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Municipal Solid Waste Management practices: Towards adoption of a Responsible Innovative Model for the City of Harare

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Abstract. This study took a historical retrospective approach to Solid Waste Management (SWM) focusing on how it started, how it became a growing concern with ripple effects to society and ultimately, how the City of Harare (COH) can adopt a sustainable and responsible innovative solid waste management practice. The study adopted a pragmatism philosophy, by making use of mixed method approach. 130 Google online forms and 6 key informant interviews were used to collect data from the respondents. Stratified purposive sampling was used to select the respondents in the 46 wards of Harare. Data was analysed quantitatively using descriptive and inferential statistics generated from the Google online forms, and qualitatively through thematic content analysis. The study found out that the COH's failure to effectively manage solid waste is due to the lack of resources and a lack of sustainable and innovative ways of SWM. Chi-Square test for the two variables was 0.61 and it is greater than 0.05. This shows that there is no association between the types of waste managed or collected and the strategies that they use to improve solid waste management. This led the researcher to accept H0 and reject H1. The study concluded that the adoption of a responsible and sustainable innovative model for the city positively impacted COH's financial performance. It was recommended that the COH improve its budget in sustainable and innovative means for SWM and adopt a cost leadership strategy to reduce its costs and enhance profitability. In conclusion to the above findings the researcher recommends technical and financial support to be given to the community based organizations (CBOs) in all their aims to manage solid waste and wanting to make Harare urban a clean city. Environmentally sustainable solid waste management practices guided by the principles of the integrated approach and invigorated by environmental education must be fully adopted.
Keywords: *Solid Waste Management, sustainable, responsible, innovation*.

Introduction

Management of Solid Waste (MSW) has continuously stood out as the foremost problematic issue for Harare Metropolitan city. The amount of solid waste created in the city is higher compared to the City of Harare`s (COH) capacity to contain the impasse primarily because of limited technical, financial and human resources that are required to parallel and control this challenge. By the year 2025, the Harare City Council aims on its strategic blueprint and on its main objective to attain a first-class city standard, (City of Harare, 2012). The strategic plan of the COH to achieve this, stresses a smart environment devoid of pollution in its operational parameters (Sani, 2018). This demands that there should be clean streets and regularised city activities. Compounded by the non-performing economy after the year 2000,

the city has been experiencing gross challenges including revenue generations and the incapacity of the citizens to pay. Overall, from 1980 to 2001, major cities realised phenomenal growth rates of about 5% per annum in population (Central Statistics Office (CSO, 1982; 2002). Incessant periodic droughts since independence, rural poverty and a shrinking communal farming space coupled with acute socioeconomic challenges continue to necessitate rural to urban migration with Harare being the most affected city. This study focuses on municipal solid waste management practices with a particular attention to City of Harare (COH). The study sought to explore the level of sustainable innovation for the COH waste management practice, to determine the effect of governance as a factor in Solid Waste Management (SWM) and recommend innovative and sustainable SWM strategies.

Background to the Study

Due to high unemployment and shrinking economic space, the majority of the rural to urban migrants become survival entrepreneurs whose activities are in the informal sector which is, in most cases unregulated. While their urban economic contribution is undeniable, it does not translate to the COH's revenue streams to necessitate the reciprocal proportional service delivery in tandem to their use of city space since they do not pay taxes and such fees to the authorities. On the other hand, the COH relies primarily on funds from the central government although these funds are not proportional to the population increase thereby worsening the diminishing overheads in per capita terms and council revenues. As a result, these unforgiving trends continue incapacitating the COH's response to planning, environmental management and basic service delivery (Tibaijuka, 2005). Furthermore, the increase in population growth is a cause whose effect is the rising generation of waste which finds its way to open dumps.

Population growth is synonymous with waste creation because it is believed that the larger the populace the greater the proportion of refuse creation (Medina, 2010). According to (Saungweme, 2012), the waste build-up in open spaces and roadsides is indicative to the miscarriage of service delivery by local authorities. Similarly, (Mafume et al., 2016) postulates that, in many Less Economically Developed Countries (LEDCs) in the SADC region, there is a mismatch in revenue collection in comparison to population growth thereby frustrating municipal solid waste management. The rate of escalating unofficial settlements across the length and breadth of the COH is reflective of the Council's failure to plan and appropriately manage solid waste at domestic level, (Chinobva & Makarati, 2011).

The Zimbabwean government acknowledges that population growth is the major impediment for the urban local authorities in coping with environmental and human health challenges related to the creation, carriage and discarding of SWM (Feresu, 2010). Feresu further highlighted that the majority of Zimbabwe's urban local authorities fail to meet the refuse collection and disposal demand due to the ever-increasing population growth. Mapira, (2012) buttressed this view by affirming that MSW is the major problematic area for urban authorities in Zimbabwe. Masocha & Tevera (2003) assert that about 60% of urban generated solid waste is discarded at official dumpsites 40% is disposed of illegally in undesignated areas that is to say in roadsides, alleys, storm water drains and open spaces. As a result, (Feresu, 2010) reaffirmed that improper disposal of waste pollutes the air, environment, underground water through leachate, ground water and breeding spaces for disease-causing-vectors.

Problem Statement

The COH is inarguably grappling with a multiplicity of challenges which include budgetary deficits; broken down equipment; ineffective and inefficient solid waste collection practices, unhygienic and poorly funded operations; incapacitated environmental control mechanisms; arbitrary illegal littering and dumping; solid waste open burning; and a general public insensitive to SW in their vicinity or to what symbolises responsible and sustainable innovative SWM practices. The effects of these problems is as a result of the COH's incapacitation in its solid waste management strategies. COH's management of solid waste practice therefore requires an immediate remedy that is sensitive to the conception and

effecting of lifelong responsible and sustainable innovative measures. The problem affects its performance and its goal of becoming a world class city by 2025.

Significance of the Study

The research focused at highlighting the possible policy together with practice gaps contributing to the growing problem of SWM for the COH. The paper helps universities and other stakeholders to have an understanding of the relevance of sustainable innovation in case of waste management practices. Furthermore, the study sought to enthuse central government to get a clearer view on facilitating and overseeing responsible, sustainable and innovative SWM. The study highlighted ways to enhance sustainable and responsible innovation in COH's operations and this helps government to implement policies with respect to the effective and efficient use of waste management practices.

Literature Review

Solid Waste Materials: Types, Composition and Location

SWM is the gathering, moving, treating, recycling or relocation, and inspection of SW created by human activities, aimed at reducing its impact on the wellbeing of the environment and its people (UNEP, 2006b). Waste is either fluid or solid and can be decomposable or non-decomposable matter (Hardoy et al. 2001). The average composition of MSW consists of 40-51% biodegradable, 32% fine materials, 10%plastic, 7% paper (United Nations Report, 2004). SW has become a predominant feature in our metropolitan environs giving rise to MSW challenges, (United Nations Report, 2004).

Solid Waste Management Legislation in Zimbabwe

Zimbabwe has numerous pieces of legislation that are in place to regulate how SW is handled and disposed of. The Environmental Management Authority is the regulating board under the EMA, Chapter 20:27 Act. In section 70 (1) of the Act, it states that "No person shall discharge or dispose of any waste in a manner that causes environmental pollution or ill health to any person". Any person, therefore, who has a direct contribution to the generation of waste is obligated to use methods that reduce the waste through handling, reclamation and reusing, among others. Furthermore, the EMA Act in section 83 (1) outlaws littering by declaring that: *"No person shall discard, dump or leave any litter on any land or water surface, street, road or site in or at any place except in a container provided for that purpose or at a place which has been specially designated, indicated, provided or set apart for such purpose".* (Environmental Management Act [Chapter 20:27]) The Urban Councils Act, 2015 declares that gathering, movement together with discarding of SW is the prerogative of town councils in areas of their administrative jurisdictions. The EMA Act and the Urban Councils Act form part of legislation regulating SWM in Zimbabwe.

Sustainable and Responsible Innovative Solid Waste Management (SRISWM)

The COH highly depends on landfilling to manage the bulk of its solid waste. Waste-to-Energy Technologies (WtE) innovation is a welcome renewable energy source that is responsible and sustainable. Waste is a striking all-seasons unusual source of fuel. In Africa, there are many benefits obtainable from the co-operation between (NGO's), (CBO's) and the government within the country. Lee-Smith and Stren (1991) posited that in order to have an essential framework for service delivery in African, the public had a better mediation role. Increased shortage of resources and a lack of innovative technologies create greening opportunities for the waste sector by the growth of the waste market. Globally, the waste market was estimated at 410 billion US dollars a year in 2011 from collection to recycling. This was excluding the large informal segment in LEDCs. UNEP reaffirmed this position by stating that recycling was more likely than not becoming a preferred factor for GWMS, moreover generating decent occupation for many (UNEP/IETC, 2011).

Lombardi, et al. (2015) suggested that incineration was most preferably the most advanced technology to create energy from waste. This involves high temperature furnace burning of waste while

the heat produced is used for electricity generation or heat itself as a resource. Residue and exhaust gas are by-products that can further be processed into construction materials while metals can be removed for recycling. Mostly, up-to-date incineration plants have energy generation adeptness of about 30%. Assimilated Waste to Energy (WtE)-Gas Turbines electricity generators have been poised to increase energy efficiency to at least 40% and in 2012, only Spain, Netherlands and Japan had three of these plants (Branchini, 2012). While this technology is yet be considered matured, the assimilated gas turbine classification appeared to be the future of WtE incineration technologies.

Incineration is believed to be the most preferred option relating to capacity, category of waste cured and capacity decrease (Bosman et al., 2013). The prospective residual economic contribution is an additional advantage of the technology. However, Evans (2016) argued that WtE incinerators are costly among negative impacts to society and the environment. He further substantiated this opinion by stating that establishment costs of WtE incineration infrastructure are very high and people are ordinarily opposed to living close to incinerators due to the adverse living conditions around the site. Toxic gases, dioxins and polluting metals, all products of incineration are injurious to human well-being and contaminates the atmosphere. Nevertheless, it is notable that the amounts produced have lessened due to extensive technological progression in the past few years as a result of governments imposing stringent rules (Scungio et al., 2016).

According to CEWEP (2017), Europe has successfully implemented the technology of WtE incineration. The United Kingdom, Sweden, France, Italy and Germany are the largest investors in this technology which reduce the level of waste disposed of in landfills by 90%, (EU Data, 2016). Incineration allows investors to reduce the volume of waste disposed of in landfills by 90%. Consequently, 26% of waste In European Union (EU) countries, was used to produce energy in 2015 (Sandford, 2017). The energetic valorisation symbolises 1.3% of ultimate electricity usage and 8.9% of heat usage. In 2012, the number WtE plants that were recorded was 409 in the EU and these accounted for burning 74 million tons generating 30 TWh of electric power in addition to 74 TWh of high temperature (Union européenne, 2015).

Theoretical framework

The study adopted the Concept of Institution by Scott (2001) in conjunction with Capacity Building by (Janicke, 1997). These two theories were instrumental in identifying the COH's institutional makeup of Municipal Solid Waste Management (MSWM) systems.

Institutional Concept

Legal systems, government structures and constitutions are formal forms of rules which form the basis upon which an understanding of the concept of institution is attained to embrace casual facets of life. Mungure (2019) postulates that there are three pillars of institutions that are significant. Notably, these are cultural cognitive, regulative and normative systems which Scott (2001) has acknowledged as crucial ingredients of institutions. It is important to regard these three pillars as contributing factors to the interdependent ways and the social framework fabric that binds responsible, sustainable and innovative MSWM togrether. Accordingly, this provides an understanding of how MSWM in a social system can be implemented. The theory brings in the Normative Pillar, Cultural Cognitive Pillar and Regulative Pillar. The theory is useful in the study since the COH is a powerful actor with legitimate power to craft rules and laws and to enforce them for the council to exercise its right for ensuring that residents' wellbeing is achieved.

Capacity Building

Capacity building was adopted in the study to ensure improved performances in providing a thoughtful correlation linking institutions to capacity building in the way organisations are run. Effective management of solid waste in African cities is impeded primarily by insufficient capacity. Mungure (2019) avers that a well-organised, successful and environ-friendly solid waste disposal calls for the construction of organisational competence in both private and public sector administration. This, he

further buttresses, includes the technological competence for operational needs. According to Mungure (2019), there is a dearth of technical knowhow and financial knowledge in many SWM employees from all sectors to operate effectively and efficiently. Therefore, creating competencies across all levels require training. This means that to achieve responsible, sustainable and innovative MSW, there is need for capacitation for all personnel engaged in SWM. Capacity building and Institutional theories are insightful to what an establishment or organisation ought to be. This discourages individualism among actors and encourages group work hence illustration of its relevance in the research for MSWM.

Understanding Solid Waste Management Challenges: Global, Regional, National Trends and Context

SWM is the practice of gathering, keeping, handling and discarding of SW such that it is not hurtful to animals, plants, humans, and the environment generally (Williams, 2005). SW can be described as "any substance or object in solid form which the holder discards or intends to discard" (Waste Framework Directive 75/442/EEC, 1975, Article 1 (a). Williams, (2005) however contends that refuse is subjective in that what may be considered waste by one person may be a resource to another.

Some people dispose of their waste through the process of incineration. They burn their waste at home in the backyard, a process that is easy and inexpensive. However, burning causes air pollution, destroys soil nutrients and kills small insects that take habitation in the soil. Khan (2003) quoted in Chirisa (2013) defines solid waste as "…material that is cheaper to throw away than to store or use." This can either be organic or inorganic material that can be separated for recycling or reuse in society. Organic material decomposes and can be used as manure in farming whilst inorganic material can be recycled for reuse. Only solid waste that is not fit for reuse and recycle should be transported to the landfill.

Research done by Gumbo (2005) discovered that individual residents were dumping between 0.481 kg and 0.301 kg per day of SW and 60–80 % was compostable or eco-friendly refuse. These statistics stood similar to generation proportions in other urban global cities. 50% of this SW were food-stuff left overs with a 50-70% moisture content. The remainder was biodegradable SW made up of tree leaves, natural grass, crop residues and weeds (yard waste). Crop residue is prevalent in Harare due to urban agriculture which has since been accepted as a contributor to the ecosystem, generation of income and health nutrition.

With regards to the disposal of waste, residents are not experiencing a higher level of satisfaction because there has not been improvement in environmental management since independence. In residential areas, only a small percentage of the population separate organic from inorganic waste whereas the majority throw all their waste in the waste bags without systematic separation (Sinthumule and Mkumbuzi, 2019). Afroz et al. (2011) indicated that the majority of people in Bangladesh do not separate waste they dispose of because they do not have time, recycling facilities and incentive. This is the same trend in Harare where people throw solid waste anywhere when they are outdoors because the waste bins are few and unevenly distributed. Bins provided for use in the city are stolen or destroyed. The city has no by-laws or power to arrest culprits who litter or vandalise its assets.

The Problem of Open Dumps: Global, Regional, National Trends and Context

SWM is not only a techno-practical challenge, it is largely affected by economic, political, socio-cultural, resource availability and the environment. These factors are intertwined into complex WMS, (Kum et al., 2005). Urban centres in developed economies generate large volumes of SW and have the capacity to effectively manage SW, (Srinivas, 2003). Research has demonstrated that solid waste that is created in developed nations is evacuated and arranged in a protected and proficient way as proved in these urban areas. UNEP (2002) highlights that most solid waste created in these urban communities is sorted at collection point before it is transferred to landfills. In opposition to this, urban centres in developing nations in Sub-Saharan Region, for example, Harare (Zimbabwe) are still in the process of accomplishing better solid waste administration frameworks since they currently have an inadequate strong waste gathering and poor transfer frameworks (Srinivas, 2003).

SW in LEDCs symptomatically has an extraordinary amount of carbon-based material in comparison to first world cities. For instance, researches carried out in Africa projected that in Juba-South Sudan, carbon-based waste represented approximately 31% of all generated waste by weight (UNEP, 2013), 61% in Ghana (Miezah, Obiri-Danso, Kádár, Fei-Baffoe, & Mensah, 2015) and 54% in Ethiopia (Getahun, Mengistie, & Haddis, 2012). The extraordinary carbon-based content has repercussions for WM comprising reprocessing, but also a prospective cause of ill-health if managed badly.

Desta, et al. (2014) found out in their study that more developed countries produce larger quantities of solid waste than developing countries but the garbage does not pose any challenge in the former. The municipal solid waste creation rate in Addis Ababa was 0.5kg/person/ day whilst in New York City it stood at 4.6kg/person/day (PlanNYC, 2013).

Consequently, the waste creation rate of New York City was 9 times that of Addis Ababa. Desta et al. (2014) found out that the poor municipal solid waste management in Addis Ababa was as a result of unlawful disposal of waste on undesignated sites, open disposals, limited, defective operating equipment, inadequate governance in the waste management system, lack of effective public participation and poor condition of the final dumpsite.

Desta et al. (2014) recommended early key stakeholder engagement and involvement at the planning stage to improve residents' buy-in. 92% of Bulawayo residents, according to the research done by Mudzengerere and Chigwenya (2012) were given refuse-collection bins. Notwithstanding, only 48% were putting environmentally friendly plastic refuse bins to use. They additionally deposed that the only official dumpsite for the entire city is an open dump although it is not accessible to individuals other than the council workers and those authorised to dump. Contrarily, this provides an opportunity for employment creation through recycling of waste.

The study findings done by Chinobvu and Makarati (2011) during their study of SWM in the Highfield suburb of Harare in Zimbabwe indicate that SWM infrastructure is too expensive to run, too old, and largely inadequate. They recommended that residents should be informed on the practicability of the three Rs (reduce, reuse and recycle), compositing and sustainable waste disposal. In Chinhoyi town, Musademba et al. (2011) in their study found that the failure by local authorities to provide safe potable water was a result of ineffective SWM primarily because of irregular waste gathering and disposal which resulted in communicable diseases such as cholera and typhoid.

Jerie and Tevera (2014) in their City of Gweru studies asserted that biodegradable material such as incinerable waste in the form of paper, textiles and rubber and vegetable waste constitute the large amounts of solid waste which is disposed of irresponsibly, unsustainably and with no innovation. Further, they indicate that the City of Gweru is marred by a heightened dearth of transportation equipment for gathering waste notwithstanding the high rate of waste generation for the city. Their study concluded that apart from the erratic SWM for the City of Gweru as evidenced by some waste collectors leaving behind some waste during collection, 32% of their respondents showed a willingness to recycle the waste (Jerie & Tevera, 2014).

Makarichi, et al, (2019) contend that either 6.4% of the commercial and service sector energy consumption or 3.2% of current residential energy consumption can be recovered from MSW Incineration. The gasification probable output was approximated at 4.4% and 8.8% respectively. The study showed that thermal MSW treatment with energy recovery can increase the share of biofuels and waste to electrical energy production in Zimbabwe from 1.3% to at least 2.2%. Given the results reported in this study, the implementation of WtE in Zimbabwe can go a long way towards meeting the challenges related to poor solid waste management. An overview of similar studies in selected African cities shows that more research and promotion is necessary to facilitate the adoption of thermal MSW treatment, (Makarichi et al., 2019).

Methodology

The researcher adopted the pragmatism philosophy as a research paradigm in this study. Pragmatism research philosophy accepts concepts to be relevant only if they support action (Saunders et al., 2012). The researcher adopted the pragmatism philosophy since it accepts that "there are multiple realities out

there that are open to empirical inquiry" (Creswell & Clark 2011). The study took the mixed approach to broaden the scope in understanding Municipal Solid Waste Management (MSWM) for the COH. Mixed approach design helped in triangulation between quantitative and qualitative data for a deeper understanding of a subject under review (Hashemi and Babaii, 2013). The target population included Harare City Council officials (both elected and technocrats), residents and Residents Associations and senior officials from government departments. Data was collected from Council, ordinary residents, Department of Works, Department of Health, the Council Municipal police and the Environmental Management Authority (EMA) respectively.

The study took the stratified sampling method as the most preferred method so as to have all institutions being represented. Stratified purposive sampling was employed to select key informant interviewees. A total of 130 participants were used. Purposive sampling was used to select 6 key informants for interviews. Google Online Form Questionnaires with closed-ended questions to collective quantitative data. In order to address the validity and reliability of the study, Cronbach's Alpha was conducted.

The results of the reliability test indicates the level of internal reliability and consistency in the questionnaire that was used. This therefore proves that the study addressed the quality control tests for the study. The study indicates a Cronbach Alpha of 0.920 which indicates that reliability of the research instrument and questions asked was very high. Therefore, further test can be conducted.

RESULTS, ANALYSIS AND INTEPRETATION

Table 1. Response Rate

Data Collection Method	**Number of Targeted Respondents**	**Number of Actual Respondents**	**Response Rate**
Questionnaire	130	104	80 %
In-depth Interviews	6	4	66.70 %
Total	**136**	**108**	**79.41**

Source: Survey Data (2021)

130 residents were targeted for the study sample for the 46 wards in Harare. 6 key informant interviews were scheduled for the stakeholders directly involved with service delivery.

Rating of solid waste management among other competing urban challenges

Firstly, it can be noted that there were about one hundred and four responses from the study. Ninety responses came from different wards in Harare high-density suburbs, medium-density and low-density suburbs namely Hatfield, Greendale, Mt pleasant, Dzivarasekwa, Mbare, Waterfalls and Sunningdale to mention just a few.

The highest response and average rate were 7.8 % which came from Marlborough, a low-density suburb because people living in these areas are capable to afford the internet, have better living conditions and have better income levels. The moderate response was 3 % on average and came from medium-density suburbs mostly due to the fact they can afford the internet and are capable to afford the bills. The lowest average response rate was 1 % because the wards have low-income levels such as Dzivarasekwa and Mbare.

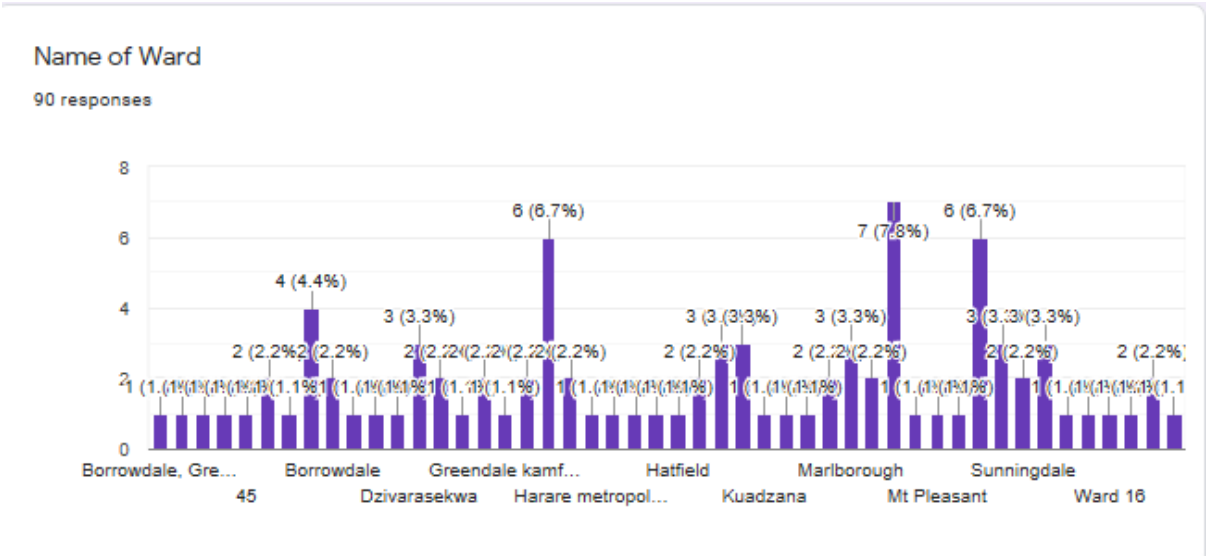

Figure 1: shows the ninety responses that can from different wards in Harare (Survey 2021).

The level of sustainability and responsible innovation for the COH waste management practice

The relationship between different wards in SWM

In carrying out this study, the researcher noted that there are 46 wards in Harare Metropolitan Province. The highest ward which contributed most was Ward 5 with 9% as a result that waste management practices were poor and there was need for a revamp. The second ward which contributed was ward 41 with 6% because the ordinary residents were complaining that waste management was collected twice a month by the local authority. During the study, it was noted that generally, most wards in Harare constituted 1% as a result of poor waste management,

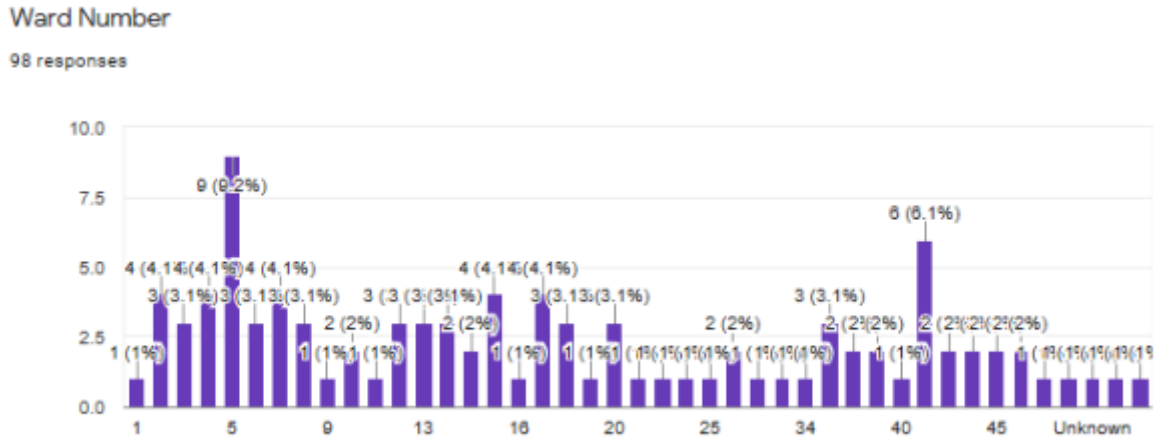

Figure 2. *The relationship between different wards (Survey 2021).*

Relationship of Crime, power and water shortages in SWM in different wards

Crime increased from 10-20% across most wards in the past few years. The highest percentage crime rate during the study was 39 %. This was due to the unlawful ways including burglary, inconsequential stealing, car break-in, and household attack hence the criminalisation and monopolization of removing waste by the COH, especially in high-density areas, where nearby illegal dumpsites have become criminal hide-outs apart from other potential risks of causing waterborne diseases. The moderate crime

rate was 21% and the lowest recorded was 2% in different wards. The conclusion which can be drawn from this study is that the crime rate is generally increasing in all wards. Also, in tandem with crime increasing, most wards have experienced an increase in power outages with thirty-three 33% as the highest percentage from different wards during the study. The incessant power shortages were necessitated by the limited electricity generation capacity at the Lake Kariba South Power Station coupled with lack of foreign currency to supplement the power supply by electricity imports from the region.

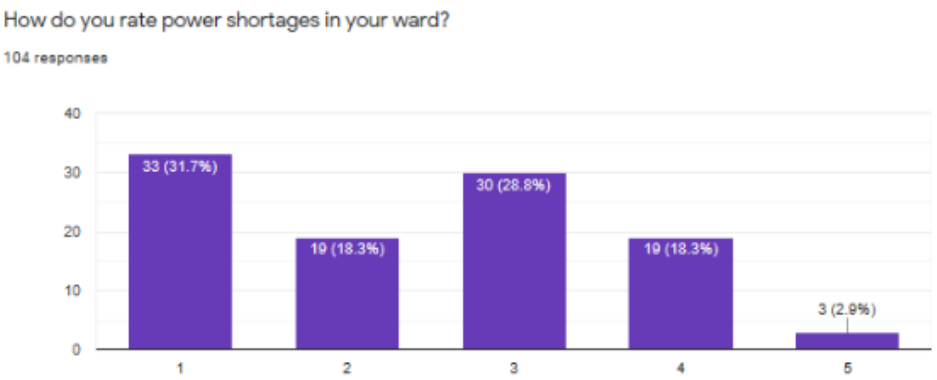

Figure 3: shows the increase of power shortages in different wards (Survey 2021).

The increase of water shortages in different wards

There was an increase in water shortages in different wards in Harare, the highest water shortage percentage was 37 % during the study from the one hundred and three respondents. This was because the city does not have adequate potable drinking water. Resultantly, millions of people are at their breaking point and the risk of cholera or typhoid epidemic that could infect the entire population since there is poor waste management and people are suffering from acute water shortage at home after the main waterworks were shut down. The moderate rate of water shortage percentage was 19% during the study because city authorities said that the drinking water crisis is caused by a lack of foreign currency to pay for the water purification chemicals necessary to purify drinking water that is supplied by dam reservoirs. The lowest rate of water shortage percentage was 1% because most residents resort to fetching clean water from boreholes that are scattered within hard-hit areas facing major water challenges rather than relying upon COH's tap water which seldom is available and dirty whenever it is available.

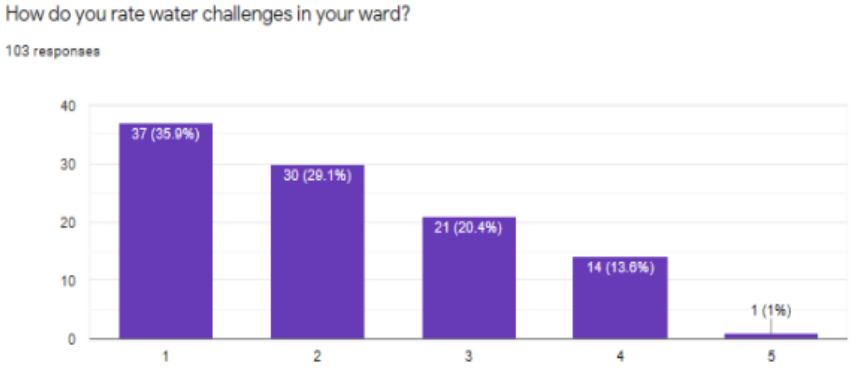

Figure 4: shows the increase of water shortages in different wards (Survey 2021).

Many significant costs that include driver stress, lost time, accidents and air pollution through vehicle emissions are incurred by motorists due to the failure of traffic signals. Traffic congestion and noise pollution were noted to be increasing in different wards gradually with the highest traffic congestion percentage being 31 % during the study from the one hundred and three respondents. This was because the traffic congestion issue is also exacerbated by the residents who are formally employed, those running their businesses and the informal traders usually travel to and fro the CBD at the same time thereby causing congestion. Noise pollution had the highest percentage of 28% as a result of traffic congestion which is usually caused by motorists wanting to move at the same time. More so, water pollution was also experienced in different wards during the study, it can be noted that the highest percentage was 33% and its lowest 4%. The highest water pollution was also experienced due to lack of refuse collection by city authorities, as the Combined Harare Residents Association (CHRA) noted.

The increase of waste management challenges in different wards

In August 2020, the Combined Harare Residents Association (CHRA) petitioned the Parliament of Zimbabwe over poor service delivery primarily the provision of potable water and refuse collection but there has not been traction over the issue. Currently, the City of Harare has (14) fourteen functional refuse trucks to service forty-six wards of Harare most of which have surpassed their life span. Solid waste management (SWM) refers to the gathering, transportation, handling, reusing or transfer, and checking of solid waste materials produced by human activity, and is for the most part attempted to decrease their impact on wellbeing and the environment. During the study, the researcher noted that waste management identifies with materials delivered by human exercises and is embraced to decrease their impacts on human wellbeing, the environment and aesthetics. Waste management challenges were very high with a percentage of 35 % due to the result that the COH has been grappling with challenges of removing sprouting dumpsites in most suburbs due to the non-collection of waste by the local authority caused by a depleted fleet of refuse trucks. CHRA (2021) argues that *"Most of the challenges faced by the COH in this regard have more to do with a management crisis primarily caused, by the interference of the Local government Ministry on the affairs of the City. Key decisions are superintended over by the Minister of Local Government thereby clipping the hands of the council to execute on their primary responsibility, that of service delivery."*

Figure 5: shows the increase of waste management challenges in different wards (Survey 2021).

The City of Harare's failure to regularly collect waste is no secret. While the city has a statutory mandate to collect and manage waste, this study noted that the city could not deliver and that the poor state of affairs on waste management is a testimony to this failure. Thus, mechanisms to boast the city council's capacity to deal with waste management challenges should be explored to avert a potential environmental and health catastrophe. This is because this study has shown poor planning and

misallocation of financial resources as one of the reasons for the poor waste management situation in the city.

Consequently, the HCC was only managing to collect and dispose of 54% of the 1400 tonnes/day of waste generated within the city due to shortages of fuel and the much-needed foreign currency for the repair of an old fleet of vehicles and equipment. This was also evidenced by the fact that the City Health Department now had on paper, 40 refuse collection trucks but only 8 to 14 of them were operational consistently. Litter in some suburbs went for up to two months without being collected. The uncollected waste remained strewn on the ground, littered in open drains or garbage dumps, often resulting in municipal sewer and storm water drains blockages. However, the city's litter crisis is not over as residents from these wards studied continued to dump litter on undesignated open spaces as soon as their bins filled up.

Strategies used for waste management

From the study, the researcher noted that refuse burning was very common in high and medium-density suburbs. This was evidenced by the highest percentage of about 32 % as a result of the fact that the residents depend on burning as a strategy to minimise the huge waste used. CHRA (2021) asserts that *"City of Harare has (14) fourteen functional refuse trucks to service forty-six wards of Harare of which most of them have surpassed their life span."* As a result of this, there is high criminalisation and monopolization of removing waste, especially in high-density areas, where dumpsites have become potential risks of causing waterborne diseases.

During the research, different strategies used for waste management were noted. These include reuse and burying and these were on average very common with a percentage of 30% because Harare residents are forced to employ better solid waste management strategies since the COH has an inadequate solid waste collection and poor disposal framework. Waste practises like sorting, recycling, reducing, and refuse are undertaken whilst most urban authorities usually concentrate on collection, carriage and disposal of waste at the waste dumpsites because of limited financial, human resources and expertise. Therefore, the residents have adopted the 3Rs Concept that is Reduce, Reuse and Recycle to mitigate the unending challenges of waste because waste in general is very subjective; one may deem an item to be waste whilst another might see it as a resource.

In addition, composting is on average a very fair practice commonly known by residents in different wards with a percentage of 35% and separation with a percentage of 33%. This was because the nature of each industry or sector varies thereby necessitating the employment different strategies for management.

The dynamic nature of consumer/end-user products, packaging materials, environmental regulations and public attitudes has made the development of solid waste management strategies an increasingly complex task. Informal waste pickers contribute significantly to waste management separation and resource efficiency by collecting, sorting, trading and sometimes even processing waste materials. Therefore, the researcher noted that house to house collection of solid waste methods should be more organised by using the methods such as the collection of daily waste by using proper scheduling and timings. Maintaining proper recycling units will save valuable raw materials and resources of the country and helps us to reduce the need for landfills space. Promotion of the waste management systems will upgrade the living and the working condition of the waste pickers and other marginalized groups.

Waste management as a challenge

Waste management is a challenging issue from an environmental, political, legal and social point of view. During the research, the researcher noted that managing paper and plastic is very demanding with high percentages (paper 33% and plastic 35%). This has been so because people rarely recycle. However, in recent years, significant progress has been accomplished in solid waste management, through the increased allocation of funds, focusing largely on the promotion of recycling and the expansion of the number of managed sanitary landfill sites throughout the country.

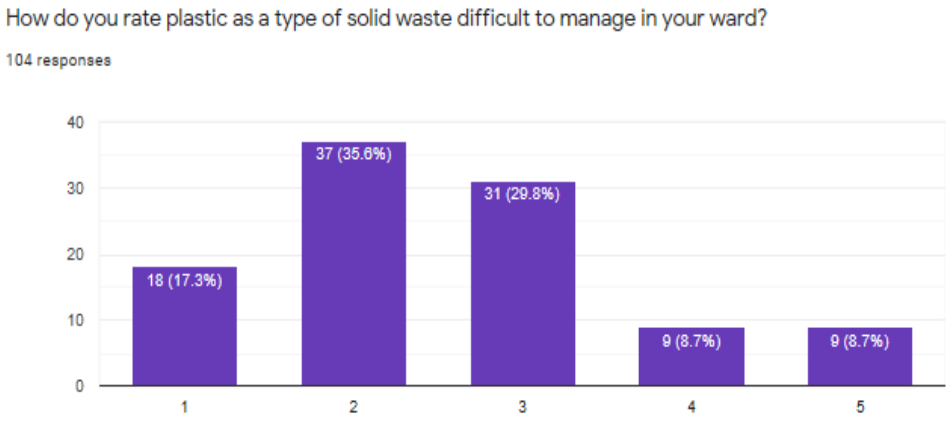

Figure 6: shows plastic as a type of solid waste management (Survey 2021).

In carrying out this study, it was noted that the management of rotten fruits and vegetables was fair with an average of 36 % for fruits and 42 % for vegetables. This was because fruits and vegetables are biodegradable since they easily rot.

Open dumps were very problematic in different areas and wards. The highest percentage for open dumps was 39%. This is so because garbage thrown in the street or open spaces creates a public health hazard, while waste dumped near rivers, lakes and streams contaminates the water supply. Open dumps recorded the least percentage of 6% especially residents that stay in low-density suburbs. Therefore, garbage dumped in the countryside or open dumps is not simply an eyesore but entire landscapes are ruined and unique habitats for flora and fauna are lost.

Analysing the information from the study, 20 and 26% were the present collection average rate and is below 7% in several wards in Harare. However, this may be overestimated by the municipalities due to the lack of scientific recording systems. Citizens dispose of waste within their compound either by unscientific composting, open burning or throwing the waste in the surrounding open space. Collection, city cleaning, and sweeping are not done daily except in main markets, along main roads, and in some residential areas. The rest of the areas are served intermittently from twice a week to twice a month or are not served at all. Therefore, service delivery is very low.

Strategies for SWM in different wards

Clean-up campaigns from the study were noted that on average range from 17% and the highest campaign ranging from 38% as a result that clean-up campaigns are also undertaken by the CBOs and they are supported by City of Harare.

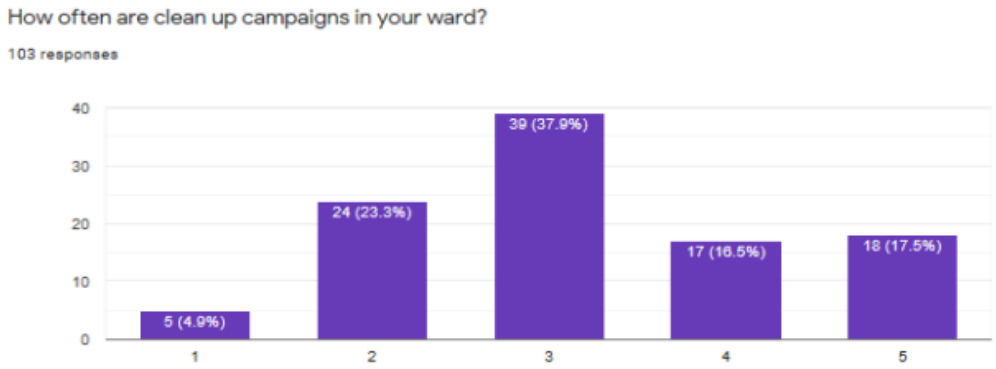

Figure 7: shows clean-up campaigns from the study (Survey 2021).

The practice of recycling by collecting recyclable solid waste is common practice in different wards by different organisations and from the research, the highest percentage practised is 34%, practice for this recyclable solid waste is common practice with an average percentage of 17% due to the method of the 3Rs is showing effect because the community-based organisations are engaged in solid waste collecting, sorting, recycling and reusing. The recycling method has proved to be a huge success because the products that they are making can be sold. They are making baskets, doormats, hats to mention just a few and the products are sold.

During the research, it was shown that it is very possible to have a local waste disposable site, the highest percentage reached being 32 %, this was visible because there is need for a monitoring and evaluation system that helps to analyse the quantity of the waste generated on a daily basis that will help to overcome the challenges. However, it is very low and disagreed to have waste disposable site from the study showing the lowest percentage 10% because the problems facing the COH include waiting for the central government's resolution and approval for land acquisition of proposed landfill sites, lack of technical support, financial constraints, problems in area selection, and strong opposition from nearby communities. Political interference has also been observed in many municipalities as well as technical problems such as flooding, shallow water table, highly permeable soil, and slope instability.

Figure 8: shows how if it is possible to have a local waste disposable site (Survey 2021).

Participatory members are very low in participating strategies for solid waste management with a percentage of at 4% because the demand is higher for other public services in many municipalities and local bodies are experiencing difficulties in developing management plans due to the lack of SWM baseline information and data related to the functional elements of SWM. It is essential to know the quantity and composition of MSW when designing and implementing proper waste management plans that include resource recovery through appropriate methods.

Relationships between mobilizing resources and SWM in different wards

How politics mobilise resources for SWM

The researcher noted that politics to a lesser extent find it difficult to mobilising resources as evidenced from the study that more response rates disagreed. This has been due to t the fact that since the attainment of independence in Zimbabwe, waste management in Harare has been treated as a political football. Responsibility for waste management has changed hands from one department to another within the City of Harare. Unfortunately, each change further deteriorated the system, bringing it on the verge of collapse. Before 1996, the Department of Works was responsible for waste management in the city. This responsibility was transferred to the City Health Department in and after 1996. It was during

this period that the HCC contracted out 56% of the refuse collection to some private companies with the City Health Department retaining responsibility for the remaining 44%. Therefore, the unbundling of waste management was meant to cope with the ever-increasing population of Harare, which is currently estimated to be around three million.

It was found that it's very hard and very low to mobilise finance funds for SWM from the research as noted by lowest percentages during the research f 5 % and 12 % respectively. This is due to the reason that huge finance is needed for best SWM, According to CHRA states that;

"The situation with the COH regarding SWM is quite despicable. The council is failing to meet up to the challenge of the ever-growing demand for proper solid waste management from the basic transportation and disposal of refuse from the length and breadth of the 46 wards of the COH. Right now, the COH is considering procuring new refuse trucks amid revelations that they are no longer pursuing the 15 refuse compactors they bought from FAW Zimbabwe (Mass Breed Investments) but the trucks were never delivered. These financial leakages are the COH's greatest u doing as far as effective service delivery is concerned primarily SWM."

How technology mobilise resources for SWM

Also, it was found to be very achievable to mobilise technology for SWM from the research as noted by moderate percentages during the research f 37 %, 29 % and 21 % respectively technology will change outdated and bring in new innovative ideas. The use of GIS will enable new landfills to be created effectively. The dissemination, updating, and management of simple information will play an essential part in improving planning by the local bodies and monitoring implementation progress. However, technology is costly in our HCC as evidenced by the Acting Mayor for Harare City Council, Councillor Stewart Mutizwa appealed to the public to help with any resource that can assist the city in clearing dumpsites and refuse collection. This happens at a time when the COH has been grappling with the challenges of removing sprouting dumpsites in most suburbs due to the non-collection of waste by the local authority caused by a depleted fleet of refuse trucks.

From the study, the most commonly used technology is the bum with 31 %. The bum was used at the highest percentage because it's an easy method to dump waste. Secondly, the recycling was the second-highest method used during the study because the recycling method has proved to be a huge success. After all, the products that they are making can be sold. They are making baskets, doormats, hats to mention just a few and the products are sold.

Figure 11: technology used in SWM (Survey 2021).

Statistical testing of waste managed and the strategies to improve SWM

The Chi square was used by the researcher as a statistical testing and the types of s**o**lid waste management and the strategies used by the researcher.

Hypothesis

H_0– There is no association between the types of waste collected and the strategies that are used to improve solid waste.

H_1 – There is an association between the types of waste collected and the strategies that are used to improve solid waste.

Table 2: Chi-square test

	Value	df	Asymp. Sig. (2-sided) Pearson
Pearson Chi-Square	4.479a		.612
Likelihood Ratio	6.311	6	.389
No of Valid Cases	30	6	

11 cells (91.7%) have expected count less than 5. The minimum expected count is .20.

Basing on the information shown in Table 3 for the Chi-Square test for the two variables was 0.61 and it is greater than 0.05. This shows that there is no association between the types of waste managed or collected and the strategies that they use to improve solid. This means that there is no one unique strategy that is used but rather all the strategies can be used to improve solid waste despite the type of solid waste. The main objective is that the waste be managed despite the strategies used. This led the researcher to accept H0 and reject H1.

Perception on Environmentally SWMS

According to "Chapter 20:27 Environment Management Act (Effluents and Solid Waste Disposal) Regulations, 2007 ,14 (1),""Every local authority shall designate suitable sites as waste collection sites within its area of jurisdiction for the management of wastes and ensure a waste collection frequency that minimizes accumulation and avoids decomposition of waste on collection sites." Waste management was viewed differently by interviewees as one said that *"The situation with the COH regarding SWM is quite despicable. The council is failing to meet up to the challenge of the ever growing demand for proper solid waste management from the basic transportation and disposal of refuse from the length and breadth of the 46 wards of the COH. Right now, the COH is considering procuring new refuse trucks amid revelations that they are no longer pursuing the 15 refuse compactors they bought from FAW Zimbabwe (Mass Breed Investments) but the trucks were never delivered. These financial leakages are the COH's greatest u doing as far as effective service delivery is concerned primarily SWM. As CHRA, we have in August 2020, partitioned Parliament over the matter but there hasn't been traction over the issue. Currently the City of Harare has (14) fourteen functional refuse trucks to service forty six wards of Harare of which most of them have surpassed their life span."*

An official from the Department of Waste said, *"One of our councillors, Hatcliffe Ward 42 Councillor, Elvis Ruzani was arrested by police for clearing a dump site at Matombo area in Hatcliffe and later released without charge. This happened barely a week after the Acting Mayor for Harare City Council, Councilor Stewart Mutizwa appealed to the public to help with any resource that can assist the city in clearing dumpsites and refuse collection. This happens at a time when the COH has been grappling with challenges of removing sprouting dumpsites in most suburbs due to non-collection of waste by the local authority caused by a depleted fleet of refuse trucks. Therefore the criminalization and monopolization of removing waste, especially in high density areas, where dumpsites have become potential risks of causing waterborne diseases."*

Firstly, different responses were taken from different wards during that include high-density suburbs, medium-density and low-density suburbs. The highest response rate came from Marlborough, a low-density suburb because people living in these areas are capable to afford the internet, have better living

conditions and have better income levels. The lowest average response rate came from low-income levels such as Dzivarasekwa and Mbare.

Strategies used for waste management

The notion of the 3Rs has turned out to be the back of the study and Eco-friendly education consciousness was also recognized as a SWM strategy accepted by the COH. 'WASTE IS MONEY'is a concept used in the gathering, sorting, carriage and disposal of solid waste because not all refuse is refuse since some can be recycled or changed from its original use into other useful purposes. The COH and EMA have the mandate to conduct structured occasional outreach programmes to promote community awareness on waste management.

Solid waste should be managed through a number of activities—waste prevention, recycling, composting, controlled burning, or land filling. Using a combination of these activities together in a way that best protects your community and the local environment is referred to as integrated solid waste management (ISWM). An ISWM program can help reduce greenhouse gas emissions and slow the effects of climate change". (www.epa.gov/osw).

According to (Saungweme, 2012), the waste build-up in open spaces and roadsides is indicative to the miscarriage of service delivery by local authorities. Similarly, (Mafume, Zendera, Mutetwa, & Musimbo, 2016) postulates that, in many Less Economically Developed Countries (LEDCs) in the SADC region, there is a mismatch in revenue collection in comparison to population growth thereby frustrating municipal solid waste management. The rate of escalating unofficial settlements across the length and breadth of the COH is reflective of the Council's failure to plan and appropriately manage solid waste at domestic level, (Chinobva & Makarati, 2011).

Conclusions and implications of the study

The study conclude that Management of Solid Waste (MSW) has continuously stood out as the foremost problematic issue for Harare Metropolitan city. The amount of solid waste created in the city is higher compared to the COH's capacity to contain the impasse primarily because of limited technical, financial and human resources that are required to parallel and control this challenge. While MSW is one of the most pressing negative occurrences for the City of Harare (COH), it is not a new phenomenon. The study further conclude that solid waste should be managed through a number of activities—waste prevention, recycling, composting, controlled burning, or land filling. In addition, the study concluded that governance positively influence SWM practices in COH.

Therefore citizens should be educated about local environmental quality and the effect of existing environmental management practices in view of sustainable and responsible innovative ways of solid waste management.

The mechanism for raising awareness should be through school curriculum, training programs for target groups such as employees of solid waste sector, school teachers, health workers, children, media and public campaigns. It is recommended that future studies focus on other management strategies on different types of wastes. In addition, future studies could focus on developing models to enhance solid waste management strategies.

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