segregated into the various categories of wastes – from those which consist of biodegradable substances to non-biodegradable substances such as plastics, paper, synthetic materials, and so forth. These are then differentiated as to whether materials can be reclaimed from them or they can be burned down into ashes by the incineration method. When it comes to most household wastes and biodegradable organic substances, incineration or pyrolysis methods are commonly used. Resource recovery is an important aspect of a business's ability to maintain international standard organization (ISO14001) accreditation. Companies are inspired to improve their environmental efficiencies yearly [14].

2.8 Incineration with energy recovery

Municipal solid waste may be utilized to create electricity power. Landfill gas capture, combustion, pyrolysis, gasification, and plasma arc gasification are just a few of the technologies that have been developed to make the processing of MSW for energy production cleaner and more cost-effective than ever before [23]. While previous garbage incineration plants produced substantial quantities of pollutants, current regulatory improvements and new technology have lowered this worry dramatically. Regulations enacted by the US Environmental Protection Agency (EPA) in 1995 and 2000 under the Clean Air Act lowered dioxin emissions from waste-to-energy plants by more than 99 percent below 1990 levels, while mercury emissions were cut by more than 90%. In 2003, the Environmental Protection Agency (EPA) acknowledged these advancements, noting waste-to-energy as a power source with a lower environmental effect than practically any other source of electricity [14].

3 Significance of Processing Solid Waste

Current global attention in solid waste management is shifting towards solid waste processing which emphasizes the systems that have minimum impact on the environment and with no threats to human health and safety, [10]. In this context, various studies show that Solid Waste Processing involves storage at the primary source of generation, [24], and proceeds with materials sorting and separation, [25], reducing biodegradable wastes sent to landfill, [12], reducing the hazard of waste, recovering materials that can be recycled, [26], deriving energy from waste (EfW), [23], as well as extracting refuse-derived fuel (RDF). It also includes reduction of mass and volume of the wastes, [14]. The volume of waste can be reduced by up to 90 % and the weight of the waste by up to 60 %, [13]. Waste recycling of both solid organic and inorganic materials is gaining popularity across the world. For example, the recycling of organic and bio-degradable materials into compost manure is used to substitute chemical fertilizer in urban agriculture [18]. Recycling residential solid organic waste as compost manure in agriculture will add savings to the economy [26]. It will lower the consumption of chemical fertilizer and prevent land degradation [26]. Solid Waste Processing calls for a radical review of existing systems and methods of handling solid waste generated, to acquire effectiveness, not only in mere collection and disposal services but more importantly in developing a rigorous waste management framework. It emphasizes waste sorting, re-cycling, and re-use, as well as other practices that reduce waste management costs, and protect environmental resources from depletion; to develop techniques that minimize adverse environmental effects from solid waste, and improve in the systems and methods that provide economic incentives to stakeholders to make advantageous use of solid waste [27]. It also redeems the availability of land from conventional disposal practices such as landfills. It also leads to reduced requirements for new energy sources; development of local, sustainable employment in new sectors focused on recovering resources from trash; generation of new streams of revenue for communities to offset infrastructure costs; decrease of infrastructure's life-cycle cost; reducing greenhouse gas emissions by diverting waste from landfills, and generating revenue from infrastructure; it introduces many techniques for recovering resources from the waste stream including aerobic composting of organic waste; anaerobic digestion to create fuel for heating or vehicles; combustion or gasification of wood waste to create fuel and cogeneration of electricity [28]. Processing of organic and biodegradable content of solid waste would significantly reduce volume and impact positively on cost reduction within the entire chain of waste management systems from collection to final disposal. The case studies from Developed and Developing Nations have been gathered in the following sections.

3.1 Italy

Working on an environmentally sustainable decision model for urban solid waste processing in Genova Municipality, Northern Italy [23] identified solid waste processing as one of the priority issues concerning environmental protection and resource conservation, and developed a Decision Support System that can help decision-makers in choosing the size and the types of separators, incinerators and other waste processing

plants, based on careful analysis of the chemical composition of the produced refuse. Their study aims to limit the presence of specific various substances as well as combustion process plus landfill saturation limitations. In the specific context of environmental constraints, they used constraints on incineration emissions, Refuse Derived Fuel (RDF), and Stabilized Organic Matter (SOM) chemical contents. They found that produced RDF must have specific chemical characteristics, fixed by regulations, to limit pollution derived from its combustion, while SOM is obtained from the treatment of humid materials coming from separators. They noted that it is necessary to guarantee a minimum content of organic material and the maximum content of the glass, plastic, and C/N fraction, (carbon to Nitrogen ratio), and the fraction must not be too high because if high the quality of the product obtained may give problems as regards N content, pH (the negative logarithm of the hydrogen ion concentration from 0 to 14 with pH 7 as the neutral point.), and emissions of bad odor.

With regards to incineration, the process constraints, show that the minimum power for plants burning RDF in Italy must be 10MW which means constraints in incineration emission. With regards to Landfill saturation they argued that to prevent rapid saturation of the available sanitary landfill, the function should be expressed in terms of the minimum filling time for each sanitary landfill. Thus, the main import of their work is the development of waste processing procedure that requires a consideration of a quite heterogeneous set of sub-systems that are affected by the decision, such as material flows to the plants, plants capabilities, material, and energy recovery, recycling costs, possible benefit from the sale of electricity and the design, location, and capacity of sanitary landfills for final disposal.

3.2 Wales, United Kingdom (UK)

The study of scenarios of municipal solid waste processing in Wales [16] used LCA (Life-Cycle Assessment) to show that, incineration is preferable to landfilling (in Wales/United Kingdom – the study area). But more interestingly, however, their research reveals that, when compared to alternative solutions such as recycling, incineration has greater operating costs and fewer related jobs. They, therefore, stressed the need to consider the financial costs of collection, processing, and disposal, for effective SWM. They concluded that integrated Waste processing will ultimately be the most cost -effective in terms of both economic and environmentally friendly options in the long run. They concluded that the expenses of diverting waste away from landfills are mostly controlled by many factors. They pointed out that one of the primary problems for the local government in achieving reduction objectives through recycling, composting, and EFW (Energy from Waste) is lowering costs while preserving customer satisfaction. Specifically, the cost of separation and processing of materials in the waste stream needs to be considered for which there are numerous variables.

3.3 Chile

Working on waste processing in Chile [26] focuses on determining MSW mass and volume, as well as improving materials sorting and separation of existing MSW. Their study found common incidences of uncontrolled landfills and in many cases illegal disposal sites with no proper lining system to prevent surface ground water from pollution. Furthermore, composting, incineration, and recycling were not widely applied. Instead, land filling with untreated, unsorted waste was more in practice. MSW is still collected in donkey-driven carts. Consequently, they recommended the use of MSW incineration plants, Landfills of various technical qualities ranging from sanitary landfills that are designed and operated to controlled landfills.

3. 4 Asian Developing countries

In Singapore, waste recycling centers are set up by the Ministry of Environment in hotels, hospitals, schools, offices, factories, clubhouses, and residential buildings. These are "in-house" waste recycling centers catering only to a targeted group of users. By 1995, 1,255 "in-house" recycling centers were set up. With the sponsorships of private organizations, the ministry also set up public recycling centers across the islands [29]. These public recycling centers are located near residential areas to encourage recycling among nearby residents who do not have access to other kinds of recycling facilities. These centers contain bins for the recycling of "dry" recyclable waste like paper, plastics, and cans [30]. Today, there are 165 public recycling facilities spread throughout the country. Pick-up service is also available to some residents living in high-rise public housing after the launch of a National Recycling Program in April 2001. Composting is applied, though in limited proportion. In India composting was for only 10-12 %, while in other countries like Nepal, Pakistan, Bangladesh, and Sri Lanka the proportion is less than 10 %. The following proportions are used to treat solid waste: open dumping (above 50 percent), landfill between 10 percent to 30 percent), incineration (between 2 percent to 5 percent), and composting (less than 15 percent). The final stage of disposing of is an open-dumped-landfill [22].The study observed that composting is one of the treatments for solid waste, which is more suitable than other treatments such as an incinerator, in Asian developing countries because the composition of solid wastes (SW) in those countries is mainly decomposable with high moisture content. The study highlighted high operating and maintenance costs, poor facility maintenance operation, and incomplete separation of non-compostable materials. Composting is further hindered by its higher cost when compared to commercial fertilisers. On the contrary, SWM in Asian developing countries is affected by less financial resources and low enforcement of environmental regulation. Overall, the study discovered that there was no separation at source, difficult collecting operations, open dumped landfills, and no management of gas emissions and leachate in landfills in emerging Asian nations. The most appropriate management strategy is decentralization [22].

3.5 Egypt

In Egypt, the average solid waste generation rate at the household level was 1.2 kg/person/day, with a high percentage of metal (cans), plastic (water containers), and food items. The MSW management system not only improves social, economic, and environmental efficiency, and support sustainable development, but it also aids in the resolution of the dual dilemma of resource scarcity and environmental degradation. Waste problems cannot be solved by the authorities alone. To achieve an appropriate solid waste management system and waste reduction, public participation and awareness generation are required [9].

3.6 Ghana

In Ghana, investigations into issues regarding solid waste generation, collection, and disposal practices that are employed by households and city authorities in the rapidly urbanizing city of Wa revealed that 810 tons of solid waste are generated daily, out of which; 216 tons are collected leaving a backlog of 594 tons uncollected posing serious environmental and public

health hazards, infrastructural facilities are in a bad state and some cases none existent [31].

3.7 Solid Waste Processing in Nigeria

Inefficient collection techniques, poor coverage of the collection system, and incorrect disposal define solid waste handling in Nigeria [11]. In Nigeria, there are no organized recycling or resource recovery initiatives, and no composting regulation. Recovery/recycling operations are now mostly carried out by the informal sector [32]. Scavengers and small scale industries provide raw materials up to 48% to companies in Onitsha. At Uwani in Enugu and Lagos [32], materials recovery facilities (MRFs) serves as disposal sites. [32]. Solid Waste Processing in Bauchi Nigeria is limited in scope. The extensive search for literature on the internet showed only a study of the role of women in solid waste processing. [33] studied the role of women in solid waste segregation in Bauchi. A proportionate unit of the household was chosen – a 4 percent sample size from each ward was adopted, and questionnaires, interviews, and direct measurement of household solid waste at source were used for data collection. The study found that women dominate the generation, storage, plus collection of household solid wastes, with 81 percent, 96 percent, and 91 %percent respectively in the study region which provides the basis for recommending their integration into the waste management system of the town. The survey also discovered that women with free time in town can efficiently carry out sorting 95 percent of the time.

4 Role of Informal Sector in Solid Waste Processing in Nigeria

Individuals, families, groups, and small businesses operate in the informal sector, which is unregistered and unregulated. [34]. In the collection of waste, the informal sector plays a critical role in collecting trash. This sector removes 30% of all garbage generated in urban centers, and they do so without sufficient safety gear [35]. The common constraints facing the sector include lack of institutional arrangement, insufficient financial resources, absence of by-laws and standards, inflexible work schedules, insufficient data on the amount and composition of waste, and inappropriate technology [11]. To achieve sustainable and effective solid waste management in Nigeria, further study on institutional, political, social, financial, economic, and technological elements of solid waste processing is required. [34]. If recycling rates are to grow, a collaboration between communities, the informal sector, official garbage collectors, and authorities is required. It is necessary to promote markets for recycled materials. Small-scale garbage composting operations, meanwhile, might help with employment, revenue production, and poverty reduction. Waste management regulations must be enforced, as well as a comprehensive strategy and planning framework for waste management.

4.1 *Stakeholder Identification*

Stakeholders are persons, groups, or institutions who are likely to be impacted negatively or favourably by a proposed intervention, or who may influence the intervention's result [36]. The process for identifying a stakeholder focuses on who may directly or indirectly be affected by a project, both positively and negatively, and the first step is to build a stakeholder's map. To start with, stakeholder's identification can be done through a collection of comprehensive records of people/groups/institutions [36]. The more the involvement of people and stakeholders, the fewer chances to miss out on a stakeholder. To keep track of everything, it's a good idea to arrange and/or group them in a second phase. Mind maps, Venn Diagrams, and organized tables may all help with this. Once the list is relatively full, priorities may be assigned, and the 'highest priority' stakeholders can be translated into a table. The number of possible stakeholders will always outnumber both the time available for analysis and the mapping tool's capacity to show the results in a meaningful way. The problem is to concentrate on the 'proper stakeholders' who are now significant and to utilize the technology to visualize this key subset of the whole community [37].

4.2 Stakeholders in Solid Waste Management

United Nations Environment Program, (UNEP), has identified 15 stakeholders and their expected roles and responsibilities. These, along with similar information from other sources, [37, 9, 38], are reviewed and presented as follows:

4.2.1. Public health and sanitation departments

Preservation of public health and sanitation is a vital public obligation, and it is normally within the authority of the local public health department, especially in low-income and transition nations. This department frequently has inspection and enforcement duties in an integrated system but is not directly engaged in collection or disposal activities [31].

4.2.2. Public works departments

Local government units most often have operational responsibility for waste collection. Public sector bodies that deal with solid waste matter. e.g. Bauchi State Environmental Protection Agency (BASEPA) in Nigeria [26].

4.2.3 Natural resource management agencies

These entities are frequently in charge of actions related to MSWM, like materials recovery or composting, at the local or regional level [16].

4.2.4 National or state/provincial environmental ministries

At these levels, a general waste management strategy is frequently adopted. They design policies and plans to implement them, as well as integration in accordance with the policies [39].

4.2.5 Municipal governments

In most nations, local governments are responsible for overseeing waste management activities, including ensuring that garbage is collected and sent to processors, markets, or disposal facilities. The local government, which is ultimately accountable, frequently spends funds for trucks, workers, and equipment [40].

4.2.6 Land use or town /physical planning agencies

When waste management infrastructure is being created, it is necessary to engage with them frequently. This is especially true when it comes to choosing a location for disposal and transfer facilities [10].

4.2.7 Regional governments

Landfills, incinerators, composting facilities, and the like are sometimes the responsibility of regional authorities or big city governments, especially in nations where local disposal space is limited. The regional governments in charge of these facilities usually enjoy a steady source of money from garbage collection businesses' disposal fees [34].

4.2.8 Private sector companies

As concessionaires or contractors from the appropriate government authority, private sector enterprises are increasingly involved in garbage collection, street sweeping, material recovery, and, increasingly, the building and operation of landfills, incinerators, and compost facilities. Because private firms, unlike governments, are not directly responsible for maintaining public cleanliness or health, their engagement is confined to activities in which they may profit. Private sector waste management service providers (current and future) are primarily concerned in generating a return on investment and can work with the public sector in a variety of ways [41].

4.2.9 Households/residential waste generators

Residents that are underserved frequently organize community-based organizations (CBOs) to improve local environmental conditions, enhance services, and/or petition the government for better service. CBOs, which may emerge in both middle- and upper-income communities as well as low-income regions, can help the government manage waste locally [42]. Community groups, when properly structured, offer a lot of potential for administering and funding local collection services, as well as trash recovery and composting initiatives [43]. Residential families are primarily concerned with having cost-effective and trustworthy rubbish collection services. So long as the quality of their living environment is not harmed by dumpsites, disposal is usually not a top priority for service users [44]. People only grow concerned about the larger goal of ecologically appropriate trash disposal as they become more knowledgeable and conscious citizens [9]. The total waste system is influenced by residents' choices for certain sorts of waste services, their willingness to source independently, and their ability to transport garbage to common collection locations. Residents' tastes and conduct can be influenced by incentives. There are all together, 46,056 households spread over the study area (Wales). This figure represents the total number of households in the town. It is well documented that households or residential areas are the source of municipal solid waste generation (80 % to 90 %) [16]. Furthermore, solid waste processing at the primary points of generation, that is the household units, is critical to waste reduction through sorting/separation, reuse, recycling, and recovery [25]. As a result, household units will provide data on the amount or volume, as well as the types and characteristics of daily solid waste generated in the research region. Similarly, the household units will be studied to understand their involvement in processing the waste they generated, and whether there are incidences of collaboration in their waste handling practices. The low participation of households in waste management programs is due to a low level of environmental education and because they view solid waste management as a low priority activity [42].

4.2.10 Business waste generators

Businesses create waste as well, and they may become a major actor in the waste management system, especially if they must pay for their waste service directly. Incentives, like residents, can have a big impact in determining behavior [45].

4.2.11 Informal sector workers and enterprises

Individual employees and unregistered small businesses in low-income countries recover resources from waste streams by separated or specialized collection, purchasing recyclable goods, or sorting through waste [21]. These people and businesses clean and enhance the recovered materials before selling them to a middleman, a broker, or a manufacturer. Workers in the informal sector have been known to make new things out of recycled materials [11, 46].

4.2.12 Non-governmental organizations (NGOs)

NGOs frequently have a purpose to improve the environment or the quality of life for poor or disadvantaged people, and as part of that mission, they may support small-scale businesses and initiatives. Because waste materials are often the only expanding resource stream, these businesses usually focus their efforts on extracting and processing materials that aren't currently being recovered in order to add value and generate money [37]. NGOs may also be able to help trash workers and businesses in the informal sector organize themselves, better their working conditions and facilities, boost their wages, and expand their access to key social services like health care and schooling [9]. People's awareness of waste management problems, organizational capacity and the formation of community-based organizations, channels of communication between community-based organizations (CBOs) and government authorities, CBOs' voice in municipal planning and implementation processes, and technical know-how of locally active CBOs and access to credit faciliate are all things that NGOs can help with.[37].

4.2.13 Community-based organizations

Community-based organizations play an active part in garbage management activities in certain regions where there is insufficient collection or the neighborhood is underserved. These organizations (for example, resident associations) may begin as self-help or self-reliance units, but with time, they may mature into service organizations that charge fees to their collection customers and sell collected items [21]. Community participation in solid waste management can take many forms, including raising awareness, teaching proper sanitary behavior, donating cash, goods, or labor, participating in consultation, administration, and/or management functions, facilitating the separation of waste for the waste collector, granting space for waste management vehicles, and more. With more public participation, the community can cooperate with public or private entities.Community management gives the community authority and control over the operation, management, and/or maintenance services benefiting its members. Community management may come about through a partnership with governmental agencies and NGOs [42]. Community-based solutions can use preliminary research and input from the community to generate a list of desired services, appropriate incentives for households and servants, and systems for cleaning streets and other public places. They operate when the need for cooperative action arises, usually prompted by environmental threats, including waste management problems, in their community, and no cash payments are made to volunteers [9].

4.2.14 Poor and residents of marginal and squatter areas

Waste service, like other public services, sometimes follows political power, leaving people of impoverished and disadvantaged neighborhoods with little (or no) service, filthy streets, and a constant accumulation of waste and feces on the streets and in other public locations [21]. These individuals frequently have the greatest need for enhanced or expanded garbage collection services [36].

4.2.15 Women

Women are disproportionately affected by waste management. Women frequently gather waste and either lay it out or transport it to community transfer stations. They are the

most active group in home waste segregation, accounting for 95% of the segregation [33, 48]. Women can be represented in SWP activities if women's groups are included in the participatory process.

4.2.16 Scavengers

This is the most vulnerable group in the informal waste recycling chain. They are poor and mainly young orphans, moving from one waste dump site to another, searching for reusable and recyclable solid waste materials [26]. They do not have the capital to buy and resale recovered materials. They physically involve themselves in the search for waste recyclables from all possible sources in the city, to generate income [49].

4.2.17 Cart pushers, bicycle, and tricycle riders

This stakeholder's group does not pick from dumpsites, but hold reasonable capital, and move from house to house buying reusable and recyclable materials for resale directly to local community agents who weigh and buy according to prevailing rates for each material [11]. The Cart Pushers move shorter distances compared to the Bicycle and Tricycle riders. The effective involvement of all the stakeholders is essential for adequate sustainable solid waste management.

4.2.18 External funding agencies

Funding agencies are frequently the most worried stakeholders about implementation delays caused by the requirement to engage and negotiate with other stakeholders. Participation exercises might cause disbursement to be delayed and short-term management tasks to be hampered. When these organizations are aware that important stakeholders, if allowed to participate in the decision-making process, may strongly disagree with the course of action recommended, they may use the time issue as an excuse for non-participatory approaches [36]. External Funding Agencies, on the other hand, frequently provide essential technical assistance to the projects/programs they agree to sponsor [47]. The focus of this research is on stakeholder participation in solid waste processing (SWP). By active engagement and constant contact, each stakeholder has a particular, clear, and active role in improving the efficacy and efficiency of SWP.

5 Resource potentials of solid wastes composition

In an analysis of solid waste characteristics and recycling potentials in Phnom Penh, Cambodia [50] collected solid waste daily for two weeks from the streets, and households. The waste collected was separated into three categories, (combustible, non-combustible, and recyclable), and quantified in terms of weight. The results show that combustible constituted 89.70 percent; non-combustible 8.90 percent; and recyclable 1.40 percent for street waste; while 91.53 percent, 8.08 percent, 0.39 percent for household waste, respectively. The combustible materials mainly consisted of food 58.76 percent, plastic 17.27 percent, paper 7.71 percent for the street waste, and 66.20 percent, 9.80 percent, 4.50 percent for household waste, respectively. In terms of proportion, Food waste was the most common, 60-70 percent, C/N ratio of 20:1, and moisture content 63.10 percent . Based on these findings, the study recommended that composting could be good for the treatment of household waste in Phnom Penh, Cambodia, because of the low heat value (LHV), at 894 kcal/kg, and high moisture content 63 percent, which shows are not suitable for incineration. However, the study also found that sorted waste was mainly food, followed by glass bottles, paper, PET bottles, aluminum cans, and steel. Its study of waste characterization and quantification [37] shows that urban wastes can be classified into two major components -- organic and inorganic. It is further said that the organic components of municipal solid waste can be categorized into three groups: putrescible, fermentable, and non-fermentable. Putrescible wastes degrade rapidly and produce unpleasant smells and visual effects unless well regulated. Fermentable wastes disintegrate quickly but do not produce an offensive odor. Non-fermentable wastes tend to resist decomposition and decompose slowly. [51] selected three locations, (City core, GRA, and Neighbourhood) as case studies and used 370 household units for evaluating the composition of municipal solid waste generated by households in Bauchi town. The study estimated the potential of resource recovery from the waste as 59.88 % of the household solid waste, (HSW) was organic, and 16.65 % recyclable materials, which indicates the huge resource recovery potentials from the household waste in the town. [52] studied the energy potentials of solid wastes in Bauchi Town. The study was based on data collected from the Bauchi State Environmental Protection Agency (BASEPA) and Cosmopolitan Cleaners Ltd. A digital calorimeter was used to determine and evaluate the energy potentials of the solid wastes collected per unit mass. The study found the waste types as plastics, rubber and polyethylene bags 33 %, textile materials, leathers, and wood 26 %, and papers and cartons, 15 %; and the heating values of the wastes to be 6.83 MJ/kg, which indicate a good basis for waste to energy incineration system and solid waste recycling in form of compost and re-use.

[53] worked in Bangkok the research focused on waste recycling and reuse. The study considered solid waste materials separation at three levels of the collection procedure: by stakeholders at the source of generation, before collection; by the collection vehicle crew members; and by scavengers at disposal sites. The survey discovered that there are small-scale recycling businesses positioned near the larger dumping sites, where collecting personnel and scavengers sell gathered items. The trash pickers' total daily tonnage of recyclable rubbish gathered at the source is estimated to be 286 tons, or roughly 5% of the garbage collected by the city. The pickup crew distributed between 1-6 tons of materials every day to small-scale recycling enterprises. The quantity of items retrieved by scavengers (at the dump site) ranges from 50 to 150 kg per person every day. As a result, approximately 7.5 percent of solid waste is recycled [53]. However, there is no rule governing recycling in Thailand, and there is little incentive for consumers to segregate solid trash for recycling because garbage costs in Bangkok are low and irregular. The research concluded that to make the pricing system more structured and recycling more successful, legal measures need to be adopted and implemented.

[54] studied the Characterization of Municipal Solid Waste in Abuja, Nigeria. The properties of the components, average mass (kg), and percentage created per district were determined in their investigation. Food/putrescible waste accounts for 56.20 percent /52.0 percent of solid waste generated in the area, with rubber accounting for 10.20 percent /3.56 percent, paper accounting for 10.00 percent /12.46 percent, glass/ceramics accounting for 7.60 percent /1.42 percent, plastics accounting for 7.4 percent /2.85 percent, metals accounting for 2.60 percent 0.71%, and other waste accounting for 5.60 percent /25.62 percent (dust particle, ash, As a result, solid waste resource potentials can be classified as combustible, non-combustible, or recyclable. [50] putrescible, fermentable, and non-fermentable, [55] compostable, recyclable, and others [51] in terms of the components, average mass (kg) and percentage

generated per district, and separation at three different stages of the collection process: by stakeholders at the source of generation, before collection; by the collection vehicle crew members; and by scavengers at disposal sites [53]).

6 Stakeholder Capacity for Solid Waste Processing

Insufficient capacity is a fundamental impediment to sound solid waste processing activities in much of the developing world [6]. Operating an efficient, effective, and environmentally sound waste processing system requires building administrative capacity for government and private sector players, and technical capacity for designing, operating, maintaining, and monitoring each part of the process [37]. Often stakeholders such as informal sector operators, private sector companies, NGOs, and government entities lack the technical and financial knowledge to operate efficiently, and having skilled and motivated staff is also a key factor to consider in the assessment of resource capacities of stakeholders, and solid waste processing chain requires rigorous use of environmentally sound technologies (ESTs) for its activities which could be from basic primary containers to as complex incinerators for disposal of hazardous waste [38]. A related study, [36] show that the possible technological interventions within the SWP chain may include different activities such as recycling of reusable materials (e.g., plastic and glass containers); recycling of materials for industrial production (e.g., paper and iron), converting waste into energy (e.g., burning tires in a cement kiln to produce heat); and converting waste into resource (e.g., composting and landfill gas). Thus, technological advancement can determine the level and sophistication of stakeholder involvement in SWP activities. Training that builds human resource and institutional capacity at appropriate levels is essential. Peer-to-peer training for everyone from waste-pickers to local government officials has proven effective in extending and sustaining waste processing programs [38]. In West African cities, as many as 70 percent of trucks are always out of service at any one time, and the urban population grew by 150 percent between 1970 and 1990, and in 1999 the City of Harare failed to collect refuse from nearly all of its residents because only 7 of its 90 trucks were operational. Adequate capacity ensures planning, design, construction, operation, maintenance, and oversight [56]. Evaluation of resource capacities of stakeholders in SWP should cover the public and private sectors for technical and financial resources, including expertise, skills, and access to capital [37]. Private companies must possess the required facilities and equipment, or have a business plan that covers them [11]. Governments must have both the capacity to monitor performance and the political will to enforce contractually or license agreements [38]. Table 1 shows the waste processing tools of Environmental Protection Agencies of some Nigerian cities. The table shows the types, numbers available, and population/equipment ratio. The ratios show the weak state of resource capabilities of the regional headquarters of Nigeria in 1998, especially the situation in Kaduna, the regional headquarter of northern Nigeria. Table 2 shows the working equipment of the Bauchi State Environmental Protection Agency in 2011. The table shows that the working equipment of BASEPA in 2011 is not any better than the 1998 situation of the Kaduna state environmental protection Agency.

6.1 Financial resources

The informal sector, Public and Private SWP activities often face financial difficulties caused by inadequate incentives and sanctions [57]. Possible sources of funding for capacity building among stakeholders in SWP include communal or municipal funds, taxes (local taxes), user charges (flat or graded rate), vending arrangements, local revolving funds or credit circles [37] and lotteries and auctions, raffles, bazaars, or entertainment (such as movie showings), donations from prominent individuals, and launching community-based organizations, [38].

Table 1: Equipment of solid waste management agencies in some Nigerian Towns

City	Type	No. available	Equip./pop ratio
Ibadan	Tippers	46	1:57,000
	Vehicles	6	1:433,000
	Bulldozers	14	1:15,000
Kaduna	Tippers	10	1:450,000
	Vehicles	6	1:300,000
	Bulldozers	2	1:900,000
Enugu	Tippers	55	1:900,000
	Vehicles	6	1:67,500
	Bulldozers	3	1:135,000

Source: [44]

Table 2: Working Equipment/Machines in Bauchi State Environmental Protection Agency (BASEPA)

Equipment	No. Required	No. Available	Condition on Road	Off-road
Bulldozer	2	0	-	-
Tipper trucks	10	3	4	1
Dino trucks	5	2	2	-
Tractors	10	6	4	2
Pay loaders	10	2	1	1
Tankers	5	3	1	2
Refusecontainers	300	80	80	-
Shovels	1000	600	-	-
Brooms	1000	600	-	-
Hoes	500	300	-	-

Source: [44]

These can be harnessed through operational collaborations between stakeholders and regulatory authorities for effective and adequate waste processing activities. Prospects of Stakeholder Collaborations for Enforcement of Solid Waste Processing. Collaborations are means for the involvement of stakeholders to increase capacity and operational efficiency in achieving set goals and objectives [58]. Such means mainly cover policies relating to regulatory standards; specifying standards or limits (command and control) in existing solid waste processing system, including standards for waste reduction, reuse, recycling, and recovery, as well as enforcement of the standards or limits and the incentives and disincentives [37]. These become the most crucial aspect of policies for Solid Waste Processing, as they could make an impressive improvement if they are properly enforced at all levels of the processing chain. Regulatory organizations must continuously exchange ideas with the stakeholders to bring the desired regulations which can help bring the required improvements in the SWP system [37]. Sound collaboration between operating stakeholders and regulatory authorities, can address motivational problems by involving stakeholders in decision-making, using special group incentives, and, in some cases, by granting exemptions from municipal taxes. Furthermore, space problems for keeping working equipment and vehicles can be resolved by lobbying municipalities and local leaders, as well as conducting media campaigns in the neighborhood, [38]. If solid waste processing is badly

coordinated between stakeholders and regulatory authorities the community may lose interest in trying to improve the waste processing situation. Extending service, mobilizing communities to lobby the regulatory body for assistance, involving local authorities, and structuring formal and informal opportunities for cooperation all improve the performance of regulatory authorities and stakeholders' support for waste processing plans and programs [58]. Uses of economic instruments which are market-based provide incentives and disincentives for the involvement of stakeholders in solid waste processing. All relevant economic tools addressing one or more aspects of SWP must be documented. Economic incentives (such as subsidies or repayment for recycling) and financial disincentives (such as taxes, levies, fines, and penalties for trash producers) might be common economic tools [25, 37]. Other examples in this respect include: Levy on use of fresh resources in industrial production, subsidies for recycling in industrial production, volume-based solid waste fee on non-recyclable waste, penalties on hazardous waste, subsidies for resource recovery, including power-generation at a landfill [15]. Member nations in Europe have built an integrated electronic working environment that allows environmental personnel from all around Europe to collaborate online [59]. EIONET (a collaborative network of the European Environment Agency, EEA, and its member states, connecting National Focal Points in EU and accession countries, European Topic Centres, National Reference Centers, and Main Component Elements) supports the collaborative process and reduces the reporting burden for environmental protection agencies throughout Europe, according to the study. In practice, it may be difficult to achieve sustainable solid waste processing without collaboration, and a city's total integrated solid waste management system may become less effective [15]. Thus, collaborative efforts between the stakeholders and regulatory authorities are necessary for effectiveness in SWP operations. This creates space for greater participation and more effective contributions of stakeholders towards sustainable solid waste management.

6.2 Stakeholder Processing outputs and Contributions to Solid Waste Processing

Globally, stakeholders are the most important players in each community's solid waste processing operations and programs. Studies have shown that benefits accruing from their collective involvement represent a monumental contribution towards effectiveness and sustainability in solid waste processing activities around the globe. In Uganda [60] investigated stakeholders' participation in the decentralization strategy in the country and found that the strategy was failing mainly because stakeholders' roles in waste recycling were not mainstreamed into the local plans. Thus, stakeholder participation is key to success in local SWP plans. [57] examined the informal SWP system in the Gweru Municipal area of Zimbabwe and found out that the methods are unsustainable in the long run because waste minimization and reduction practices in the sector are not effective in transforming waste into a resource that could be reused and recycled. [61] focused on private sector participation in waste reuse and recycling in Kenya. The study found that participation was spontaneous, unplanned, and open to competition without the Nairobi City Council (NCC) regulation; the companies violate many of the solid waste laws and by-laws, especially those on disposal. This shows that even where solid waste laws and by-laws are in place, lack of enforcement will make stakeholders violate many of the laws, especially those on disposal, and make their participation spontaneous, unplanned, and open to unhealthy competition in their operations. Therefore, enforcement of solid waste laws and bye-laws is necessary for effective and sustainable SWP activities. [42] studied households in 59 selected cities in India to understand why solid waste management is failing and found that, the practices being used did not adequately involve reuse and recycling. On the other hand, in Enugu, south east Nigeria, [21] focused on informal sector operators and found that the contributions of the stakeholders in the sector to the solid waste management system is huge due to sorting re-usable and recyclable materials from mounds of trash in dumpsites and converting the wastes to wealth. [11] examined waste scavengers in north-central Nigeria and found that their contributions to the economy were enormous in terms of income generation, employment, tax revenue, and skill/technology transfer. [61] studied the implications of limited waste processing among stakeholders in SWP in Kano, north-central Nigeria, and found that waste recycling is limited to the extent that bacterial isolates were obtained from waste dump sites, three of which were coliform bacteria, *(E. coli, Klebsielle* sp, and *Shigella* sp.).

In Bauchi Town, [44] studied waste evacuation and found that waste evacuation is weak as dumpsites of co-mingled solid waste are common in different parts of the city. Other studies [33,48] focused on the role of women in Bauchi walled city and found that although their contribution in waste segregation is significant, their exclusion from operation keep Bauchi clean activities has negated the effectiveness of the program.

7 Conclusion

On the whole, this paper has covered relevant grounds in the literature for understanding the phenomenon of solid waste, its generation, challenges, processing approaches and strategies, the underlying philosophies in the approaches and strategies, as well as case studies of the efforts made in different parts of the world, with interest in driving factors for stakeholder involvement in solid waste processing. In particular, the review found that information on the failure of existing SWM systems in developing countries of Africa, Asia, and Latin America are widely reported, but the explanation on the capacity and networking/collaborations for the involvement of stakeholders is found to be limited in scope and utility. This review has highlighted information that equips the researcher to investigate the scope of involvement of the stakeholders in solid waste processing, with particular attention to their resource capacity and networking/collaboration efforts to contribute towards bridging the knowledge gap in this respect as outlined in the objectives of the study.

References

1. Gana BA, Involvement of stakeholders in solid waste processing in Bauchi. Nigeria. 2016. *Ph.D. Thesis*, Department of Environmental Management Technology, Abubakar Tafawa Balewa University Bauchi-Nigeria.
2. International Solid Waste Association. Waste Management during the Covid-19 Pandemic: ISWA's Recommendations. 2020. April, 8 .https://www.iswa.org/fileadmin/galleries/0001_COVID/ISWA_Waste_Management_During_COVID-19.pdf.
3. Kaza, S. 2020. "Waste Workers Are Protecting Our Communities during Covid-19." April 9. https://blogs.worldbank.org/ sustainablecities/waste-workers-are-protecting-our-communities-during-covid-19.
4. Thaddeus CN, Adaeza UP, and Ejika, A. Solid waste management during Covid-19 pandemic: policy gaps for inclusive waste

governance in Nigeria. Local Environment. 2020 Vol 25, No 7, 527-535 https://doi.org/10.1080/13549839.2020.1782357
5. Jie Peng MM , Xunlian Wu, Rongli Wang MM , Cui Li MM , and Qing Zhang BM , Daiqing Wei MD. Medical waste management practice during the 2019-2020 novel coronavirus pandemic: Experience in a general hospital. American Journal of Infection Control. 2020 https://doi.org/10.1016/j.ajic.2020.05.035
6. Hugo HE, Solid waste reduction management with Special reference to developing countries, 2005. *PhD Thesis*, University of South Africa.
7. African Development Bank. Study report on solid waste management. 2005. Sustainable options for Africa.
8. Yildirim, V. Application of raster-based GIS technique in siting of landfills in Trabzon province, Turkey; a case study. 2012 Waste Management & Research https://doi,org/10.1177/0734242X12445656
9. Umaru, Ibrahim. Recycling of solid waste and the ``*Yan Bola*' underground economy: a survey of environmental entrepreneurs in Central Nigeria, 2010, Journal of Human Ecology, 30(1): 45-54
10. Hung, Mung-Lung; MA, Hwong-wen; and Yang, Wan-FA. A novel sustainable decision making model for municipal solid waste management. 2006. 27 (2007) 209-219
11. Jibril, DJ,I., Bin Sipan, IA, Shika, SA, Aminu, DY, Shahabudin, A. & Shahril MA. Public awareness on 3r's system for an integrated solid waste management in Kano State metropolis, 2015. in iiste, http://www.iiste.org/Journals
12. Butter, Colin. Methods of waste disposal - landfill, incineration and recycling. 2012
13. Emery, A. Davies, A. Griffiths, A. and Williams, K. Environmental and economic modeling: a case study of municipal solid waste management scenarios in Wales. Environmental Management. 2006. 22(6), 849–856. https://doi,org/10.1007/s002679900152
14. Chandler, D.The meaning of the three R's: reduce, reuse and recycle. 2013 retrieved 24th June, 2016 from (http://greenliving.nationalgeographic.com sighted 24/06/2013
15. Downmore M. Musiyandaka S. Muzinda A. Nhemachena B. and Jambwa D. Municipality solid waste (MSW) management challenges of Chinhoyi Town in Zimbabwe: opportunities of waste reduction and recycling. 2011. Journal of Sustainable Development in Africa 13, (2) ISSN: 1520 – 5509 Clarion University of Technolgy, Pennsylvania.
16. Adurokiya E. We want to empower Nigerians through waste recycling. 2012. Environment Watch retrived 25/06/2016 from http://www.ehow.com/
17. Cointreau, S. Occupational and environmental health issues of solid waste management special emphasis on middle- and low-income countries. 2006. The World Bank Group, Washington, D.C.
18. Anierobi C. Efobi K. Towards incorporating the informal sector operators in the organizational structure of solid waste management agencies in Anambra State, Nigeria. 2013. Civil and Environmental Research. www.iiste.org ISSN 2225-0514. 3 (9)
19. Dhokhikah Y. Trihadiningrum Y. Solid waste management in Asian developing countries: challenges and opportunities. J. Appl. Environ. Biol. Sci. Journal of Applied Environmental and Biological Sciences. 2012 ***2*(7),** 329–335. Retrieved from www.textroad.com
20. Costi P. Minciardi R. Robba M. Rovatti M., and Sacile R. An environmentally sustainable decision model for urban solid waste management. Waste Management. 2004. 24 (3), 277e295.
21. Zurbrugg C. Urban solid waste management in low – income countries of Asia: how to cope with the garbage crisis. 2003. Swiss Federal Institute for Environmental Science and Technology, (EAWAG).
22. Bartelings H. Municipal Solid Waste Management Problems: An Applied General Equilibrium Analysis; 2003 Ph D Thesis, Wageningen University, Netherlands.
23. Bezama A. Aguayo P. Konrad O. Naria R., and Elorber K. Investigations on mechanical biological treatment of waste in south America: towards more sustainable municipal solid waste management strategies. Waste Management. 2006. 7 (2007) 209-219.
24. Narayana T. Municipal solid waste management in India : from waste disposal to recovery of resources. Waste Management. 2009. 29(3), 1163–1166. https//doi.org/10.1016/j.wasman.2008.06.038.
25. Pratap R. Singh P. Araujo A S F. Ibrahim M H. & Sulaiman O. Resources , conservation and recycling management of urban solid waste :Vermicomposting a sustainable option. Resources, Conservation & Recycling 2011 55(7), 719–729. https//doi.org/10.1016/j.resconrec.2011.02.005.
26. Salma D. A & Yvon P. Stakeholder theory in perspective. corporate governance, Wiley-Blackwell, 2005, 5 (2), pp.5-21. <halshs-00154129>
27. Matter A. Dietschi M., & Zurbrügg C. Improving the informal recycling sector through segregation of waste in the household - The case of Dhaka Bangladesh. *Habitat International*.2013. *38*, 150–156. http://doi.org/10.1016/j.habitatint.2012.06.001.
28. Amoah, Samuel Twumasi, and Enoch, Akwasi Kosoe. Solid waste management in urban areas of Ghana: Issues and experiences from Wa." Journal of Environment Pollution and Human Health. 2014. 2(5): 110-117.
29. Umaru, Ibrahim. Recycling of solid waste and the ``Yan Bola' underground economy: a survey of environmental entrepreneurs in central Nigeria. Journal of Human Ecology. 2010. 30(1): 45-54.
30. Ogwueleka, T., & Ogwueleka, F. Modelling energy content of municipal solid waste using artificial neural network. 2010. Iranian Journal of Environmental Retrieved from http://journals.tums.ac.ir/abs/16152.
31. Bogoro Audu Gani, Ali Chiroma And Bukar Abba Gana. "Women and Solid Waste Segregation in Bauchi, Nigeria. 2012. Journal of Environment and Earth Science 2 (8) 25-45.
32. Agunwamba JC. (1998) Analysis of scavenger's activities and recycling in some cities of Nigeria. 1998. Journal of science, 14(21), https://doi.org/10.1007/s002679900152.
33. United Nations Environment Program. 21 Issues for the 21st Century - results of the UNEP foresight process on Emerging Environmental Issues. 2012 Environmental Development. 2012 (Vol. 2). http://doi.org/10.1016/j.envdev.2012.03.005.
34. United Nations Environment Program. Developing integrated solid waste management plan, training manual: volume 2: assessment of current waste management system and gaps therein The UNEP Division of Technology, Industry and Economics (DTIE). 2009. www.unep.fr
35. Snel Marielle and Ali Mansoor. Stakeholder analysis in local solid waste management schemes. 1999 Water and Environmental Health atLondon and Loughborough(WELL),Task No: 69. https://www.lboro.ac.uk/well/
36. Marques R. & Simões P. Incentive regulation and performance measurement of the Portuguese solid waste management services. 2009. Waste Management & Research. Retrieved from https://wmr.sagepub.com/content/27/2/188.short.
37. Qian W. Burritt R. & Monroe G. Environmental management accounting in local government a case of waste management. 2011. Accounting Auditing & Accountability Journal. https://doi.org./10.1108/09513571111098072.
38. Bartone CR. (2001). The role of the private sector in municipal solid waste service delivery in developing Countries: keys to success. in: challenge of urban government: policies and practices. Freire M. and R. Stren (Eds.). 2001. World Bank, Washington, DC., USA., pp: 199-214.
39. Kamara AJ. Household participation in domestic waste disposal and recycling in the Tshwane metropolitan area: an environmental education perspective. 2005 M Ed project. university of South Africa.
40. Mihelcic J.R. Crittenden JC. Small M J. Shonnard DR. Hokanson DR. Zhang Q. Schnoor JL. Sustainability science and engineering: The emergence of a new metadiscipline. Environmental Science & Technology.2003.37(23),5314–5324.https://doi.org/Doi 10.1021/Es034605h.
41. Bogoro AG. Babanyara YY. Evacuation of solid waste in residential areas of Bauchi metropolis, Nigeria. 2011. Journal of Environmental Sciences and Resource Management, Volume 3, December 2011, www.cenresinpub.org
42. African Development Bank. Study report on solid waste management. sustainable options for Africa . 2002.

43. Al-Khatib I A. Arafat HA. A review of residential solid waste management in the occupied Palestinian territory: a window for improvement. Waste Management & Research. 2010. 28 (6), 481–488. https://doi.org/10.1177/0734242X09345274.
44. Nzeadibe TC. Solid waste reforms and informal recycling in Enugu urban area, Nigeria. Habitat International. 2009. vol. 33, no. 1, pp. 93–99, 2009. https://doi.org/10.1016/j.habitatint.2008.05.006.
45. Asomani-boateng R. Closing the loop community- based organic solid waste recycling, urban gardening and land use planning in Ghana, West Africa. Journal of Planning Education and Research. 2007. 27(2), 132 –145. https://doi.org/10.1177/0739456X07306392.
46. Bogoro AG. Bukar AG. Samson MN. and Rasheed O. Economic factors that determine the quantity and characteristics of Solid waste in Bauchi Metropolis, Nigeria. Journal of Environmental Science, Toxicology and Food Technology. 2014. 8 (6) 01-07 .
47. Tevera DS. Waste recycling as a livelihood in the informal sector: The case of Harare's Teviotdale garbage dump scavengers in Harare. in Zinyama.1993. University of Zimbabwe publications, Harare, Zimbabwe.
48. Mongtoeun Yim. Analysis of waste generation and recycling potential for development of 3r-based solid waste management in Phnom Penh, Cambodia. 2015. Ph D Thesis, Royal University of PhnomPenh, https://doi.org/10.13140/2.1.1022.0327.
49. Harir IA. Kasim RI. Bala and Gumau BG. (2016). Characterization and management of household solid waste in Bauchi metropolis, Nigeria. 2016. in Proceedings of the 2nd International Conference on Science, Technology and Social Sciences 2016 (ICSESS2016), Universiti Teknologi Malaysia.
50. Lawal AM. Garba I. Study of the energy potential of solid waste in Bauchi town. 2013. International Journal of Computational Engineering Research,Vol, 03, Issue 5, www.ijceronline.com
51. Muttamara S. Visvanathan C. and Alwis KU. (1994). Solid Waste Recycling and Reuse in Bangkok.1994.Journal of Waste Management and Research" http://journals.sagepub.com/doi/abs/10.1177/0734242X9401200205
52. Abur BT. Oguche EE. & Duvuna, GA. Characterization of municipal solid waste in the Federal Capital Abuja, Nigeria. 2014. Global Journal of Science Frontier Research: Volume 14 Issue 2 Version 1.0; Publisher: Global Journals Inc. (USA)Print ISSN: 0975-5896.
53. UNEP (United Nations Environment Programme). 2005. Solid Waste Management, vol. 1. UNEP.
54. USAID. Solid waste: generation, handling, treatment and disposal. Environmental Guidelines for Small-Scale Activities in Africa (EGSSAA). 2009.
55. Jerie S.Tevera D. Solid waste management practices in the informal sector of Gweru, Zimbabwe. Journal of Waste Management. Volume . 2014 (2014), Article ID 148248.
56. Klundert A. Van De. & Anschiitz J. The Sustainability of Alliances Between Stakeholders in Waste Management - using the concept of integrated Sustainable Waste Management. Working paper for UWEP/CWG, 30 May 2000.
57. UNEP. Framework for global partnership on waste management. Note by Secretariat. 2010. http://www.unep.cr.jp.
58. Pires A. Martinho G. & Chang N. Solid waste management in European countries : A review of systems analysis techniques. Journal of Environmental Management. 2011. 92(4), 1033–1050. doi:10.1016/j.jenvman.2010.11.024
59. Okot-Okumu J. and Nyenje R. Municipal solid waste management under decentralisation in Uganda. 2011. Elsevier, www.elsevier.com/locate/habitatint
60. Karanja SN. Mwangi SW. Kibet N. & NK. Influence of informal solid waste management on livelihoods of urban solid waste collectors: a case study of Nakuru municipality, Kenya. International Journal of Humanities and Social Science 3 (13); July 2013.
61. Nabegu AB. An Analysis of municipal solid waste in Kano metropolis, Nigeria. Journal of Human Ecology. 2010. 31(2): 111-119.