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Predicament in adoption of solid waste treatment technologies in developing countries: A Case of Majengo neighborhood in Dodoma City, Tanzania

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Abstract: The paper is on predicament in adoption of waste treatment technologies in developing countries. It links findings of a study carried out in Dodoma City and other studies elsewhere. The general objective was to investigate predicament in adoption of waste treatment technologies in Dodoma City. Specifically, the paper examined current solid waste management technologies and the current interventions in adopting new technologies in Dodoma City. Both purposive and non-purposive sampling procedures were used to select respondents and informants respectively. The sample population was 120 respondents. In order to collects adequate and accurate data, triangulation of data collection methods was inevitable. Documentary review was used in collecting secondary data, physical observation, interviews, and focus group discussions were used in collecting primary data. The data was analysed by using computer software namely IBM SPSS Statistics version 20.The study found that due to rapid influx of people to urban areas and the socio-economic development solid waste management has become a serious concern in Dodoma City. The current solid waste management technologies include composting, incineration, landfill, and recycling. Due to inefficiency of the technologies, solid wastes still accentuate environmental and public health risks. The paper recommends to different actors to carry out researches to find out appropriate technologies that will assist the authorities to convert waste into re-usable assets and energy for different uses.

Keywords: Solid wastes, treatment, appropriate technologies and adoption.

1.0 Introduction

Throughout history, human advancement has been intrinsically linked to the management of solid waste due to its effect on both public and environmental health. Solid Waste Management (SWM) has a long and convoluted history (Nathanson, 2015). Systems of SWM can trace their roots all the way back to ancient times. One of the first instances of waste management occurred in the 4th century A.D. with the Ancient Greeks. The Greeks had to deal with the multiple challenges of aligning waste removal systems with a growing population, lack of space and sanitation problems. Waste management practices were very rudimentary with trash just being collected and transported to pits outside the city (McAllister, 2015). Early waste-management techniques were developed in Europe during this period to combat the spread of plague disease that affected Europe between the 14th and 16th centuries but the political and social problems of the time did not see great strides in waste management (Nathanson, 2015).

It was not until the 18th century that municipal collection of garbage had begun in some of the world's major cities, but the methods were still fairly crude (Metzger, 2009).During the Industrial Revolution, Europe and the United States were experiencing rapid development that created greater amounts of waste. Waste started to become a concern and this "Age of Sanitation" began. Communities began to organize waste collection and disposal to help maintain public health (McAllister, 2015). In the latter part of the 19th century and into the 20th century, technological advances included the use of garbage cans and creation of incinerators and sanitary landfills; the latter replaced the practice of open dumping and has become a common practice in the developed world (Hoornweg and Giannelli, 2007 as cited by McAllister, 2015).

Africa has a varied historical and political background of waste management. There have been, for instance, allegations that some African countries serve as dumping grounds for toxic and hazardous waste, produced mostly in the developed world (Simelane and Mohee, 2012). To some extent this is directly linked to a culture of economic dependency on developed countries; the inherent belief that Africa can be used for any purpose; corrupt traditions and practices that are endemic to Africa and which ultimately affect all facets of lifestyles in Africa; and environmental management practices(Simelane and Mohee, 2012).Waste management in urban centres of East Africa has for a long time been centralised (Liyala 2011), with the use of imported refuse truck (Okot-Okumu & Nyenje 2011) that collect wastes from sources or transfer point and deliver to designated waste dumps. Municipal solid waste management (MSWM) system in East Africa has changed from the colonial days in the 40s, 50s and early 60s when it was efficient because of the lower urban population and

adequate resources (Okot-Okumu & Nyenje 2011) to the current status that displays inefficiencies. The centralised waste management system has evolved into the current management mixtures that include decentralised as well as the involvement of the private sector.The storage, collection, transportation and final treatment/disposal of wastes are reported to have become a major problem in urban centres (Kaseva & Mbuligwe 2005; Okot- Okumu & Nyenje 2011).

Key solid waste issues in developing countries are substantial population growth in urban centers, lack of legislation and policies for realistic long term planning, inadequate storage and limited collection, lack of proper disposal, use of inappropriate technology and equipment and insufficient knowledge of basic principles (Diaz, 2011). The attractiveness of many cities in Africa is marred by the inefficient collection, management, disposal and reuse of Municipal Solid Waste (MSW) (Simelane and Mohee, 2012). MSW needs to be viewed as a resource that should be incorporated into human development agenda and urban development. This has the potential for generating income for cities in Africa through the re-use of waste for purposes such as energy generation (Simelane and Mohee, 2012).

In Tanzania more than 10,000 tons of municipal solid waste is generated per day countrywide.On average, about 50% of solid wastes generated in urban areas are collected daily and disposed.Note most of the wastes are generated from manufacturing and households (NBS, 2017).Dodoma Municipality is estimated to generate 305 tons of solid waste daily from different sources including domestic houses waste 218 tons, institutions 20 tons, industries 15 tons, markets 30 tons and commercial sites 22 tons (Yhdego and Kingu 2016).The capacity of the council to remove solid waste is only 100 tons (33%) out of the 305 tons generated in CBD wards. The remaining 67% of daily waste generated may be improperly disposed of directly or indirectly, leading to disease and health risks such as malaria, bacillary dysentery, and cholera. In Dodoma City, solid waste is not recognized as a source of income to the city (Yhdego and Kingu 2016). The existing literature on the adoption of technology in treatment of solid wastes in the study area has done little to convert solid wastes into other forms such as resources and put value addition that would increase people's income and Dodoma city revenue instead solid wastes were accumulated on dumping sites. This, however, requires the adoption of appropriate technologies, most of which are not readily available in the study area. Therefore the intention of this study was to examine the predicament in adoption of waste treatment technologies in Dodoma City Tanzania.

2.0 Methodology

Data and information were gathered from Majengo neighborhood in Dodoma City. The neighborhood was selected because has groups managing urban environment thus were found information rich. Through a cross-sectional survey, primary and secondary data were gathered. A sample of 120 respondents was interviewed. Documentary review, interviews, focus group discussions and physical observations methods were used in data collection. The data was analysed by using computer software namely IBM SPSS Statistics version 20.

3.0 Results and Discussions

3.1 Characteristics of respondents

In this study on the current solid waste management practices, characteristics of 120 respondents were discussed basing on their age, level of education, marital status, occupations and income level. On age of respondents, data analysis revealed that all 120 respondents had age above 18 years. Concerning education of the respondents, 67 respondents equivalent to 55.8 % had primary education. Pertaining to marital status, it was noted that 61 respondents who form 50.8% of the respondents were married. Findings indicated that 64 respondents who make 53.3% participate in informal employment. Additionally, it was found that many household heads participate in more than one economic activity. The findings indicate that the data was gathered from the representative sample.

3.2 Solid Waste Management Practices in Majengo Neighborhood

As regards generation of solid wastes, the study found that the residents garbage, plastic bags, and plant residues, remains of building materials. The study found that 160 kilograms were generated daily in the neighborhoods. As regards to solid wastes collection, the study revealed that 17.5% of the respondents reported that they have dustbins, 42.5% of the respondents acknowledged that they throw solid wastes on open spaces, 27.5% of the respondents disclosed that they throw solid wastes off roads and 37.7% of the respondents admitted that they throw into holes.

Table 1: Solid Waste Storage Facilities (N=120)

Practice	No. of Respondents	Percentage
Dustbins	21	17.5%
Open spaces	51	42.5%
Off roads	33	27.5%
Holes	45	37.7%

Lack of formal solid waste storage facilities led to haphazard spread of light solid wastes as well as blockage of drainage systems. Improper storage of solid wastes has been a root cause of poor vista of the urban environment.

3.3 Adoption of Emerging Solid Waste Management Technologies

The study carried out in Majengo Neighborhood assessed rate of adoption of composting, landfills, incineration, aerobic and anaerobic digestion, hydrolysis, thermal gasification, chemical processing, and mechanical processing as alternative solid waste management technologies. It was found that 69.8% of the respondents practice burning. The respondents 36.5% reported that mechanical processing is used by the residents, 13.5% of the respondents disclosed use of composting, about 4.2% of the respondents indicated landfill as a solid waste management technology largely used and lastly all respondents reported no use of Aerobic and Anaerobic Digestion, Hydrolysis, Thermal Gasification, and Chemical Processing as emerging economic and environmental friendly solid waste management technologies.

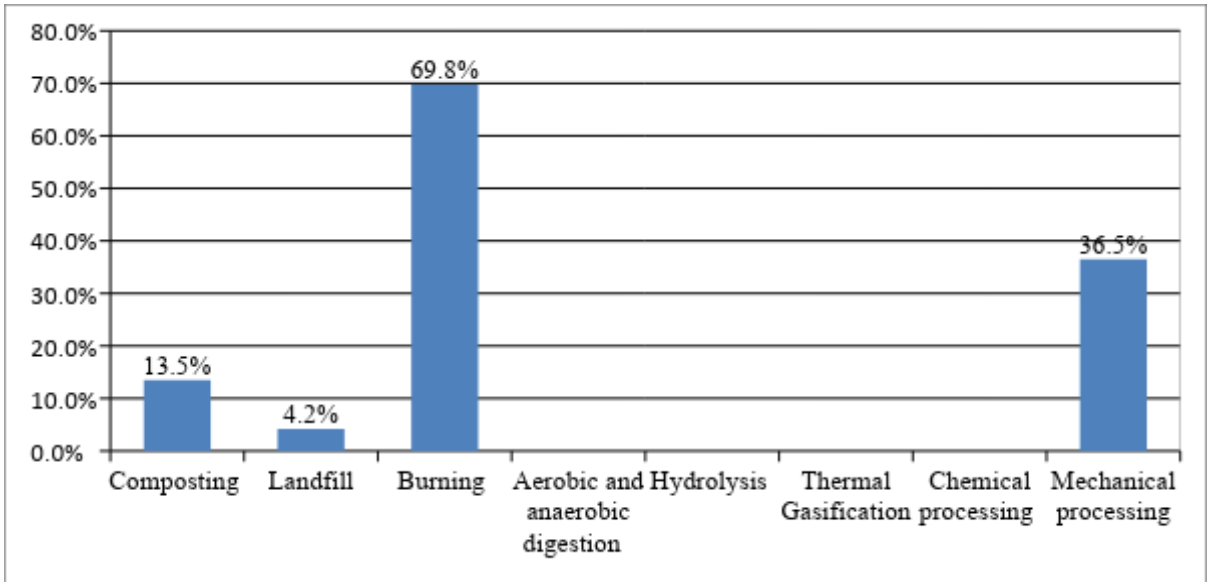

Figure 1: Use of solid waste management technologies

From the discussion it can be concluded that the rate of adoption of emerging economic and environmental friendly solid waste management technologies is low in Majengo neighborhood. Additionally, the findings support the work of Simelane and Mohee (2012) indicating inability of African countries to adopt a set of appropriate technologies that will assist the developing countries to convert waste into re-usable assets. Studies indicate that countries such as Armenia, Bangladesh, and Brazil, Hong Kong, India, and New Zealand, Russia, Switzerland, and United Kingdom, and the United States of America have adopted solid waste management technologies (Coufal, 2008). Adoption of the solid waste management technologies was a step towards compliance to the international agreements such as Bamako Convention, Basel Convention, and EU directives on batteries, landfills, incineration, waste water, WEEE and London Convention, Oslo Convention, and OSPAR Convention.

3.4 Factors hindering effective use of new technologies

The study explores factors hindering effective use of new technologies. The results indicated that 92.5 % of the respondents admitted that inadequate capital hinders effective use of new technologies, 65.0 % of the respondents acknowledged inadequate technology hampers effective use of new technologies and 59.2 % of the

respondents replied that negative attitude inhibit effective use of new technologies, 73.3 % of the respondents reported that lack of knowledge slows down effective use of new technologies, 67.8 % of the respondents said that climate deters effective use of new technologies and 57.5 % of the respondents admitted that giving low priority to technological innovations obstructs effective use of new technologies (Table 2).

Table 2: Factors hindering effective use of new technologies

Factors	No. of Respondents	Percentage
Inadequate capital	111	92.5
Inadequate technology	78	65.0
Negative attitude	71	59.2
Lack of knowledge	88	73.3
Climate	81	67.8
Priority	69	57.5

Basing on the findings above, adoption of the new technologies such as Anaerobic Digestion, Gasification, Pyrolysis, Plasma Arc, Anaerobic Digestion Plant, gas control, conversion of landfill biomass and gas to electricity and landfill cap design depends on many factors (Vicente and Reis, 2008).

Studies carried out in developed countries support the finding that introduction of new solid waste management technologies is expensive. The literatures indicate that Anaerobic Digestion, Gasification, Pyrolysis, Plasma Arc. Anaerobic Digestion Plant Operating since September 2008 in Sydney Australia is digesting 300 tons per day.The interventions were among capital intensive investments.Concerning technology, adoption of technology from the developed countries is barred by social, economic, and political dimensions. However, according to Surroop and Mohee (2011) power generation from solid waste is an inevitable solution towards sustainable solid wastes management.

Studies describe clearly negative attitudes towards solid wastes. Currently, Municipal Solid wastes are viewed as wastes that should be discarded. Such an attitude is one of the hindrances towards adoption of new technologies. Haphazardly throwing of Municipal solid wastes and inadequate use of solid waste are indicators of wrong attitude towards Municipal solid wastes. However, Nzeadibe (2009) unveiled emerging practices such as informal recycling. The emerging practices guarantee solid waste reforms potential in changing of the attitude of community members. Pertaining to lack of knowledge on the potential of solid wastes and secondly knowledge on appropriate knowledge that take into account social, economic, and political dimensions.The study carried by Zake (2008) insists that waste is wealth. Lack of adequate knowledge on solid waste management technologies was disclosed by the study of Nhamo (2011) suggesting investigation regarding future use of solid wastes.

4.0 Conclusion and Recommendations

4.1 Conclusion

Currently, the rate of generation of solid waste in urban areas is increasing due to increase in population, social, and economic activities. Practices such as composting, separation and recycling solid were interventions aimed at converting waste into assets. The practices have brought no sustainable solid waste management. The current practices lack advanced methods supported by appropriate technologies thus have led to very few alternative uses of solid wastes. Improper handling and disposal of wastes is an indicator of a need for new intervention using appropriate technologies.New technologies that convert solid wastes to energy are in place. However, adoption rate of the new technologies has been low.

4.2 Recommendations

The paper recommends to stakeholders in solid waste management to research and introduce appropriate technologies for converting solid wastes into gas, electricity and fertilizers. The literature review disclosed that in the developed countries sustainable management of solid waste is no longer a burden because the countries have introduced appropriate technologies that convert solid wastes into resources. There is a need to carry out a study on first potential solid waste management technologies and second on the anticipated impact on natural resources, social norms, economic factors that promote waste production and triggers use of solid wastes, political willing, policies, legislations and local bylaws, and institutions at various levels.

In addition, a technological development is expensive. It is recommended that urban authorities improve revenue collection. Concurrently to revenue collection, sustainable solid waste management is possible if the urban authorities make technological development in solid wastes a priority.

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